

CHAPTER 1

The neo solar system

The Exodus Path, My Struggle.

Although I really did find a way to power the rockets to take hundreds of us throughout the solar system, the only product of my entire career struggle working in so-called "rocket science," was that people wanted to hear the story.

As the "Featured Evening Speaker", again and again, they would keep me long after I was finished talking, asking me questions. What was so captivating? Was it the stories about how we can actually leave the Earth? Or was it just that I was telling them stories and entertaining them? Or was it my struggle against the real world and reality? I can't tell, so I am telling the story

The struggle to make a Vision come alive, a kind of Exodus Path to Leave Earth, became intense, compelling, overpowering, and took on a single purpose at the moment when I first found out there was water in space. I knew immediately I could use it.

At the end of that career, after I "retired" and started another, I had discovered comparatively simple ways to do it:

- to use the water objects and ice comets in neospace as gas stations,
- to use nuclear-heated steam rockets to move us, to travel the solar system,
- maybe to live on ice moons of the Sun System,
- maybe to use giant, ice-igloo, hollow wheels as space ships,
- to move killer asteroids and comets out of the way without atomic bombs.

We would inhabit, occupy, move minor planets and other celestial objects.

After all the effort, all the Visions, I got old instead of making it happen.

This is no science lesson. This autobiographic story describes my struggle, about US government laboratories where I worked, about how I found, and how I tried to tell but was too autistic to tell effectively. I have Asperger's syndrome. And then I got too old, too soon.

I had become excited because everything we would need to inhabit the "neospace", the places between here and the edge of the Solar System, had just become known. Some was already there and telescopes and space probes just revealed it. Some was just developed because of the failed efforts to develop manned Mars missions.

This is *not* sci-fi. The names are real and the stories happened.

Nature seduced me with the excitement. She let my colleagues and me discover water objects in the space near Earth, in "neospace", the space almost near enough for us to get to and use, between here

and Jupiter, Saturn.

Water in space turned out to be *everywhere*, from the planet Mercury in its the forever dark craters, in the moon, and in mostly everything to way past at least Pluto,

Long ago, when people landed on the moon and when Star Trek inspired us, we thought we could just go there, to space, to the moon, to other planets like Mars or Mercury. But at every turn, we discovered another bad thing to stop us.

We did not find what we needed to live, like water. Our rocket ships were too feeble, too huge, too expensive, and blew up too often. Low gravity in space would float poop, snot and vomit in the air, stinking up the ship and forcing us to breathe it. Low gravity drained our bones of calcium and disabled our lymph system. Space was more radioactive than sitting on pile of old fallout from an atomic bomb. Mars had a little bit of a poison, carbon monoxide, in its carbon dioxide air. Mars would be a poison planet.

So, we gave up. No one even went back to the moon.

Mother Nature only tricked me a little, but she did it again and again. A new problem would suddenly appear just when an old problem was solved.

Mother Nature fooled me. She showed me how it seems there is enough water for us to start leaving Earth. She teased me to think we could be explorers who could inhabit what we explore.

But, she knew I won't get to go there. I am old already. And the world went broke.

More annoying: Mama Nature told us clearly that we were the wrong species for space and she would not let us have the "clear profit" we would need to start The Exodus. She seemed to point to her bulging stomach, pregnant with the new species, her digi-sapiens children, cyborgs, robots, androids.

It's about the water

More than anything, we needed to have water in space. Every time we looked, we would not see any water.

We simply could not afford to launch the Gulf of Mexico into space. We could not even launch a small fishing lake into space. But that was what we needed. Everything we do to live our lives requires not just water but a lot of it.

We needed Warp Drive. Instead, all we got were feeble toys, little rockets that could barely shove a porta-potty space-can to the moon and back.

We needed strong legs and powerful wings, so to speak. Instead, we were oozing and sliming like snails and clams. Our space ships needed to be more like ocean cruise ships and aircraft carriers, not like NASA's space jails.

Everything in space was mostly too far apart. Whatever rocks, moons or planets were there, were so far apart that a very short trip, like to the Moon, would take many days, not hours like an airplane trip. A quick trip to Mars would take 6 months or longer. A trip to Jupiter or Saturn would take years.

I thought the 14 hour plane trip to Australia was a very long ride, in a cramped seat, rubber cardboard food, kids running up and down the aisle, engine noise, white knuckle fear of flying.

Most places in neospace seemed to be barren rock-deserts, harder than sidewalks and as dry as a fireplace.

Autistic, Like Mongoloids and other Weird People

I was also recently diagnosed to be born with a common and peculiar form of autism: Asperger's syndrome. My genetic breed of human focuses hyper-intensely and takes people literally. We are sometimes called "Aspies".

Most of us Aspies are a bit like Spock, of Start Trek. It makes us a bit difficult to work with or understand. Often we blurt out what's on our mind and interrupt you. We often act inappropriately when we do and say things.

Some Aspies can not look you in the eye. Not me. I stare, deep. I will hit on pretty ladies and stare deep into their eyes every chance I get. I only do that if their person is totally captivating, and not necessarily for neurotypical reasons.

One of my psychologists said he never met an Aspie with less than 130 IQ. This weird combination of inappropriate behavior, smarts and focus makes me and Aspies like me sometimes hard to follow. More than sometimes. In that aspect, we are like those with Downs

The other places seemed to be giant oceans with no surface, just gas, poison gas, that got thicker and thicker and thicker, and with hyper-hurricanes the size of the world, and lightning everywhere. That's Jupiter, Saturn and such.

Nothing seemed to work. We would be stuck here with the terrorists and tax collectors, forever. Instead of space travel, we would be stuck here with the Liberals fighting Creationists, all fighting beheaders and rogue atomic bombers, with high unemployment, inflation, a Carbon Usage Tax, and Global Warming.

And it was all about the water.

I should have quit, but it was too exciting.

I don't know of anyone who put it all together. That is why I am telling my part of the story. I put it all together.

syndrome, or Tourette's syndrome, or with other types of autism that favor intelligence. Mongoloids (Down's people) can sometimes figure big prime numbers in their heads. I can't to that.

I will sometimes go too fast. I will sometimes say things that are simply not supposed to be said that way. Because I am an Aspie, I can't see what's wrong with doing these things at all. If I went too fast or confused you, tell me and I will try to fix it. Maybe not.

If I use inappropriate language or say things that are too graphic and just not proper in mixed company, or that are insulting or too mean,
too bad.

I'm an Aspie.

You are supposed to treat me nice, like we treat mongoloids and other weird people.

CHAPTER 2

- 1968 physics grad student and Dyson Starship

Someone Inspired Me Physics Graduate Student, Anxious for Escape

The rocket science part of my career was a like a fanciful journey by someone too naive to know the difference. I started on this journey when I was a graduate student in physics and read the words in a physics trade journal:

".... take a town the size Princeton New Jersey to the nearest star cattle and livestock"

The article described a starship propelled by nuclear explosions, atomic bombs.



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Nuclear explosions would power Dyson's "Orion Starship"

When we discovered and detonated the atomic bomb, it unleashed a powerful Virus Of Change upon the world. It infected us with visions of really leaving the planet, and not just as ghosts. For the first time, we could see how we could someday inhabit space. The energy released was extreme.

How could we use this? Could we make cars that never need gas? All cars need gasoline. Could we make airplanes that just keep flying and never need to refuel? Could we heat our homes without ever needing to chop wood or shovel coal into the stoves?

When I heard of the atomic bombs, I was little, 7 years old, and had to shovel heavy coal into buckets and carry them in. My father had to lift the heavy buckets and dump the coal into the mouth of the pot belly stove in the dining room. Could I use nuclear heat to escape this? Even at 7 yrs old, I thought of it personally, as in "Could I use...".

The world was locked in a Cold War and the United States was fighting a real war in Vietnam. At the same time, the USA was preparing to send people to the moon. These were confusing times and depressing times.

Could we use the atomic bomb energy to make rockets? The Germans used rockets to send bombs to England during World War II, to kill civilians, on purpose. Both the Russians and the Americans were making rockets that would kill all the civilians in the whole city all at once, on purpose.

If we would use the nuclear energy to power the rockets, could we go to Mars or Venus, instead? Flash Gordon went to Mars in the movies.

It had been a dismal time, a dark and stormy time, a confusing

time. Blacks were Negroes and had to sit in the back of the bus. People shot the Kennedy's and Martin Luther King. The Democratic Parties of Chicago and Kent State beat us up and killed us because we did not want to go to Viet Nam to kill Vietnamese for them.

And there I was in Cleveland, Ohio, back in the fall of 1968, a graduate student studying solid state physics, nothing at all related to space. I was stuck doing a worthless Ph.D. thesis on "magnetic thin films".

I saw how Physicists with Ph.D.'s were pumping gas and selling shoes instead of getting jobs. Meanwhile the Electrical Engineer PhDs were getting multiple job offers. Not one single professor told me "thin films" were something of extreme value in Silicon Valley.

I was stupid. I had chosen to study Physics in Graduate school, instead of Engineering.

No one had taken close up pictures of anything in space other than the moon. In sharp contrast, the article in the trade journal told us how to propel a rocket ship with people and livestock to the nearest star. The article shocked me.

In those days, most people somewhat expected that kind of shock. The world had just discovered

atomic bombs and nuclear power, and transistors, and color TV, and jet airplanes, and penicillin, and cars, and radio, and plastics, and DNA, and computers, and rockets,

all in one breath,

all within about 40 years,

all within half a lifetime.

It was a shock hurricane of knowledge.

The nuclear devices were extremely powerful compared to anything. The nukes were at least 10 million times more powerful than anything our Life Form had ever seen. It was about 10 million times more powerful than chemicals such as high explosive, food or gasoline. Not a 1000 million, not a zillion, but about 10 million. The nuclear energy made it possible to think about space travel. This was the first realistic proposal on how to do it. It captivated me.

This was the start for me, 40 years ago. Was it Fanciful? Of course. But I was a graduate student. What did you expect? That's what you get when you are a student or a professor. When you are young and a graduate student, anything is possible, even the impossible.

I did not know it was fanciful. "Fanciful" can mean having a curiously intricate quality, or it can also mean unreal, not based on fact. This one, single, fanciful article inspired me to spend an entire career trying to make and power the space ships for us to inhabit outer space.

The starship powered by nuclear explosions was credible because a famous, very respected scientist showed how to do it. The scientist, Dr. Freeman Dyson, showed how to propel a space ship with people on board that could travel far beyond the solar system, and even to the nearest star.

When I first picked up the article I was walking to the physics lab in which I was an instructor. It was October 1968. There was only time for a few fleeting glances at the tempting pages. All I could skim was that Dr. Freeman Dyson, the physicist author, had detailed his proposal to use atomic bombs to propel a very large space ship to the nearest star, and, at a Flash Gordon speed of up to 1% the speed of light. We did have Star Trek then, so Dyson's ship was just Flash Gordon speed, extremely fast for us, but sci-fi slow.

Quickly skim-reading the article in quick glimpses the whole afternoon, I saw how Dyson would propel his space ship by pounding the back of it with atomic bombs. One huge bomb would explode about a mile behind the huge space ship, one bomb every 3 seconds. The atomic blast would pound a bomb-blast-catcher into shock absorbers and springs. The shock absorbers and springs would cushion the blast and accelerate the huge space ship.

Dyson's description was so simple, it seemed to me we could just go make it tomorrow, if we wanted to.

INTERSTELLAR TRANSPORT

Two space-ship designs show that nuclear-bomb detonations could take over from chemical propulsion as an energy source for long-range space travel. If our economic growth continues at its present rate, interstellar voyages with ships like these could begin in about 200 years' time.

FREEMAN J. DYSON

THE OCEAN PROJECT, with which I was involved about 10 years ago, aimed to build space ships powered by nuclear explosions. We began work on Okeanos after the Russian Sputnik went up and before the US was committed to a big space program with chemical propulsion. We felt then that there was a reasonable chance that the US could jump directly into nuclear propulsion and avoid building enormous chemical rockets like Saturn V. Our plan was to send ships to Mars and Venus by 1968, at a cost that would have been only a fraction of what is now spent on the Apollo program. We never got the green light; so nobody can be sure if our schemes were sound. I am not against the Apollo program; I much prefer it to no program at all. Still, I believe that fundamentally a Saturn V bears the same relation to an Okeanos ship as the majestic airships of the 1930's bear to the Boeing 707. The airships were huge, finny, with a payload absurdly small in comparison to their size, just like the Apollo ships.

Chemical and nuclear propulsion
Chemically propelled ships are inefficient for journeys to the moon, and

are practically incapable of making round trips to the planets, because of their staging problem. A chemical propulsion system has an exhaust velocity of about 3 km/sec, which means that about a stage is needed in a ship designed for velocity increments of 30 km/sec. Each stage represents a factor of about 4 in the total weight. So the mass ratio

$$R = \frac{\text{take-off weight}}{\text{final weight}}$$

is given approximately by

$$R = 4^n = 47^n$$

for a chemically propelled ship, where V is the total velocity change required in km/sec. Roughly we have

$$\text{for low earth orbit } n = 2, R = 16$$

$$\text{for high earth orbit } n = 3, R = 64$$

$$\text{for soft landing on moon } n = 4, R = 256$$

$$\text{for landing on moon and return } n = 5, R = 1024$$

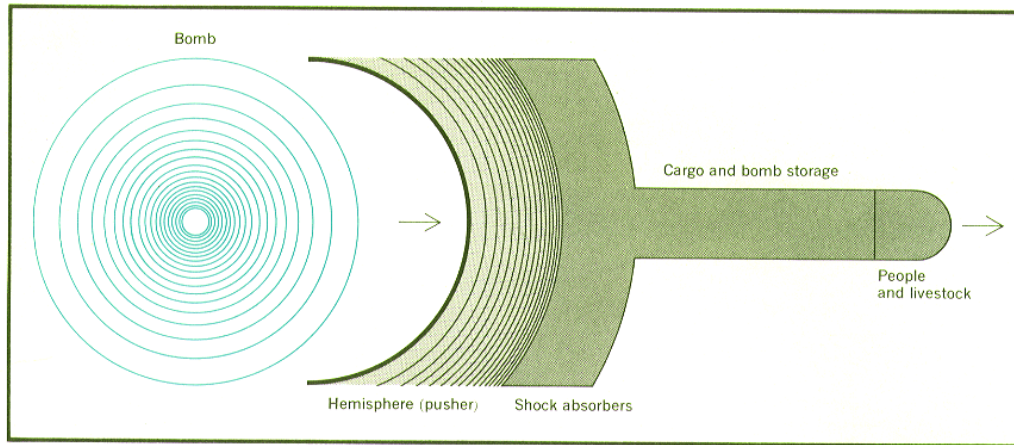
These numbers show that chemical propulsion is not bad for pattering around near the earth, but it is very

uneconomic for anything beyond that.

The basic virtue of an Okeanos ship is that it has only one stage, with a mass ratio well under 10 for long trips around the solar system. It can be built small and rugged, and it is comparatively cheap. It avoids big mass ratios because the effective exhaust velocity of the debris from a nuclear explosion is hundreds or thou-



Freeman J. Dyson came to the US from England in 1947, with a BA from Cambridge, as a graduate student at Cornell. He became a professor there in 1951 and joined the Institute for Advanced Study at Princeton in 1953. He was elected a Fellow of the Royal Society in 1952. Still at the Institute, his interests have changed from pure mathematics through particle physics to astrophysics.



BOMB-PROPELLED SPACE SHIP. Debris from the exploding bombs transfers momentum to the shock absorbers and hence to the payload section of the ship. Mission velocities for this primitive design would be 500–10 000 km/sec; the upper limit is similar to supernova-debris velocities.

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copied directly from : Physics Today, October 1968

**Freeman Dyson would propel the spaceship to the nearest star
by pounding it with repeating atomic bombs. It was atomic bomb blast propulsion.**

Most scientists familiar with the proposal thought it was a bit impractical. Most engineers thought it would not have worked like he said. Dyson was a physicist, not an engineer. A physicist figures out the principle of things. An engineer makes things work.

There was a joke:

If it stinks, it's Chem Lab.

If it's green and slimy it's Biology Lab.

If it doesn't work, it's Physics Lab.

If you ever tried to do what someone else said was easy and that you should go do it, then you know. You know it was always much easier said than done. Any engineer would tell you how difficult it would be to make Dyson's starship. But, I was a student then and did not know what the "big kids" did.

I do remember this epochal event, that day I got the article, because it really was epochal, for me. It changed everything. Like when someone shot Martin Luther King. I remember where I was, watching the 14 inch round screen color TV in our apartment just before supper. Devastating.

It tattooed my brain cells like when Jack Kennedy was shot. I remember what boards I was walking across to keep my feet dry between the construction site mud-mess on the university campus. Or when the first Shuttle blew up. Or when Princess Dianna died.

This Dyson Starship day is a slowly fading brand in my memory.

In those days, using atomic bombs was ok. The Communists were the terrorists then, with real atomic bombs really pointed at every city in the USA, for real. They built an Iron Curtain and they shot people.

Physicists, like some of my professors, invented good atomic bombs, because God was on our side and gave us the bomb first and let us stop World War II with them. Ours were good. Theirs were evil. The Commies were Atheists. That made the Commies bad in the USA, Cleveland and Texas. But, my professors did not talk about it much because it was all Top Secret.

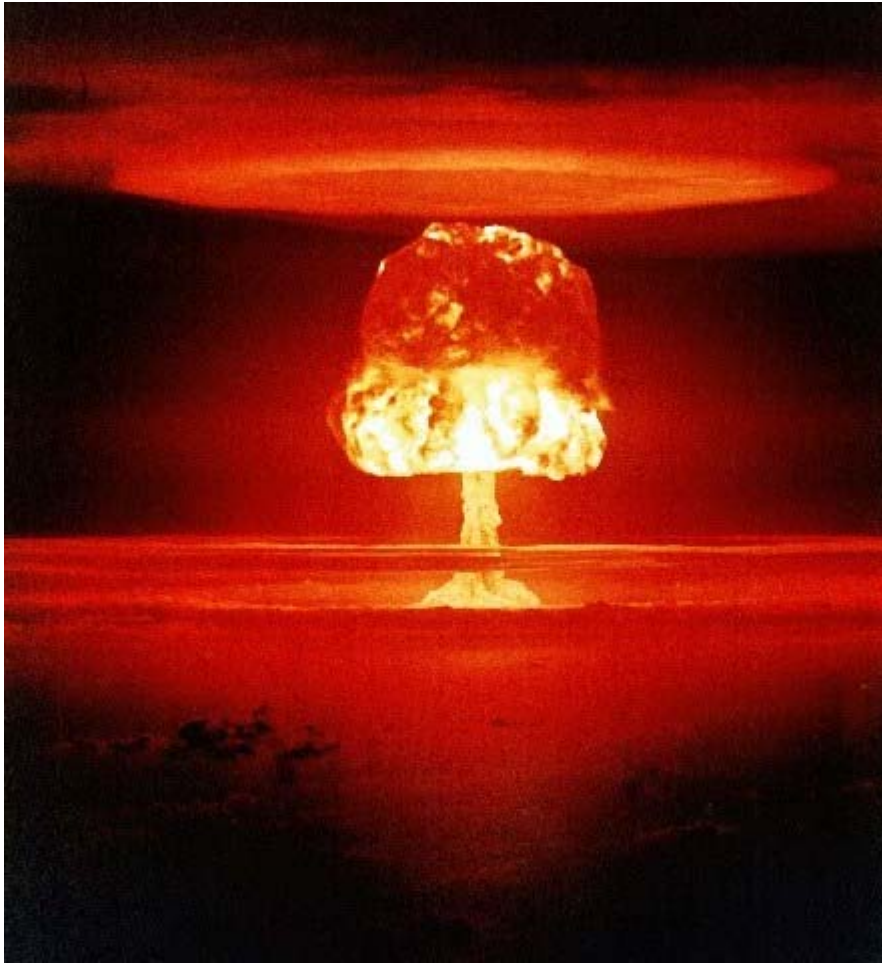


USA atomic bomb

I knew what atomic bombs looked like. Pictures were everywhere.



The communists were going to bomb us with them unless we made our atomic bombs bigger and better than theirs.



atomic bomb

I was ready for escape. We were all ready for escape. Just like now.

I had wanted to find a way to leave the planet from the moment I read the article on Interstellar Transport.

The Interstellar Transport article seemed to be real.

Later that evening I read more. Dyson was presenting calculations. I read how Dyson really did write how he learned from the secret, atomic bomb tests how to make a starship that could go to the

nearest star. What especially caught my eye were the words in his simple figure: "... people and livestock ..."

I read the trip would apparently only take hundreds of years.

"What?" I thought.

The "hundreds of years" was nuts. But I ignored that part.

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Credits: Charlou Dolan prompted me as a co-author to write an early version, coaching me carefully on how to write like a neurotypical and not like an Aspie. Neither of us knew "Aspie" at that time. This version is considerably different. Her influence persists.

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other interesting chapters/sections recently more refined:

[Cheek on a Megaton Bomb](#)

[Make no long term plans](#)

[Emory's Atomic bomb stories](#)

[Vomit in the Space Ship](#)
[NASA meeting on space and asteroids](#)
[First International Meeting On Killer Asteroids](#)
[The ice would burn](#)
[Bloody Fingernails in Space](#)
[seriously crazy rocket science meeting](#)
[Space Gas Stations Everywhere](#)
[Hazard meeting with Carl Sagan](#)
[Survival Of The Lucky](#)
[Clear Cutting the Kuiper Belt Comets](#)
[space aliens 10 miles under ...](#)
[Meteor Bomb UFO's](#)
[The Iceship And The NASA Space Meeting](#)
[To Inhabit the Solar System](#)

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CHAPTER 3

First Job at the AEC, and the Dyson Starship

When I finally got my Ph.D., Physics doctor degree, I deliberately got a job working for the United States Atomic Energy Commission (AEC). I did that because I wanted to know how to make a starship just like the one Dr. Freeman Dyson described. Also, they were the only ones hiring.

The Dyson Starship would use megaton atomic bombs to propel it. The AEC made just such atomic bombs.

My boss's boss's boss, who hired me, at the AEC laboratory also knew about the Dyson Starship and also wondered how to make one. His name was Dr. Tom Burford. Burford and I talked about it. As soon as I started work, he got me access to the Top Secret documents associated with the work of Freeman Dyson.

In those days the agency was called the AEC. It is now called "Department of Energy.", the DOE. Some parts of the DOE are another space agency of the United States. There are at least several, not so well known space agencies of the United States. NASA is not the only one. NASA is the adventure one. They do somersaults in space bubble, plant flags and brag. The other ones have to do real work.

You don't like my exaggeration? Too bad. I'm an Aspie.

It seems that most people who don't know me or what I did tell me the only real work NASA does is the deep space science

observations. Most people love the Hubble pictures. They really love the robots on Mars. They despise the zero gravity somersault antics and extremely expensive joy rides. The first time I heard such heresy was on a plane to Seattle for a rocket science meeting. The high paid computer geek young guy sitting next to me loved the robots on Mars. He hated the entire manned program. He shocked me. I did not tell him my job was to develop engines for a manned Mars mission.

One always has a "day job" that you do to get money. One also has a fantasy, a hobby daydream you think about all the time. It's the daydreams that make magic happen. And that is what happened. However, it took a while and was mostly disappointing the entire time. I never got rich either. And I got fired a couple of times. Aspies just have a hard time with social situations, like a boss.

Back in the early 1970's, my first job with the AEC was to analyze beam weapons, like "phasor beams", to shoot atomic bomb-tipped missiles out of the sky. My second job was to work on spy satellites to catch other nations testing or shooting atomic bombs. As a side project, I had quickly maneuvered for one of my first projects to use a kind of Dyson starship propulsion.

My incidental job also included finding ways to get and use energy, such as solar power, fuel cells, geothermal things. That is a totally different story. That one was more profitable.

- **Beam Weapons ... Laser and the Lesson**

Laser Beams and Phasor Banks

The beam weapons were a daydream fantasy that many of us had, because the scientists had just perfected lasers and the engineers had just built large subatomic particle accelerators. Both of them appeared to have what you need to make a phasor beam.

"Phasors" were Star Trek language, of course. All the younger scientists and engineers watched Star Trek, even though it was somewhat trite and childish and the acting was bad. We loved it. I related to Spock immediately.

We referred to our work as "directed energy weapons" when we were giving official presentations.

The laser beam weapon started out to be fun, but quickly disappointed me. My boss's boss's boss arranged for me to get a briefing by a Major Axelman regarding a laser phasor beam that would shoot down a fighter jet. That would be really neat. As it turned out, the laser was mounted inside a building as big as 3 houses on a little hilltop in the desert. The little hill was about 2 miles from the side of a small mountain.

Already it was not sounding good. Phasors were little things Captain Kirk and Spock and I could carry with us in our pockets when we land on some alien planet. Something as big as 3 houses would not even fit on an airplane.

Major Axelman said he would put on a face guard helmet and fly the fighter jet between the little hilltop and the small mountain. They would put a target on his airplane and the laser would try to shoot at him.

"What?" I thought, "This guy is nuts."

After they described the laser a bit more, it was clear this would not be a very good phasor beam. The laser was powered by some chemicals. But the chemicals were deadly poison. The laser was only a small prototype and would only heat up the target, not vaporize it, not melt it immediately, not even knock it down. And the engineering details would show that it would not be so easy at all. It was easier said than done.

The laser beam also had to be aimed and focused on the target. My boss's boss paid for a trip for me to see the aiming telescope. At first it was captivating.

We were in one room, watching through a big window. The workers were in the other room on the other side of the big window, working with the telescope and doing things that looked important. It was a backwards telescope. Instead of looking into the eyepiece, they would shoot the laser beam into the eyepiece. That was clever. The beam came out of the big part of the telescope. Then whatever was at the end of the beam should be vaporized.

The engineers had designed a telescope that would swivel and point fast enough to track a fast fighter jet flying by. The telescope would focus the laser on the fighter jet, and then melt a small, one foot diameter spot on the jet.

"Melt?" I thought, "That's all it will do is melt a small hole?"

This was disappointing. Unfortunately, the laser would never be able to do much more than that, melt the skin of the airplane. And worse yet, during my career, the laser would never be as powerful as the competition.

The competition was just simple, small rockets using real, physical high explosives. Even a terrorist could fire one from his shoulder. That was the competition, some rag head with a Stinger missile.

It was fundamental science that stopped it. My boss's boss's colleague, a laser scientist named Dr. Garth Gobel pointed out that a simple, 1 pound of high explosive would deliver 2.2 million joules of energy in about 5 thousandths of a second to a 3 inch diameter spot on the airplane, *and blow an airplane to bits*.

Blow it to bits, Vaporize It. That's what we wanted.

The laser power was too small, by comparison. Even 20 years later, the laser would not even be able to deliver 1 million joules. That would be just the energy of less than half of a pound of high explosive. And the laser would take one second to do so, which would be about 200 times slower than the explosive.

In other words, *"no blowing anything to bits."*

The laser would be as heavy as the heaviest bomb the airplane could ever deliver. The laser was as heavy as a small airplane, was half as energetic and 200 times weaker than a small rocket fired from a fighter jet, or from one of Osama's buddies.

It was even worse than that. The laser beam had to be focused and aimed by something, an aiming telescope. But the laser was not supposed to blow up that aiming telescope. The telescope would be made of some magical something.

Spock would say that was illogical, hard to figure. If they could find that magical something that a laser won't blow up, then the bad guys could coat their airplane with that same magical something and not be blown up. This was quite illogical.

And there was more bad news. The laser beam also had to go through the air between the laser and the airplane, and not blow up the air. If the laser was powerful enough to blow up airplane skin, then it would also blow up the air in between. The air would flash

and !bam! like lightning, and would sap and drain laser energy.
There did not seem to be any way around it. It just was not working out.

This first phasor beam fantasy was down the drain, for me

Weaponization of Nuclear Explosives

----- Tom Burford and the Orion Documents -----

Our mission: make weapons out of nuclear explosives.

Sandia gave everyone I knew who worked here least one safe certified to hold atomic secrets. Like every new hire, I got to choose what kind of safe I wanted when I got my dictionary, ruler and scissors. I picked two secret safes, a big, cabinet-style metal document safe and a little cabinet safe. You had to buy your own slide rule.

The small safe was like a two drawer file cabinet, but with 2 inch steel sides, front, top and bottom, and a big, 4 inch combination lock wheel, with a handle thing to open it. It made me feel important.

The big safe was just a metal file cabinet with metal doors. Two metal bars and a pair of fat, 2 pound, combination locks kept the metal file doors from opening. This safe was taller than me and wider than a big refrigerator, but only one document deep.

I fully expected to have both safes filled to bursting with Atomic Bomb secrets very soon. Then I could make a Starship.

It was the politics protocol I didn't follow, and was too naive to realize it.

The obvious protocol was that one does not just go visit with the boss's boss's boss. One is not supposed to go over each of the in-between guy's heads.

Rather instantly, in the first few days Dr. Tom Burford, the boss's boss's boss, and I started talking. He was the only one in the chain of command who thought about things, strategically, philosophically.

The other guys just didn't know that much, I thought. They didn't act like they were driven by any vision or strategy. So I intellectually ignored them.

Burford and I were standing and looking out his second floor, north facing office windows at the Sandia mountains to the east. Burford was a "Director" working for a Vice President, so he got a 25 foot long run of window, stretching the entire length of his office.

Because he came from Bell Labs, the famous AT&T Bell Labs where transistors were invented and where people won Nobel Prizes often, and because he did some really important work with U.S. Navy underwater acoustics, his long window also faced the best view.

Whenever I visited him, which was many times a week, we both could not resist stopping a second or two to look out those windows.

You think Big Thoughts better when you see Big Things, mountains, The Layers of Time in the rock strata.

We could see the February snow outlining the rock layers on both the southern and northern Sandia mountain peaks, and we could see ridges along the 15 mile long desert mountain range rising a mile above the already mile-high floor of Albuquerque, New Mexico. The mountains marked the east boundary of the city.

The cold outside was so desert-dry and clear we could almost see the branches on old, stubborn ancient pinon trees clinging to sheer, 500 foot rock faces 10 miles away at the top of the mountain.

Burford would most often hold his head down a little and to the side, and slightly manipulate his Pall Mall cigarette, mostly without smoking it. Slightly thin, darker hair, black rimmed glasses, and clean shaven, he always wore a pressed darker suit, never looked disheveled and always seemed to be smiling.

"Did anybody ask you yet if they have to get a passport to visit you?" he joked.

Apparently, some people from back east really were that stupid. Some acted like Albuquerque was in Mexico, which is a whole different country starting a few hundred miles south of here.

Burford, the person who made the decision to hire me, seemed to be the only one who had that intense, intellectual curiosity, like the people at the university. The rest of the people I met here were smart enough, but they just seem to plod and do work. They didn't think about things.

He smiled and raised his eyebrows. "You know, you can see the geological layers quite well, with the snow outlining them." he said. "That top layer on South Peak is Late Pleistocene." he

asserted. He knew I liked fossils. He seemed to understand the timelessness and infinity of existence one can see in the fossils.

Actually, I suspected he was planning a neat field trip to that prehistoric-human cave on the other side of the mountain, with a parking area just off the road and 500 feet from the cave entrance. This was a cave that we could actually crawl into, legally. The pollen in the dust on the cave floor and the fire pit way deep inside had enough layers to be dated to something like 14,000 years ago. That was pre-historic man, long before the Indians.

The tip of South peak exposed a 500,000 year record in the Late Pleistocene rock layers.

"Humans were just learning to make good spears and fire pits when that layer was laid down." he said.

Our silent, 1 second stares at the mountain clearly expressed our deep, thoughts. At least I thought they were deep. I was thinking about Starships and 1000 year trips in space.

He was probably thinking he could not get his Mercedes Benz close enough to the South Peak to walk to the peak in a half hour on a Sunday afternoon. There was no road to South Peak like there was to North Peak.

It was a nice break, with the timelessness of the layers of rock in the formation on the mountain, like tree rings capturing 500,000 years of time.

We were supposed to be making weapons of mass destruction. Instead, we were watching snow fall on a mountainside, and talking about fossils. Feeling guilty, we always got back to work pretty fast. Work was mostly exciting.

This laboratory weaponized nuclear explosives. We took the nuclear explosives the Los Alamos scientists invented and made weapons out of them.

"What do you think we can do with a nuclear explosive?" he asked, posing the general concept of trying to figure out how to do something really AT&T-like, Nobel-prize like.

He stared out his window again, holding that cigarette, with the fire end pointed away from him and like he was about to flick the ash off.

"Did you ever hear of the Orion Program? The Atomic bomb powered starship?" I asked.

It was an outlandish question, quite a bit out of the blue, and completely unrelated to ballistic missiles or weapon effects.

I fully expected he would just not care, and that he would know nothing of the program at all. But I had to try.

"Oh yes, quite impressive. You heard about that, eh?" he replied, smiling, grinning almost.

"What?" shouted a loud surprised voice in my head, receiving an instant reward for asking a bold, outlandish question.

"You did?" I answered. This is the first time I met anyone in two years who even heard of it.

"It was really quite impressive. They actually did some experiments to find out how it could work, with high explosives. It was kind of cute how the tiny rocket actually worked." he explained.

"Really," I responded, my neuron circuits jammed, not knowing which of many questions to ask next. He started talking about Dyson's Orion Starship all on his own. I did not have to prod him or coach him about it.

Burford continued, motioning with steady and very mildly graphic, Italian-like gestures how the rapid fire explosives pushed the rocket. I never heard of this before.

Explosives??

His gestures and mannerisms were the opposite of emotional. My gestures and mannerisms were typically the opposite of his.

As Burford was telling me about the "Orion Test" I realized that instead of real atomic bombs at the real Nevada Test Site, with a real fireball hitting a real atomic bomb catcher, he was talking about a toy rocket loaded with sticks of dynamite.

Instant disappointment.

I thought he was going to tell me they fired some real atomic bombs at a real atomic bomb catcher. But he didn't. All he described were just non-nuclear tests, with high explosives.

All I could think of while he was talking was "bunch of boys shooting firecrackers under tin cans." Their excuse to waste the money was that they were demonstrating that you could blow up a bunch of bombs behind a rocket and push it.

! Dumb. Stupid !

He was describing some kind of engineering effort, but I was seeing a cartoon story. Every word he said created another picture. A small, toy rocket, a basket of hand grenades, sticks of dynamite. First dynamite stick blasts it into the sky. Whacks the toy rocket into the air, like it was hit with a hypersonic baseball bat.

Rocket flies off in some direction; like a fly ball; not like a rocket that goes in a well defined direction, but just somewhere. "Rocket" disappears. Just like I would expect something to be if it were on

top of a stick of dynamite. Split second just after the first stick: the second stick goes off. Whacks the rocket in some other random, wild direction.

Then they all sit around a dark room playing a movie where we see the toy rocket disappear, and they all clap.

What a disappointment. All I could feel was:

Not impressive at all.

What horribly un-visionary experiments.

But Tom Burford calmly and casually kept on talking, "General Atomics did it. You can get the Secret documents from the Classified library."

"Are they about nuclear things?" I asked, meaning "are they about atomic bombs, or just dynamite firecrackers," and anticipated he would say "No," meaning "just firecrackers."

I already knew I would go away disappointed and would drop the topic forever. He had just destroyed my Vision of Dyson's Orion Starship.

"Oh yes," he replied.

??What??

"You can go over to that double story building, attached to the library, and get the documents from the Classified library," he said, looking out his window and pointing to the small building across the sidewalk and main road between the buildings. "You can look them over in your office."

He made it very clear: he was telling me that I should definitely go right now and get the classified documents and definitely read about it.

Not only did he know about the Orion program, he knew where to get the nuclear, secret part of the story. He understood.

This was completely unexpected.

He knew very well that our Sandia Lab could implement the atomic bomb propulsion if we needed to. He could decide to make something of it if he wanted.

"You think we could find a way to use it? um?" he smiled as he posed his question like a comment.

I was elated. I thought how wonderful it was that he did not pontificate or mandate that we do it, like some arrogant, aggressive boss. Instead, he commented it, softly. He often ended his sentences with a combination "um?" phrase, a light chuckle and a smile.

Wow.

He just told me to go learn about Dyson's Orion Starship. I knew I had gone to work at the right place.

I walked around his dark wood conference table.

"You know, the Orion really could take us to the nearest star. It's amazing. We actually did put someone on the moon." I emoted, like a wide eyed graduate student, almost stuttering.

"I didn't really think we would be able to do it." I blurted again, meaning "go to the moon."

He smiled and replied "Yeah, it is pretty amazing. Exciting."

As I walked out of his office I almost talked to myself embarrassingly aloud. "I can and I will just march across the street and get super secret Orion Starship documents."

I thought this almost audibly, moving my lips. I almost forgot to say "bye" to Helen, his secretary. I always acknowledged her.

"Burford will tell them to give them to me," I almost audibly said again, almost aloud talking to myself some more, perseverating and staring at the sidewalk, walking with a side to side wagging of my head in step with my gait, unaware of anyone around me, as I headed straight for the library.

I really was just a young kid. Bright, but quite Aspie.

Classified Library

The classified library was just a bunch of memos and documents in a big, two floor room. I expected a "LIBRARY," with mysterious books. I expected high-secret protocol, with a deep underground chamber, protected from atomic bomb blasts and bad guys. I expected something intimidating, with serious credential checking and military uniforms.

I imagined how I would very importantly tell them "Burford told me to get these documents." And then they would obediently and very reverently go get them.

Instead, I walked into a brightly lit room about the size of two gasoline station garages, and just as spacious. The metal second

floor was clearly visible from the metal first floor, and all I saw was rows of metal bookshelves.

Some of the metal was painted that light creamy color and not that poo green or military gray, so it looked somewhat like office space and not a garage or a military depot. That was the positive feature. This was a very bright room.

Not many books. Just documents. All kinds of documents. There were about 6 female helpers who knew where all the documents were and how to find out if I had access to them.

This place was not a library at all. It was a storage room for all kinds of studies plain old regular people wrote.

I found it quite simple to get the documents on the classified version of the Orion Starship. The intelligent females helped. They even knew I had the right access without asking me.

The one nice thing about the classified library I really liked was that I didn't have to carry the classified documents myself. They

carried them for me. Special couriers delivered whatever secret documents anyone wanted to the important person's office.

The couriers transported the documents in a special, metal, classified courier cart from wherever to wherever, inside the guarded area. The couriers checked to make sure the document-taker had the correct secret access. They would not give up the documents until whoever took them personally signed that they took them out of their hands.

All I had to do was tell the smart ladies what I wanted, and it would be delivered to my desk.

When I got back from the Classified Library I blabbed and blabbed to Marylee, our 40 year old, smart secretary, about what these documents could mean.

"That's pretty impressive." she remarked, looking directly at me with a bright smile through glasses that made her eyes seem bigger than they were. I liked her from the moment she looked at me on my first interview. You might say I hit on her every chance I got. I could really feel her intense intellectual stimulation.

----- The Orion Documents -----

It seemed like this whole pile of "Secret Restricted Data" documents about the Orion space ship didn't take up more than a foot or so of my metal cabinet safe. I really expected more.

A foot of documents is not very much space in that metal cabinet safe. My safe was mostly empty. A mere foot of documents was not very many for a topic so important.

Once I started talking in the open about Dyson's Orion, another guy appeared and said he heard of it. "In The Open", of course, meant in a secret building and with people having Secret , Restricted Data clearances. What he told me, however, was no secret, according to him.

I forgot his name as he was telling me who he was. He told me there was a secret military program based on the Orion, and they were so serious, he even read about some of the detail on how they would assign a Career Officer, for the people who would be on the space base. ¿ No secret? Ok.

After talking to him, I expected these documents would describe a Permanent Space Station military base, between here and the moon, just like he said.

I was looking for it. I couldn't find it. I looked again. I still couldn't find it or any reference to it or any reference to conversations to it. I looked again the next day. I couldn't find anything interesting at all in these documents.

I skimmed them a few times over, stopping at the pictures and figures. I was confident I didn't miss anything, and puzzled that I just couldn't find the Great Plans for a Great Spaceship Battle Station between the Moon and Earth, like that fellow told me. I couldn't even find a picture or drawing of a big space station or spaceship propelled by bombs. The best I could find was depressingly completely feeble. All I saw were a bunch of detailed, boring things. There were almost no secret things that I would have to forget if I ever left this Secret environment.

I imagined what I would think 30 years from now. Most of this would be too boring to remember. There wasn't anything interesting here to remember.

I was completely disappointed. The most imaginative thing I could find in the documents was a cartoon-like engineer's sketch of a guy sitting in one of two chairs in some kind of roomy cabin. The chair was not even drawn very well. It was just a sketch and nothing like a John Glenn space chair. The driver fellow was shown in a simple sketch drawing to be sitting on the top floor. The two floors below him looked like empty small rooms in the back of a big truck. And the basement was full of barrel shaped containers stacked on top of each other like beer kegs, representing atomic bombs to power the ship.

I was scrutinizing this drawing. It showed a really dinky and clearly horribly inefficient atomic bomb propulsion device. Nothing like what Freeman Dyson drew. In fact, it seemed to be drawn in a truly childlike way. The design seemed to be really dumb, like something one of my fraternity brothers would draw up

in between periods of getting drunk. This design looked like the whole set of secret documents were created by a non-believer, non-interested engineer doing a quick project for some marketer who snookered a dumb government bureaucrat out of some money. It looked like the guy in charge needed somebody, anybody, to do the work. It looked like the designer considered the whole concept to be something that some impractical professors suggested.

Why did the designers make it so inefficient? I calculated a horrible small percent efficiency. Didn't they understand?

¿¿Secret?? Every paragraph in a classified document began with some code for its classification. Unclassified. Confidential. Secret. Something.

Not a single thing I cared about or needed or wanted was marked secret or classified or confidential in any way. Huh???

Burford liked the idea that I wanted to look into it. He liked the concept of creating a technology that would enable people go to the nearest star. Bell Labs expected this kind of "imaginative." Bell Labs' ATT were in charge of this place. Burford was clearly a bit Visionary.

But this document was just plain deficient. I wondered if I really did have all the documents. I visited the classified library again, and a very wide-awake and competent lady re-assured me: this is everything on the topic and everything related to it.

This was not the only disappointment.

The Sandia Lab was an atomic weapon factory. I was definitely sure I did not like it here. Dr. Tom Burford was the only guy in my chain of command who came from Bell Labs. It was quickly clear that Burford was the only one up the entire chain of command who knew anything.

Bell Labs was the place where people earned Nobel Prizes, for inventing things like the transistor. Burford treated me like someone from Bell Labs and expected me to invent things worthy of such a prize. He understood.

And the rest of these guys were just war mongers.

----- Check on A Megaton Bomb -----

Tom Burford asked me "would you like to visit a mountain full of atomic bombs?" He was talking about one of the places where the United States stored some of them. Burford knew that if we wanted to make an Orion Starship propelled by megaton atomic bombs, we ought to at least see what a megaton bomb looked like. He arranged for us to visit an air base where the United States stored some of the old time bombs. This was our job, to work with the bombs and talk to those who deploy them. Since that was an important job, we were given unlimited air fare and travel allowance to visit wherever we need. We were Important.

The location of the old time atomic bomb mountain was close to a city whose name I am not supposed to reveal, confirm or deny. The mountain seemed to be so close to the city that if just one of them would blow up, it would completely wipe it out.

When I asked a person who was pumping gas into our car if he thought there were any atomic bombs in that mountain, he said "Sure, big ones, lots of them."

I thought it was a secret, so I didn't confirm or deny what I had not yet seen.

His face expressions and his comments scared me just like he wanted. I think he could tell I was a young, gullible out-of-towner.

All I could think of on my way to the mountain was what it would be like: first a flash, then being dead. I could not stop pondering how it would be to be living normal lives, walking around, talking to someone, and then

--- suddenly without warning

--- Nothing, Vaporized, Dead. Totally Gone.

No commotion, no screaming, no moment of terror, just suddenly becoming white hot vapor. These were megaton bombs we were talking about.

We went to the air base in suits, and we were greeted by layers of full-uniform U.S. Air Force officers checking to be sure who we were.

I expected careful protocol, and they complied. Confidential teenagers with machine guns surrounded us, everywhere. I don't know if they were teenagers, but they looked like it and were certainly younger than me, and they were all seriously armed and in their full battle fatigues.

We also had to go through layers of guards and multiple, clearly marked, clearly scary electric fences in a somewhat desert area where if we looked carefully we could see mountain tops 100 miles away all along the horizon. We finally arrived at the entrance of one of the mountains. We passed the final identification test, and the armed teenagers let us inside the tunnel entrance.

Now more teenagers with machine guns and more officers with important looks on their faces escorted us. Inside the mountain we went through several more gates and secret doors. Deep inside we finally got to a rather poorly lit room with a low ceiling and the floor space of perhaps the size of 10 garages. I could not really see how big. It was inside a tunnel, so it could not be that big. The room was full, stuffed, with what look like very long bombs, big bombs on carts with 6 or 8 inch metal wheels. The atomic bombs seemed to be so big they looked like they would not fit underneath a B-52 bomber. There could have been 10 bombs in there, or 3, or 30. I won't say, even if there were 100 in there. And, I could not brag that I knew because I only saw one next to me. I was not able not count them because the whole place was so cramped and people were talking.

None of this part was secret, but I won't tell, either. I might even try to deceive, just to play the game the way it is supposed to be played, the way some of Burford's people taught me. One of them came with us. And one thing I would say to impress people: there were at least a couple of those big bombs in there.

I just could not resist doing something that I knew I would certainly remember. No, I would not pee on a bomb. We were in suits and escorted, and I didn't know what those teenagers with guns would do to a bomb pee-er.

It was just instinct. I put my cheek against one of the more-than-one megaton bombs. I listened carefully for ticking or humming. "I don't hear any ticking," I said to Tom Burford. He chuckled. It was a line from a movie "The Mouse That Roared". Then I tried to measure bomb by wrapping my arms around it. Of course, I couldn't. It seemed wider than a pickup truck. I jokingly asked

----- An Evil Weapon -----

I guess it was really obvious I didn't think my boss's boss, who worked for Burford, knew very much. I was young. I was 26 and I had a brand new Ph.D. in Physics. My behavior was a bit more obvious, a bit less transparent than I thought, and I didn't realize it. I was not as smart as I thought.

Since I talked directly to our boss's boss's boss at random, the guys in between gave me a long leash and let me do whatever Burford and I talked about. My boss, Bill Goodsmirk, listened carefully to what I claimed the Orion rocket could do. Goodsmirk could figure pretty well. He listened well, too. He remembered important, key facts.

He told his boss, Bob Kadiddlehopper, what I said. The both of them wanted to have someone in their group design a super fast missile, so they could look smart. They wanted some weapon delivery system that could reach some far-away enemy target

one of the guides "This thing looks so big it won't fit in the bomb bay of the B-52, will it?"

He laughed and said "No, it doesn't."

I was totally surprised. I was only guessing when I asked him the question.

"They attach it on the outside, and they can't close the bomb bay doors, even to take off." he asserted.

"So, what do you do with it?" I asked, quite seriously.

"We count it." he laughed, quite seriously.

This was the Cold War, and Megatons counted. Here was a room with many, many Mega-tons to count.

These things are too damn big to put 3 million of them into a rocket ship like Freeman Dyson had in that article I read in Physics Graduate School. I don't know if Freeman Dyson ever got to visit this room. He should have. They should bring him here.

Burford did say this visit would be interesting.

The emotion I felt somewhat discouraged me. I could feel it nagging me:

The bombs are too big.

faster than the Commie Pinko Rapist Atheists at the other end could get out of bed to push their retaliation missile buttons.

But I didn't like what I heard.

Bill Goodsmirk kept saying things about the Vietnamese and the war that disturbed me. His actions and words verified to me that he was one of those Vietnam War Monger murderers, a Nazi. I thought Goodsmirk was a mobster helping that thug Mayor Daley of Chicago and his completely Un-American police riot at the 1968 Democratic Party convention. I believed that Goodsmirk was an accomplice in the same gang as those National Guard murderers at Kent State,.

Goodsmirk clinched it with the task he told me to perform. He wanted me to analyze a way to drag an *unshielded* nuclear reactor behind an airplane. He said we could "kill the gooks with

radiation, " they would fly by, dangling this gamma neutron sparkler behind.

He drew this picture on his chalk board of an airplane with a nuclear reactor dragging on a long cable. He said I should imagine a little biplane towing a banner saying "Eat at Joe's Bar," only the biplane was a B52 bomber and the banner would read "Eat this, you Commie Bastard" as it would spew killer radiation on the ground as it moved along. He laughed.

"Can you imagine," he chuckled. "The gooks would just fall over. Can't you just see it?" he fantasized out loud, with a bit of glee at how clean the battle would be and how we, he and his guys, what he thought were the good guys, would get to fly away victorious. He daydreamed out loud, assuming I would be like the four other guys in his group who I could see also had this Nazi tendency. They heard him talking about this and laughed with him.

Maybe the view out his window affected his mind. His second story window had no view at all. His north-facing window viewed the painted, light blue-white and dirty, open-to-the-sky eating area in the center the building, next to where they sold cold-fat, flat, soft French fries and shoe leather hamburgers at noon.

He was standing between me and the window, holding his coffee cup at chest height like he often did, almost blocking the door, with Marylee behind me. I didn't like it. He said I should analyze towing an unshielded nuclear reactor connected to a glider towed by a long cable behind some suitable airplane.

"Figure a way to make it work. Write a nice report about it." he instructed me, his subordinate.

I could not do it. I just seemed to never getting around to finishing that evil analysis. I was ignoring it. It was too awful. I kept stressing out, about how Goodsmirk was evil.

I guess he wasn't evil. But the Viet Nam war was going on. Traitors did have control of the USA. He was lining up with the wrong guys, guys at the top ordering war crimes just like Hitler and Mussolini.

I found it curious how on the one hand I thought we should stop killing Vietnamese immediately, and on the other hand, at the same time, that we should nuke that Commie city of Hanoi, and make the murderers quit, right now, instantly. I was stressing, and kept thinking, almost aloud as my face puckered, "And we should try President Lyndon Johnson for Treason. And his accomplices, with him. We should try these traitors in charge of our government like we tried the Nazi's at Nuremberg. Same thing. These government right wing extremist traitors are killing 30,000 guys my age, for no reason."

Goodsmirk was a friendly, professional, and sincere fellow. He was actually a good person. And he liked nuclear explosives, like I did. But he happened to be on the side of those anti-Constitution, evil thugs.

But to me an Aspie, this was perfectly logical.

I think it's an Asperger, "Aspie" trait, to be able to hold contradictory, mutually exclusive concepts together. My thinking would be illogical to Neurotypicals (NT's). I could keep elements containing apparent contradictions separate. NT's could not. Dr. Spock of Star Trek would understand completely. It was logical.

I am a tree hugger, and I love wood furniture and wood decks and hardwood floors. Stop the war immediately, stop killing people in another country that is not attacking you, and nuke their capital. My boss talks like a Nazi war criminal, and I think he is a good person. Aspie's can do this.

That is probably why I can be a Democrat and a Republican at the same time, a hippie and a conservative at the same time.

But this Atomic Bomb Weaponization Facility was not my place. I felt it. I knew it. I suffered anxiety attacks over it. A recurring emotion came over me every day as I drove to work, every time I entered the gate:

These guys are Nazi's. I want out.

CHAPTER 4

----- Beat your Plowshares into Weapons -----

"Could you deliver a big enough bomb to blow up the whole Commie Evil Kingdom all at once?" he asked me, seriously curious. He liked those kinds of phrases. He laughed. I laughed

too. It was kind of funny. If we weren't in Viet Nam and the evil traitors were not in charge of the USA, I might like the guy. Goodsmirk had a likeability, even if his office was rather small.

"How fast does it have to go?" I asked.

"Faster than they can push the button." he snapped back. Fast mind.

We all laughed. Goodsmirk was practical, and had a good sense of humor. He was still a Nazi. He was on Mayor Daly's side. Those fellows were Pigs, traitors, and bad. But he was sharp.

We had just finished a loud, hallway conversation where I boasted about atomic bomb propulsion that would make a space ship go "0.1 c," a tenth of a percent of the speed of light. I asserted how we humans could send a space ship to the nearest star, with atomic bombs pushing the ship. Huge payloads. A whole town, with livestock.

"I've got the documents in my safe," I asserted. I had hoped that there was still something buried, something I had not gotten to read about yet in the foot of documents, something that would show me how Dyson figured it.

Marylee Brighteye, our secretary, whose voice seemed to go straight into a particular primitive part of my mind whenever I heard her say anything, and whose body made me have involuntary lust thoughts the from first day I saw her, she laughed at Goodsmirk's quick wit. She seemed impressed. This was Big Time Inventions.

She was 40. I was 26. My wife Terri was way hotter than Marylee, so this was all mind twitter.

I could see how much Marylee was digging it, being there and part of the group of us talking about fast rockets and space ships, and humans leaving earth to populate another solar system. She was smiling and standing up from her desk and looking at us all like that was more fun than any of these guys have had in a while.

This place was usually a pretty boring, sleepy System Analysis Division.

I knew personally how it was a sleepy, boring place. Goodsmirk's guys did a lot of Really Boring detailed analyses here. They did the kinds of analyses that made one nod and bob one's head with a strong need to sleep, in one's office in front of one's desk in one's warm room all by yourself in the middle of the afternoon. I knew first hand.

We would be answering questions of deeply head-nodding significance, like "How often should you replace the vacuum tubes on a spare nuclear bomb part you keep in storage, given that you never use it and only intend to use it to blow up Commie missile silos, but only if they shoot first, and only if you had to use the spare vacuum tube thing?"

Another Systems Analysis question: "What is the best way to bomb a Commie navy harbor if you only have 12 atomic bombs and 3 different, somewhat unreliable rockets that can lob up to 8 bombs apiece?"

All I could think of for that stuff was "It's warm in this room. I ate too much for lunch."

Bob Kadiddlehopper, Goodsmirk's boss, was standing by Marylee's desk. He often stood around here and would casually ask key questions. He didn't know any answers. He just asked if we could do this or that, or if some other thing was possible. Most of his questions were Top Secret. He didn't know very much science and the only kinds of questions he asked were just sanity checks. He only remembered what people told him about engineering answers.

On the other hand, he really did know how to ask those damn pointed questions.

Kadiddlehopper always made it a point to talk to smart guys. I guess that is why he got to be boss. So he stood there, looking at me, and then asked the question.

"Could you deliver a nuclear weapon to Russia in 2 minutes?" he asked me.

My brain wheels were turning.

Kadiddlehopper's question translated into a need for something that went through the sky at just about ten times faster than any rocket anyone knew how to make. Everything else took 20 minutes, he wanted 2.

"Yep. That's what Orion does. Faster than anything," I said, blurting it out immediately, thinking "Dyson Starship."

I thought those words in a flash, and I immediately blurted them out, with my mouth engaged before my brain even thought about it.

"Can you really do that?," Kadiddlehopper asked.

Hesitating, my involuntary face expressions revealing that I just blurted it out without thinking first, because I knew I stepped right into it, I answered "I don't know. I'd have to figure it."

I was at least smart enough to ask for more time.

"What would it take to find out?" Kadiddlehopper asked me.

"Oh, some figuring. I have all the Orion documents in my safe," I replied, pointing to my office and the big metal cabinet safe with a foot of puzzling analyses.

"Ok, why don't you go calculate what kind of payload you could deliver," Goodsmirk broke in.

As my direct boss, he commanded me to do it. This might have been a set-up, but I was too Ph.D. to notice.

Goodsmirk's question of "Faster than they can push the button." should have caused me to slow down and think a bit. But I didn't listen to my mind. I really should have thought about this.

But all I could think of when Kadiddlehopper asked me the question was an excuse to work on Dyson's Orion Starship Propulsion, for real.

Another excuse to do this is that that a super fast rocket to kill murdering, Totalitarian Communists would be a very good thing.

In a flash, I emoted, I felt the images of how those Stalinist Pigs had hundreds of multi-megaton bombs aimed at us, right now, right at my home in Albuquerque. I felt how they were evil. I recalled the images of how the communists killed people all the time, for no reason. I thought of what they did in China, and Russia, wherever they occupied.

The fact was, I would do anything to get to work on the Starship engine.

"See if you can get there faster than they can respond," he clarified. Goodsmirk was somewhat smiling.

He had studied physics at some point. So, you could understand how he really would propose far out, totally impractical things.

"How fast is that?" I asked.

"Two minutes," he replied.

"Damn," I thought. Now I had to do it. Fourty years later I wondered if these guys were playing with me. I am still a bit slow.

But, this was my excuse, and I was going to use it. I proceeded to figure how to make a weapon powered by Dyson's Orion rocket. I would have to learn how big and how small one could make an atomic bomb. I had a perfect reason to go find out all I ever wanted to know about atomic bomb propulsion. I could feel the excitement of what I had a good excuse to do. All I could feel was "Boy is this neat."

This project allowed me to ask any secret question I wanted. I had a Q Clearance, Sigma 3. Heavy Duty. Off I went.

Goodsmirk opened up his metal phone number indexer thing and gave me the names of a handful of people.

He authorized me to talk to them, "anything I wanted to know," he said. This was a blank check.

All I had to do was figure out how to deliver a bomb big enough to wipe out the entire Evil Empire all at once, and do so faster than they could respond.

How big a bomb? As much as we had in silos, probably, all in one bomb.

Within hours of my asking, someone showed me how we could almost certainly make a 5000 Megaton bomb -- a Gigaton bomb. When I asked how big it would be, physically big, I didn't like the answer. It would be so big that no airplane could even budge it, let alone fly it.

"I see, you can make an atomic bomb bigger a whole lot more easily than you can make it smaller" I remarked, summarizing.

After a lot of secret talking and figuring and documents and estimates, I thought I might have insulted the guys when I summarized all that serious work. My statement sounded like just plain common sense to me, I thought.

I learned that small atomic bombs waste precious atomic explosive, like plutonium. Everybody knew that. Even bad guys. But I did not know that it was unclassified that bombs waste a lot.

The minor nuance here was that "small" meant "megaton."

Whoa.

"Megaton" blows up the whole city of Albuquerque, all at once. It was no wonder people like me were scared out of our minds about atomic war.

Focus. This was all about Starships. Focus. The whole exercise was about starships, space ships. I had to keep reminding me of that.

I had to learn about spy satellite procedures first. I had to learn what the Bad Guys would need to go through to decide to push the Kill-The-World Launch-Button, if they saw us launch.

It was fun doing this. I sketched the scenario, trying to figure out how much time I had to deliver the weapon.

The Bad Guys, the Commie Atheists, would be sitting there by their secret TV consoles deep inside one of those Russian police states, watching the U.S.A. from space, with special, heat sensitive TV cameras. The heat-sensing space spy TV would see the bright, white hot plume of our rocket launch, immediately. Even the

worst spy satellite, one that a backward nation could launch, would immediately be able to see a rocket launch.

This was easy technology, especially for the Bad Guys.

Our rocket exhaust was really bright. The rocket had to be that powerful to lift the payload to 100 miles above earth. The exhaust from anybody's rocket was typically brighter than 100 million watts. So, the Bad Guys would easily and definitely see it on their spy TV. It's a 100 Million watt light bulb.

The Bad Guys are my target people. As soon as the Target People sitting by their secret consoles would get the message from the spy satellite TV that the Attackers, the Good Guys, are launching, the Target People have to decide: Is the Attacker launching a moon rocket, a spy satellite, a communication satellite, or are they launching an attack on us, the Victims?

Since the Attacker's rocket, ICBM's, won't arrive at their target for another 20 minutes, the Victims have about that long to decide whether or not to push their Retaliation Button.

If they push the Retaliation Button when all we were doing is launching a communication satellite, then they would start a nuclear war that would blow up the world. Big Decision.

On the other hand, if there were some kind of Crisis, like the Cuban Missile Crisis, and they did NOT press the retaliation button, they would be destroyed by atomic bombs and we would get away with it. That would be a Tough Decision.

After an hour of worrying about that, I gave up all that what-if-ing this or what-about-ing that and just asked Goodsmirk.

"What is the longest time I have to deliver the weapon?" I asked Bill Goodsmirk. I wanted as much time as he would let me have. That would let me make a slower rocket.

"Are you going to blow up all of Western Russia all at once?" he joked.

"Yeah," I answered, because that was the whole idea for this exercise. It also meant I would have to deliver a 5,000 megaton bomb.

Incidentally, the bomb would weigh as much as a big space ship with 100 people in it, headed for Neptune.

"2 minutes." he replied, authoritatively. "2 minutes from us to Russia. Special gift delivered super fast." he joked, nodding his head. He really liked the idea of a super fast, super Top Secret super weapon. They kept saying "2 minutes". Fourty years later I realize I was the fool who agreed to the stupid "2 minutes," and they were playing it back to me, sticking it to me every chance they got.

"If you take any longer than that, it won't be a surprise. They might launch their rockets and blow us up," he explained, just like any good Systems Analyst would figure.

As I look back on this interaction, nearly 40 years later, I recall it really was exactly like this. Strange that I would remember snippets of the words he used, the way he said them.

The emotion of working on things that could wipe out entire nations in a flash, was real. It was intense. No one took it lightly. Perhaps that is why I remembered it so vividly.

In any case, that was fine. The fact was that if we wanted to be sure the Bad Guys could not fight back, then Goodsmirk's "faster than they can push the button" could mean "faster than the time it takes for their spy satellite to radio down the data."

That would be faster than anything, and faster than Freeman Dyson and his Orion can deliver and faster than anything I can think of. That's as fast as the speed of light.

I decided to stick with Goodsmirk's "2 minutes to Russia."

This was all about Starships. I had to keep reminding myself.

The payload bomb that I was supposed to deliver would be a bit big, I figured. I was estimating the payload size. To blow up all of the Commie missile fields all at once meant the bomb had to be 5000 Megatons, at least, maybe bigger. Actually, that 5000 Megatons would not be big enough. The unclassified manual shows how bigger bombs get less and less effective. But I had never read anything about bombs.

When I estimated how big, physically, this bomb might be, I got "about the size of a big house" The 5000 megaton bomb would be at least that big. Maybe as big as an auditorium, like where the high school basketball game is held. Maybe that would be about the right size.

Nobody much figured my bomb, the details. It was just a paper exercise, and everybody knew it. I could somewhat tell. We were just "the Systems Analysts" to the serious engineers who actually did real things like weaponize nuclear ordnance. I did not realize they were just tossing me random numbers.

But I could feel the excitement, because *this payload was the same weight as a starship space ship.*

I started talking to myself. Whispers actually came out of my mouth as I sat at my desk. My emotions clearly enunciated. I stared at the desk, looked at my work, and quietly talked:

"But I can't tell anyone the details.
This is secret work.
I'm screwed."

"I gotta find out if it works."

I saw myself standing at the head of Burford's heavy desk, with Kadiddlehopper and Goodsmirk sitting there listening reverently to every word I say. And then very, very authoritatively I tell them the true clue.

At my desk, staring at my work, but daydreaming vividly of us in Burford's office, whispers came out of my mouth.

"We're the only guys who will know how this works.
All we can tell the people is
"This is a space ship that can take us to Saturn."

They all knew that's the way it is when you are doing Top Secret work. They nodded their heads, agreeing.

Snap. Back to figuring. "A megaton atomic bomb weighs about 1000 lbs," according to Freeman Dyson in his "Interstellar Transport" paper. I learned an accurate weight of one bomb in one of the secret documents. But "1000" was easier to figure, especially since Dyson used it. It did not matter.

I talked to myself some more, but this time only the voice in my head was speaking.

"If I tell anyone any real number, I might get me into big trouble.

I don't want trouble.
I want to make an Orion Starship."

Secrets dominated. How could I tell everyone and still not tell secrets?

I just could not keep myself from fantasizing, getting distracted. I recalled a stimulating interaction I just had with a crew cut,

bearded mathematician, Dr. Gustavus Simmons. Gus told me "Bad guys will talk to you all day just to get one number from you."

I blankly stared at the dull wall, as if looking right through the metal door with no window. I was promoted an all metal office by myself, lit with bright fluorescent lights, with a North-facing window outshining the lights. My window was way worse than Goodsmirk's. Mine was narrow and dirty, really dirty.

The situation of me telling people only what I would be allowed to tell them, and no more, took over the daydream fantasy.

"A 1000 pounds to make a megaton.
You can go look up that one yourself."

I was on a podium, answering questions from some Journalists. Some were friendly. Some were not.

"You, commie."

I said, with emotion.

"You're a third world terrorist.," I said, looking right at the bastard.

"You can just go find all kinds of official and unofficial numbers about nuclear weapons yourself.
I'm not telling you." I said.

I was authoritatively sparing with the evil spies.

I sure told them off.

I knew I really could not talk about this outside of the security area. And I had to talk to someone, an intellectual someone. So I took a break and went to talk with Gus Simmons. He always came up with outrageous, surprising comments.

----- Crafty Bastards -----

There he was, the mischievous Dr. Gustavus Simmons, with a crew cut and smiling through a grey-streaked beard that reached nearly down to his belt buckle. This time he wore a bolo tie and some drab gray suit pants, and no suit. He was the leader of a small math group under Burford. He was a magician, mathematician and a locksmith who broke into guaranteed-secure Secret safes to taunt the head of Security.

I started in with a strategy question. I asked Gus, directly "When I find out some secrets, what do I say when someone asks me about it?"

I fully expected him to tell me some interesting game theory, like he started to one time before.

"That's easy. Deceive the Bad Guys. Don't lie to them," he replied, clearly happy that I asked him something he could boast about.

"Deceive?" I said. That's lying. I didn't lie very well.

"If you can count on someone to lie, then that guy gives away the secrets because they are bound to lie," he said, expecting me to understand.

"Deceivers are crafty bastards," he emphasized, chuckling a bit.

Gus liked that phrase, "*crafty bastards*." He used it every time he could make it fit.

"The liars are honor bound to lie. You can often force them to give away a secret just by forcing them to lie." he told me, looking right at me, to appreciate my response and knowing me well enough to see that I would see right away.

He was the crafty bastard himself, full of gleeful mischief. His crew cut hair and very long grey-white beard sent deceiving, opposite messages. Never, ever sloppy, and almost never in a suit, he always played the part of a crafty character. But he wasn't playing it. He was crafty and he was a character.

"Just look at Russian propaganda. When Pravda writes that the reports of a crop failure in the Ukraine are absolutely untrue, everybody there knows they are about to go hungry," Gus narrated, like a story.

"But a deceiver sometimes lies and sometimes doesn't. You can bet that the bad guy has better odds flipping a coin than trying to get the facts from a deceiver."

Gus was a mathematician. But he also kept a current locksmith license complete with expensive lock-picking tools. He also practiced magic tricks. It was all the same topic to him.

He used the grade school phrase "Bad Guys," and I liked it. He is the one who taught me to use it.

Gus did pick locks. He would defeat the lock everybody had on the steel cabinet safes. He deliberately did that about every two or 3 years to get attention. He would always carefully show the guys in charge of Top Secret Security how he did it.

He did this knowing full well it would force the security guys to change all the locks on all the safes in the whole place. Then Gus proudly and very publicly took the credit for finding a security weakness.

The Security guys didn't really mind, too much. They got to blame Gus for all the expense and trouble of improving security. However, they then got to do work they liked, changing locks.

They didn't have anything else to do. There had not been any spies here in 20 years.

Gus was so anxious he manipulated the topic of conversation immediately and proceeded to show me exactly how he broke into the high security locks this time. He reached into his desk and took out one of the older locks that the Security guys had specified for all safes. He set it in front of me.

I recognized the lock. I had one on my safe when I first hired on. Then pretty quickly, they changed it. I wondered why they changed the locks for no reason.

"You have to make this a highly credible threat," he told me, as he fiddled with some metal things. "If a bad guy can make the tools at home, that's a highly credible threat."

He emphasized the phrase "*highly credible threat*" with a knowing nod, to make sure I understood.

Sitting around his metal conference table on the first floor office with a south facing window of the type one can not see through, Gus explained the process one must use to get the undivided attention of the Security guys. Gus liked how I appreciated that those guys in Security were surely not as clever as the Mathematicians, like Gus.

He explained this like a master chef describing how to prepare a gourmet meal.

"One must present them with a weakness so glaring even minor scoundrels can succeed at it." He used the word "scoundrel" often, too. He reached for some other metal things from his desk drawer.

"What is it?" I asked as I touched one of his metal things welded to a 4 inch rod thing.

"Like a shim." he mumbled, as he focused everything he had on a combination lock as big as an orange and 3 times as heavy. It didn't open right away. All the safes once had that lock on them because of Gus, from a previous episode, before I hired on.

He was fiddling and fuddling around, poking and twisting metal parts and things into that lock. He was shoving and pushing hard. And it looked like the demonstration was not going to work. Physics experiments do that. They don't work in public.

This was like the joke about one student telling the other how you could tell what lab you were in: "If it stinks, it's chem lab. If it's slimy and green, it's biology lab. If it doesn't work, it's Physics."

It was about to look like Physics, so I told Gus "It's ok, I believe you can do it. I used to open combination locks in college. I would show a person who locked their bike with that cable combination lock thing how I could open their lock and steal their bike in less than a minute. So they would go buy a good lock. I know how sometimes it doesn't work."

Gus stopped. But he wasn't listening to me. Or if he was, all I did was challenge him. He pulled and yanked and untwisted and unshimmied all his tools from the lock, and started over. He was pushing so hard on the metal things I thought he was going to break them. "Don't break them just for me" I blurted out. He was

banging on something and forcing a shim thing into the lock. He said he made the shim at home.

"It took a couple of weeks to get it right." he admitted.

And the lock opened up.

I left with a new feeling about security, and that I should be extra proud if I succeed at being a deceiving little crafty bastard.

----- **Too Many Bombs** -----

Back at my desk, the Secret Restricted Data about atomic bombs, was open on my desk. These were some pieces we would need to make a Starship. I knew I would have to practice telling the Orion weapon story because we would all want to know the answer. Just the answer. Almost no one would care about the details. Only the Bad Guys would care. The trick was to give the answer in such a way that a Bad Guy could not shim his way into the lock, so to speak, and get the Secret Restricted Data.

Instead of figuring the Orion weapon like I was supposed to, I started figuring the Starship. Deep in a trance of figuring and staring through the metal wall of my office, I concluded that the way to explain the Orion rocket in public would be to use public numbers, and to forget the secret, real numbers.

Anyone could figure this one for themselves. One could read in unclassified publications that a megaton bomb weighs less than about 1000 pounds.

The bomb needed to blow up the whole of Western Russia all at once had to be at least 5000 megatons. Nobody figured that number. It was just "more than we had in the missile fields." It didn't matter. It was the mass of a starship.

So the bomb would weigh less than about 5000 x 1000 lbs, or 2500 tons of payload. That's as much as 25 fully loaded, modern railroad cars, end to end. That's one Big Mother Atomic Bomb. If the thing has the density of cement, about 3 tons per cubic yard, then the Monster Bomb is 10 meters across, or 30 feet across and 30 feet high, which is as big as a rich guy's house.

Now I had to figure out how to push this huge payload of 2500 tons hard enough to deliver it to Western Russia from somewhere in the USA, in 2 minutes. That was not too hard to figure.

But my answer demanded a rocket that was way too big. The rocket would be bigger than a few aircraft carriers. This was not small.

A faceless voice in my thoughts emoted the draining feeling:
too damn big.

Two fundamental physics issues were getting in the way of our making a starship. First, the bomb designers showed how an efficient bomb can not be made small. I could not start out with a small propulsion system.

Second, to go fast still required too many bombs. Putting "not small" and "too many bombs" together meant that I could not make a small Dyson's starship. "Small" meant "as small as an aircraft carrier." The starship had to be made big, maybe as big as a small asteroid.

This was not good. This meant we could not start out with something we could afford, like some space ship to take a dozen of us to Jupiter. We would have to start out with something that would cost as much as the entire USA Gross National Product.

I didn't know how much money that would be. I was not figuring cost right now.

The speed I would achieve, about 50 km per second, would be fast enough to go from Earth to Jupiter in about 150 days, or to Mars in about 17 days.

It took only 5 minutes to figure that this small ship carrying people might really work. All I had to do was just relax the ridiculous mandate that we have to accelerate the space ship in 2 minutes, like Kadiddlehopper and Goodsmirk wanted.

If I made a people ship, everything would get easier.

I could see that if we just accelerated more gently, take 2000 minutes to accelerate instead of 2 minutes, then it could work out.

Remember, a Physicist will dream up impractical things that don't work.

I had to stop this space ship fantasy and figure something about the bomb. They were paying me to do bombs, not starships.

My atomic bomb propulsion system would putt along in space like a lawn mower engine. Every "putt" meant an atomic bomb went off near an atomic bomb catcher. The atomic bomb catcher would be attached to some mighty strong shock absorber springs, which pushed on the payload. Every "putt" would make a flash in the dark black of space. We would see the trail of flashes as it went through the dark night sky, as we looked up.

Some details were starting to crop up. I knew that every radio and every TV set and every stereo in the world would hear the electromagnetic pulse (EMP) static, loud clicks coming out of the loudspeaker, as the brilliant, flashing pulsing, too-many-atomic-

bombs-at-a-time propulsion hammered the atomic bomb catcher, accelerating the Big Bomb through the sky.

I imagined and saw it clearly in the sky above me: faster than a speeding shooting star and brighter than flashbulbs directly on your eye.

I wondered if the atomic bomb really blew the living daylights out of everything. I was learning secret things here. Those who create the images of atomic bombs made them omnipotent, irresistible forces, totally vaporizing. But I learned something different about those atomic bombs. Not everything gets vaporized. Almost like a betrayal. The bomb was not an infinite force. This was curious.

When I figured out how hard I was bashing the payload, I discovered I was banging the daylights out of it. The average acceleration was around 42 times more than gravity, enough to turn a person into manburger in one whack.

The peak acceleration on the hardware would be thousands of times higher. This was not good. Everything would almost certainly get smashed to pieces. Not vaporized, but smashed to pieces.

None of this was in any document. I was figuring it with just Dyson's paper.

I escaped back into fantasy. If we were going to Mars in 17 days, we could avoid the crushing accelerations. We could take our time setting off the bombs, and take 2000 minutes instead of 2 minutes to shoot them off. We would not mind at all that we would be accelerating 1000 times less. That would only be 0.042 G, 4 times less than the gravity of the moon. Even the peak g's would be piece of cake for the hardware.

"Hey," I thought, as I figured furiously in my all metal office, a cage with a tiny, mud-dirty window with no view, trying to make it work out, "this is just numbers to me."

It was not working out, and I had invested deep emotion in it, and blabbed how well it would work before I ever figured a thing.

I designed up a rocket that should take the whole payload to another part of the world, fast, two minutes, just like Kadiddlehopper wanted and powered by such and such many atomic bombs going off such and such often. But my design would not work.

I never bothered to ask how much of the sky would light up when more than one atomic bomb every second went off 200 miles above earth.

I had all the figuring in my classified notebook, and I wrote up a one page summary for the file. I did not need to put "unclas" in front of each paragraph. Let them discover it. I found something else to do.

After a week or two went by, Kadiddlehopper was standing in our office area as he usually does, casually talking to us about different things, and he asked me about that fast weapon delivery system.

"How many bombs does it take to make it go?" He always seemed to ask the damn pointy, embarrassing question. It was like he read my mind.

"Uh, xxxxx bombs per second." I mumbled. I had to tell him the truth. (Today, not revealing, affirming or denying any classified number, too large or not)

"Oh. How fast does it get there?" Kadiddlehopper was still probing, poker face, with no reaction at all on the ridiculously large number of bombs.

"Two minutes." I said, my hands dangling, as I looked down at the floor. I could not look him in the face.

I didn't want to tell anybody about any of this conversation, or about what I figured. I could see on Kadiddlehopper's face that he saw how stupid and impractical it was. He didn't say it was stupid. He just knew. We both communicated the conclusion "too many bombs" by the way we shuffled our feet and turned our bodies as we stood, not saying much.

For Kadiddlehopper and Goodsmirk, myself and Burford, my figuring was just a quick calculation. I was just trying to figure how well it might work, to see if we wanted to spend real time and money figuring this.

"Maybe I figured something wrong," I thought, as I shelved the whole thing.

Damn Crafty Bastard. That Kadiddlehopper was clever. He didn't give a damn if we could do it.

All he wanted to know was how hard it would be for the other guys, the Commie Pinko Rapist Atheists, to do it.

He wanted to know what to look for. When he found out, then he and Burford would go over to the spy fellows in that other bland looking, nondescript building and tell them what to look for. Then there would not be any surprises, and everybody would go home safe. He didn't care what the answer was, he just wanted to know it.

I just wanted to learn about Dyson's Orion starship.

My calculations showed that the Russians could NOT make a bomb travel faster than our response time. And if they tried, everyone in the world could easily find out they were merely trying to, because the test rocket would be so monstrously visible, exceptionally expensive, and really REALLY BIG.

The rest of my design would definitely not work. But it didn't matter. As soon as we found out it took too many bombs, we didn't need to go any farther. I never did figure how much shielding one would need, to keep the atomic bomb from getting blown up by the other atomic bombs pushing the rocket.

I know I did not figure the shock absorber part correctly. Now I see why Freeman Dyson didn't cause much of a stir.

I talk before I figure, so think first, dummy.

Some guy like Kadiddlehopper might have asked him "How stiff a box would you need to hold the your payload, and what kind of shock absorbers are you using, to keep the payload from being smashed to pieces?"

Takes too many bombs.

And I learned something really scary:

I presume Freeman's answer was "Duhhh."

We ** can** make a Gigaton bomb.

I learned something embarrassing and something disappointing:

It turned out, "too many bombs" is what everyone everywhere who ever worked on Dyson's crazy rocket figured.

- atomic bombs weaker

[S1 CH 08 A Bombs Weaker 2001.07.02p518.doc](#)

CHAPTER 5

Atomic Bombs Not Almighty Powerful

To Harness the Bomb

This was a Top Secret, Systems Analysis Division. We analyzed atomic bombs. And I came here to analyze how to make an atomic bomb-powered Starship work, somehow or another.

New to the real world of real work, I saw the 2 foot diameter clock directly above the entrance on the inside wall above the door of the Systems Analysis Division prove I was not *that* late. It shot the time message right over Marylee's desk, directly into Bill Goodsmirk's office and directly into his face. Goodsmirk's eyes stared directly at me when I came through the door. He stared hard and looked at his watch. And then at the clock. Back and forth, he was using sign language.

I was only 3 minutes late, for the 3rd or 4th time in a row. He reminded the 3 of us, the new Ph.D.'s, that "we start at 8 and we quit at 5."

His 2 ft wide, 3ft high, metal window and its metal frame let in a small patch of a bright blue sky. He had such a low a status, his window only saw a bit of sky, no view of the mountain, and the eating area in the center of the building. The bright light behind his face magnified his position as The Boss. It gave him a kind of a halo.

Marylee, our secretary, always arrived punctually enough before 8 am to open her several, metal cabinet safes, and always at least one minute before we got there. She was proud that the 6 ft high, 3 ft wide metal cabinet safes were chock full of nuclear weapon, Secret Restricted Data "SRD" documents. The "SRD" is the same as Top Secret in the Department of Defense.

This was the Atomic Energy Commission, the Famous AEC.

She would leave punctually just after 5 pm, after a prescribed, religious ritual of locking the metal cabinet safes. She inserted two, solid aluminum metal bars, taller than her, into the top and bottom slots of every metal cabinet, and then clicked a heavy combination lock into each bar. Then she had someone else, a "monitor," check to make sure she didn't leave a Secret Restricted Data document anywhere, on top of anything, and that she actually locked the locks. Then the monitor signed the monitor sheet.

I would try to inconspicuously watch her put those bars in. As she reached high above her head, on her toes, her short skirt would move up a bit towards her thin waste, revealing curvy legs. I was 26. She was 40. What did you expect?

Al Beckman, the white haired older engineer had the nice office next to Goodsmirk. Al Beckman had the biggest desk and also had a window to nowhere. He had the room all to himself. He kept lots of books in multiple bookshelves.

He kept his room and his desk perfectly clean and carefully neat. His pictures of is wife and family, tastefully arranged all over his wall and on top of his desk, showed off what he thought was the most modern, ultimate dream of suburban life. What looked like his wife's wedding picture showed a pretty lady in a pose like an actress, out of a 1940's movie.

The rest of his pictures were picture-perfect, and stuck in the early 1950's. So out of date, I thought. 20 years out of date. Ancient. But he seemed to be content. I thought he acted like he earned it and was proud of it all. He smiled, and didn't get excited about the little things the rest of us got emotional about.

His diplomacy and extreme courtesy in how he answered and interacted with me raised a shield between his inner person and me. He seemed to block my entry into his emotion world. That mannerism prevented me from empathizing or relating to him. His diplomatic barrier made me see him as old and distant.

He did not have a Ph.D., so he obviously didn't know anything.

Dr. Bill Teague and I, new Ph.D.'s, were talking in the 4 foot wide walk-space between his office and mine about the effects of a direct hit by an atomic bomb. Teague liked the mountains, and I asserted that a bomb on the other side of the mountain would vaporize all the snow, boil it to steam, and fry his playground mountain, immediately. I was trying to tease him.

Al Beckman heard us and courteously waited until the correct moment to interject himself into our conversation. With a slight smile he asked "you think the weapon will melt all the snow on the other side of the mountain?"

An atomic bomb vaporizes anything, no matter what. I know this. I have a Ph.D. So I blurted out with a knowing laugh

"Sure, a one megaton bomb will melt all the snow on the mountain, all at once."

The Little Boy in my head saw the fireball explode 15 miles away from us, on the other side of the mountain ridge The peak was 7 miles to the east of us. The bomb would be on the other side, with the heavy snow and tall trees.

As a Little Boy I had once pretended that if somebody from outer space came by in a flying saucer and tried to hurt us, we would shoot an atomic bomb at them and they could not shield against it.

"Nobody can shield against an atomic bomb," the Little Boy's voice in my mind asserted.

So I said with all the certainty of a brand new Ph.D.

"It'll vaporize everything."

And I authoritatively finished my reply to Al Beckman.

"No, I don't think that's what happens," he said, asserting himself carefully, without bending on his point. Insistent, unyielding, but exceptionally courteous.

"No. Why not?" I blurted back. I had just told him what the answer was, and he didn't have a Ph.D., so he should bow down and accept it.

"Just check the numbers." he said, slowly.

Al Beckman startled me when he contradicted my claim that a vaporizing, purple-hot megaton bomb, hotter than blue hot and much hotter than white hot, would certainly vaporize the snow.

"You need to read this book," he said, with a clear and knowing authority. He reached into his office shelf and handed me a copy of "Glasstone," the bible of the effects of nuclear weapons.

"You can figure it for yourself. You will see. I don't think it would melt all the snow."

I took the book, opened it, skimmed it for 10 seconds and there it was. Real data, detailed, everywhere. A solid book of atomic bomb data.

"Wow, this is real data. It tells you what happens," I said, oblivious that I said it aloud.

I took the book like a dog who grabbed a bone and ran off.

The whole book was so simple a high school kid could have understood it. And it was jammed full of charts and tables and figures and rather simple, power law equations, all telling the effects of an atomic bomb.

I didn't realize this was the unclassified version, and that a much better version even existed. But this unclassified Glasstone had all I needed to know.

This was Starship data.

After just a little figuring, I got Al Beckman's answer. Sure enough, the bomb would not melt all the ice on the other side of the mountain.

Glasstone detailed how the bomb would make a noise loud enough to break my ear drum instantly, like a 44 Magnum pistol going off next to my head. The little round plastic calculator in the sleeve of the book made it really easy to calculate. I could read off just how

far away I would need to be from the bomb so that it would only break my eardrums, and no more. Wow.

I read off how far away the intense heat would instantly start the trees on fire and fry skin to charcoal.

"It would cause your face to boil and turn black, and blast the living daylights out of windows and houses, blow everything to bits" I thought after reading on.

However, it would only ***blow*** the snow all over the place.

Melt the snow? No. Just the top few inches. The bomb had plenty enough energy. But it didn't penetrate the snow deep enough.

I saw a movie of it all in my mind. Bomb going off. Intense white hot fireball. Top layer of snow instantly heated into boiling steam. Under-layers of snow blasted and blown around, a second or 3 later. Twirling around, and then a shock wave would hit.

And Al Beckman was right. And he did not even have a Ph.D.! Amazing!

This was not an Aspie deficiency or failure to read Neurotypical clues. It was the arrogance of a new Ph.D.

And I had no clue. All I felt was the excitement:

"Wow. that's magic. You can live through being hit directly by an atomic bomb!"

This must have been one reason Dyson's atomic bomb starship was not so crazy.

And these atomic bombs were also firecrackers, BIG Firecrackers.

I'm a boy. It's a boy thing.

I really wanted to see an atomic bomb detonate in the atmosphere. It would really be 4th of July, a real spectacle.

I would make up excuses, like, "I want to watch one in the Pacific somewhere." My excuse: they had done about a decade earlier.

Or maybe "at the Nevada Test Site", where the Nevada-uns didn't care when the radioactive fallout covered on their sheep, because the government bought all their sheep at the high market price, immediately, for cash.

"Somewhere where it doesn't hurt anything."

The Power of the Universe, unleashed. I just had to find a way to see where they were exploding atomic bombs, underground. If we were ever going to be interested in using the Power of the Universe to travel the Galaxy, at least I could see just one of them, myself.

I didn't quite know how to get to see one. I decided to ask everyone who had contact with anyone who shot atomic bombs.

Those people were the bomb testers, and I started by pestering my boss Goodsmirk.

----- Underground Atomic Bomb Tests -----

It was a sad time for atmospheric atomic bomb shooters. Both the Russians and the U.S.A. agreed to quit exploding atomic bombs in the air. It was a Nuclear Test Ban Treaty. The Evil Russians and the Free World, which meant us and the Europeans except France, all agreed we would only test the bombs underneath the ground and never in space anymore.

The last few atomic bombs they, and we, shot off in space, scared everyone. The whole nighttime sky lit up and glowed, for hours, and especially over Hawaii. Power lines unexpectedly intercepted an Electro Magnetic Pulse (EMP), created a power spike over the electric utility grid, blew the fuses and shut off the electricity in some places. I hear the satellites in space got disrupted. The Van Allen belts got energized. It was a scary thing. It was a bit like we were blowing up the sky.

We both agreed to cork up the entire explosion.

Cork an Atomic Bomb?

We would not let it leak, not even a little. And if it leaked, we broke the Nuclear Test Ban Treaty. Bad dog.

I never saw the treaty. However, someone else said how evil the Russians were because their version read different from our version. The USA version of the treaty said we could not dump radioactivity into the atmosphere. The Russian version of the same Treaty said they could squirt their own people with radioactivity all they wanted. They only violated the Treaty if the radioactivity got past their borders.

I expected that from those commie bastards.

The Chinese Communists kept right on shooting big bombs in the atmosphere, Multi-Megaton bombs. They just did not give a damn about the Earth or anyone else. They were really evil. They didn't shoot very many, so their big evil was balanced by their almost never doing it. I suspected they were doing it for show.

The French were almost as mean, and kept right on shooting smaller atomic bombs in the atmosphere, too. They didn't give a damn about their allies. Typical arrogant French.

The French were so mean they would delay their atmospheric atomic bomb test until they knew our spy airplanes trying to peek at what they were doing would run out of fuel and crash in the ocean. Then they would shoot their bomb. They were mean, to us, their Saviors.

"So, how do they do an underground test?" I asked Goodsmirk.

"Well, you dig a tunnel straight into the base of a mountain, a mile or two into it, then you dig a side tunnel a thousand feet or 2, and shoot the bomb at the end of the tunnel," he explained, ever so characteristically clearly,

"What???"

"What? The long tunnel would still be there after the atomic bomb went off? Almost as if nothing happened? Wow." I said.

"And then go back and do it again." he continued with a smile and a laugh.

He told Marylee to pull out a document. She knew which one, automatically, because she was a smart one. It had a double-long fold-out picture of the test site, complete with pastel coloring.

I talked to Goodsmirk and myself out loud, like he was part of the voices in my head.

"Amazing" I said, a moment later, as he was paging through it, trying to find something in particular.

My curiosity and delight at dusty dirty tunnels sprinkled with atomic bomb debris seemed to delight him. I knew it would be just like him to direct me to talk with someone who does that for a living. I knew he would want me to learn more. I wanted to trick him into it.

It was just a nice coincidence that his boss, Kadiddlehopper, and another division leader, Dr. Curtis Hines, were in the office area talking about something atomic bomb-ish and got sucked into the bomb test site topic with Goodsmirk and me.

They also got excited that someone else, myself, actually liked this down and dirty, scary, messy part of atomic bombs. Apparently, almost no one else at Sandia would get excited like these guys about bomb tunnels.

Kadiddlehopper and Curtis Hines got a real kick out of my amazement that you could put hardware that close to an atomic bomb and not vaporize it, or at least blow everything to pieces.

Curtis taunted me with a smile, the kind of smile where he knows the answer and wants to tell you about it. That behavior was his inviting peculiarity.

"How would you block off the fireball and all that debris, after the bomb goes off?" he asked.

"I know the answer to that" said Me the Little Boy, waving his hand so the teacher would call on him.

Me the Ph.D. Physics Graduate Student took over as I answered Curtis: "I would use some huge doors and slam them shut with high explosives," I said, responding like a confident, recent Ph.D. with the right answer, and almost using an authority voice.

Then I meekly asked for approval with the question "Would that work?"

"Yep." Three of them all smiled. I was quite surprised that my bold guess would work.

They all knew the answer, and now someone finally came along and really appreciated how really clever and smart they were, in making those slamming-shut doors.

"They slam the door shut with high explosive pistons," Kadiddlehopper said.

"You light off the high explosives just before the bomb goes off, to get the doors moving," he explained.

When the doors smashed shut, they would pinch off and stop any vaporized dirt and bomb parts gushing towards the experiments. And our experiments would not be destroyed. Wonderful. Amazing.

The bomb would make a cavity, a bubble, deep in the ground about a 100 feet across. After the bomb cavity deep underground had cooled off, a few weeks later, somebody would put on a space suit-like set of sealed coveralls and hood, and crawl back in there and retrieve the experiments. It wasn't really safe at all. But nobody really cared.

I had to ask them to tell me again, to make sure I heard them right.

"A Door?" I asked. "A door stopping an atomic bomb?" I repeated, with honest emotion.

The Atomic Bomb Tunnel "Camphor"

The Test Director for an Atomic Bomb test and I had an appointment. The cold winter day in Albuquerque didn't seem to hurt as much as a same kind of day in Cleveland. Maybe the dry cold and constant sunshine made the cold feel warmer. Maybe it wasn't as cold here as it was in Cleveland, but it was cold enough to freeze water. I saw some thin, very high wispy clouds in the mostly deep blue sky. Those clouds were often there.

I walked up a few wood steps into a group of what seemed like connected-together mobile homes designed with offices instead of kitchens and bedrooms.

"Sure." said Curtis Hines, smirking like crazy. The three of them were so anxious to tell me about it they could just pee. Hines was rocking back and forth just unable to wait to tell the story.

"Well, yeah." said Bill Goodsmirk. "They have this big, 50 ton steel and concrete sliding door," he said, eyeballs white, teeth smiling from earlobe to earlobe, using his hands to show "big."

"And they get it moving with an explosive just before the bomb goes off. They time it just right." he repeated.

Using his hands again, talking like an Italian he repeated one more time, "Just when the bomb goes off, it slams shut."

And his hands slammed shut.

"Holy Cow." I said, using that phrase once again, too often.

"And a split second after it goes off and the door closes, everything caves in around the pipe," Curtis Hines said. "All that exploding dirt squeezes off the pipe and shuts off the hole," he continued.

I didn't know what "pipe" he was talking about, but the whole thing sounded little-boy neat.

I could just feel the excitement:
slam a door on an atomic bomb!

"You need to go see the guys that do this," Goodsmirk commanded, smiling. He completely surprised me. I really did want to see one of those tunnels. He was offering to send me on a field trip to a whole atomic bomb test site, and without even having some project as the reason.

He looked into his phone notebook, found three guys I should go see, and even told me where their offices were. Goodsmirk knew every person who ever did anything in the whole lab and had their name in that little metal, snap-shut phone book.

This was the first time I had ever seen offices like this. Somewhat shabby. They were definitely warm enough, and the rooms had everything one would need for an office. A set of toilets in some of them, and windows, bookcases, doors one could actually close shut. They were sure not very luxurious. They were drab, in fact.

They looked like graduate student quarters. The white-ish paint was dull. The windows were plain, a little dirty with what seemed like white-ish mud, like some of the dirt in Albuquerque. The desks and tables were metal and covered with that darker, hard plastic.

Two of the three secretaries had those modern typewriters, the ones with the little ball instead of typewriter keys. I saw electrical engineering equations on the blackboards. It seemed like there

were lots of buildings here that were left over from the old days, World War II, when they first worked on the atomic bomb.

Dr. James R. A. J. NiCastro, Deputy Test Director, was one of those in charge of testing our hardware. The object was to make hardware so tough it would survive a direct hit by an atomic bomb. The hardware was supposed to survive. We would use that kind of hardware in our bombs.

How close to an atomic bombs were these supposed to survive?

Devices and experiments that Sandia scientists and engineers would place directly at the edge of and actually inside the fireball of an atomic bomb actually did survive. Amazing, I thought.

"You shoot atomic bombs at hardware?" I asked Jim.

"Some of these guys are stupid. They just want to blow something up." He replied, two moves ahead of me, answering my question like a chess game.

He knew what I was thinking. He answered the question I would certainly ask later, saving me the trouble of having to go through each question one at a time.

This is classic Aspie. Step 1, Step 10, skip the middle. Aspie brains are fast.

The mistake we Aspies make with others is that we assume they are just as fast as we are. The NT's are slow-brained.

J.R.A.J. NiCastro was fast-brained, probably an Aspie.

"What do they do?" I asked in a clumsy way, wondering why else would you put something in front of an atomic bomb unless you wanted to blow it up.

"They don't calculate whether they are going to learn anything." he said. "it's pretty tricky when the thing can turn into vapor in a millisecond." he said with a laugh.

He showed me what he called a dumb experiment. Some engineer was trying to convince NiCastro and his group to let the fellow blow something up.

The engineer's whole experiment was only as big as my finger. After a few sentences of atomic bomb physics, requiring a Q Clearance, Secret Restricted Data access to hear about, NiCastro said "see?"

I saw. That guy just wanted to blow something up and get credit for "nuclear weapons effects testing."

"These guys don't understand. There's only so much space available." he explained.

"Space?" I said.

"You only get a small peek at the bomb." he said.

"What do you mean?" I asked.

"You put a bomb at the far end of the tunnel. You connect a 1000 foot long pipe, shaped like a cone, like a really long megaphone, all the way out of the tunnel. People put their experiments all along the pipe." he explained, using hand motions to speak, like animated Sicilian Italians often do.

"You get to see this yourself?" I asked, hoping he would say yes and let me go along.

"Yeah, it's exceptionally interesting." he replied, putting on the professional stare, to minimize any hint that he dug the hell out of it.

"There's some really interesting physics that goes on here."

He likes to use precise English, such as "exceptionally interesting."

"Can I go see?" I asked.

NiCastro, a Sicilian physicist about a year or two older than me and who went to the same graduate school I did, he also loved the bomb. Only he was smarter than me because he jumped over to electrical engineering. He liked the complex plasma physics that only happens when huge energy densities apply, like at the interior of the Sun or an atomic bomb. He was the Deputy Test Director for some of the tests.

"I'll take you out there and show you," he said. He was just as excited about these things as I was, except that he acted far more mature, and probably was..

So off we went. We flew out to Las Vegas, checked into our rooms downtown, and had a nice evening meal.

All the restaurants and casinos had girls dancing with no bra, no matter where we went. He drove. That's what I liked about Las Vegas. All restaurants had interesting dancers.

I saw him put a single quarter in a slot machine once, because I kept stopping and pulling the handle as we walked around. He would not put money in. I would not put any money in either. Slot machines were everywhere, absolutely everywhere.

"Here." he said. "Have some fun." as he put in a quarter for me.

I pulled the handle and watched with glee as the wheels turned. "Wow." I said, barely audible. He shook his head at me and laughed.

Part of the fascination with a slot machine is that it only costs a quarter to be allowed to pull the handle and watch the wheels turn. Sometimes the machine gives you some free pulls, when it gives you a little money you can use to pull the handle again.

And that was it, no more gambling. According to NiCastro, that was stupid.

"It does not compute," he said, with a smirk and shaking his head. He figured things a lot. He loved complex plasma physics calculations.

After walking around a bit amidst the pretty colored neon lights, and bells and a light flashing indicating somebody winning, in what seemed to be endless, connected gambling casinos, we went to watch a show for 15 minutes where the girls danced with no underwear. We only had to buy two beers to be allowed to sit there. Then we went back to our rooms and got a good rest for the next day's work.

Contrary to what everyone thought, when we go through Las Vegas on the way to the Atomic Bomb test site, it's no party.

Next morning we drove out 70 miles to "Mercury," the name of the compound for the test site. After passing through a moderately simple security system, we drove up to an old tunnel, "G Tunnel" it was called. It seemed to be recently abandoned.

A few big heavy chains and locks and gates gave only a very mild message to stay out. A portable trailer with a few people 300 feet away were the guardians. We had to check with them to enter the tunnel. And since NiCastro was the Deputy Test Director, everyone said "Hi Jim," and we went in, no paperwork.

But first, we put on some free coveralls, over our suits and ties. Just in case we rub some radioactive dust, it would stay on the coveralls. We also put on hard hats, because sometimes a piece of the roof falls on you. Now that would be dangerous. You could get hurt without a hard hat.

We were walking in a tunnel with no lights. Just flashlights. And I was talking and talking and talking. About philosophy of life, about physics, about atomic bombs, re-entry vehicles, phasor banks.

As we were walking, NiCastro pointed to my left "We shot something-or-other bomb here" as he pointed to a sealed-off side tunnel. I forgot the name of the something-or-other bomb as soon as he said it. Every atomic bomb test had some kind of cute name.

A side tunnel was just that. A tunnel would appear off to the side. Just like Goodsmirk said.

This was really amazing. Tunnels in a mountain, to corked-up bombs, atomic bombs.

"Atomic bombs really went off in this tunnel, didn't they. This is amazing. You would think the ceiling would fall in." I said to Jim, aloud. I acted like a little 4th grader on this tour.

NiCastro pointed up to the ceiling with the flashlight. "See the rock bolts."

This was even more amazing. They bolted the ceiling so it would not fall in when the atomic bomb went off just a couple thousand feet away, down a side tunnel. They screwed a 3 foot rod into the ceiling and then bolted on a steel plate the size of a big book to hold the ceiling rocks in place. They also attached a wire mesh to the ceiling. Just in case a piece fell off when you were walking by, it wouldn't hurt you too much.

And we were walking and walking. And I was talking and talking.

We were standing by the 3rd or 4th side tunnel entrance, about a mile deep into the mine shaft. I looked at the 15 foot metal hatch, like the hatch on a submarine, and I kept on talking, trying to explain something, and going on and on, and NiCastro was laughing.

And I kept talking, and talking. He was trying to say something, but I wouldn't let him. I was not done with my point yet. He laughed and kept trying to interrupt, to say something.

Finally I asked him "Why are you laughing at me? What are you laughing at?" I thought I was saying something profound, and maybe he thought it was silly. Or maybe my fly was open.

"What?" I asked.

He pointed the flashlight to the right of my pocket and with a smirk said "Look at that sign. I been trying to tell you."

The sign, at about zipper height, said in so many official words, "Don't stand here. This spot is radioactive."

"This was Camphor. The hatch leaked," he explained, using his typical shortest possible sentence.

"What?" I asked. I was acting stupid.

"The radiation blew all over the wall. You got some," he asserted.

He could often think like me and knew what I was going to ask next. He would answer what I would ask, two questions in the future. Maybe he was related to my ancestors back there in Sicily. Who could tell?

But, with radioactivity, you can't feel it or see it or hear it or smell it. So it must be ok. That's what I thought about that radioactivity. Must not be that bad.

The atom bomb shot named "Camphor" didn't quite work right. The high pressure, vaporized rock gas had pressurized the big hatch-door. That big hatch-door we were standing next to didn't quite seal. It leaked a little. Nothing much leaked. Only some radioactivity leaked into the bomb tunnel. The clean up crew removed enough of it so people could walk by somewhat safely.

The wall I was standing next to was where it squirted, apparently enough to warrant a warning sign.

I didn't know how much radiation actually leaked. I suppose I could have looked it up, or asked someone. At least two people I know would definitely tell me the truth if I would have asked.

Dr. Wendell Weart told me how the shot named "Baynberry" leaked, really leaked, into the atmosphere. He said the fire coming out the leak into the desert really looked like a bomb went off. "We actually might have violated the Treaty with that one," he said, surprising me with his frankness. He was one of the geologists on the team in charge of corking the explosions.

"It leaked off sideways, along a fault. We didn't expect it to do that," he explained.

At the end of the day, my radiation badge blared and shouted to everyone that I got some radiation. Nobody noticed or seemed to care. It was not enough to raise the alarm.

It was my initiation.

I suppose it was no worse than one of those foot x-rays I remember getting in the shoe shop back during the late 1940's. Now we know those foot x-rays were dangerous.

I just had to see more. But this time this was all we had time to see.

The Sedan Crater

We got back to Albuquerque and I pestered Goodsmirk for more access.

"Did you ever see anything interesting out there?" I asked, hoping he would volunteer something new. Then I would ask him to describe it in detail. That would get him all excited. And then I would pull the punch line: "How would I get to see it?"

"The thing that really demonstrates the awesome power of a nuclear device is the Sedan Crater," he replied, very officially, nodding his head for emphasis and affirmation.

"Really? What does it look like? Did you see it?" I asked, prodding him.

With an excited smile, holding his coffee cup in his hand, he told me "God, I couldn't believe it when I saw it. This is a *huge* crater."

"Huge." he said again, with hand motions, and almost spilling coffee out of the cup. "It digs a h-u-uge hole." He really got excited. "You gotta see it. It is like the Grand Canyon."

Wow. I didn't have to prod him. He volunteered that I should go back to the test site again.

He asserted how awesome it was, over and over, and assured me that I would see something that sounded like it would be half a mile across.

Then Al Beckman, overhearing stories about the bomb, came out of his office, which was next to Goodsmirk's, and told his version.

"I was really impressed when I saw that hole," he said. "It's really impressive. Big." he asserted.

"It makes you really think about how powerful these things are that we work with," he said, switching the flavor of the conversation. "It makes you kinda wonder if we are mature enough to have all that power over nature," he said, trying to be philosophical.

I expected to see something like a Grand Canyon. And Goodsmirk volunteered to pay for another trip.

This was exciting.

Ben Saw the First One

Ben Benjamin saw the first atomic bomb go off, at the Trinity site in New Mexico. Taller than me and heavier, and so mild mannered and gentle, a real gentleman. Light hair, fuller face, fair-skinned like a Swede I believe he was. I could prod him so easily to tell stories about people. He would volunteer them at the slightest excuse. The gentle smile of his soothing voice became tattooed in my mind.

His office was in a big bull pen building, as long as two football fields. The dozen north south hallways made a simple grid against the 4 east west highway hallways. The building was jammed with offices and rooms full of electronic devices and fabrication shops. He was in the north east end. He and Dr. George Hansche, his boss, were in charge of taking the pictures of the bombs.

We were in Ben's office and I prodded him to tell me what it was like. He said he was there at Los Alamos when the possibility of the Bomb was a super secret. He said famous physicists had done some measurements that indicated it might work. Ben was there before they tested the first atomic bomb, and they didn't know for sure if it really would work.

"I was just a teenager then." Ben paused and then started to boast, in a nice way.

"I was a very smart technician, so they abducted me into the New Mexico desert instead of letting me carry a gun and fight World War II."

"I was glad I didn't have to get shot at."

"I was just a kid. When I signed up, volunteered, I was ready to go fight the Nazi's."

"They abducted me and would not tell me where I was going. They just said 'you will find out when you get there.' "

"I wasn't allowed to write my family where I was. They changed the postmark on my letters." he said. "I was living in Los Alamos, but the letters were postmarked Santa Fe."

" They didn't tell me what the secret was for 6 months." he said.

"Do you remember anything about the first bomb going off?" I asked.

"Oh yeah. We were all huddled there, curled over, in the dark, waiting." he said.

"Then I heard somebody ask Hans Bethe "Are you scared?" just before it was supposed to detonate."

Hans was a famous physicist, one of the inventors of the bomb, one of the two or three Maximum Bosses of the entire atomic bomb project.

"And then I heard Hans say "yes, I'm scared." with that deep accent of his. "

"We didn't know whether it was going to blow up or be a dud. And then it went off."

Ben knew about atomic bombs. He was there for almost every shot the United States did, including the atmospheric shots.

"We built houses and planted trees in the desert, Frenchman's Flat, and then we blew em away," he said, chuckling slightly.

"I got to run the camera's." That was Ben's specialty then. The optics. Cameras. Fast cameras.

I had begged him to take me along on one of his NTS trips and show me what he was talking about.

So, Ben Benjamin took me on a field trip to the Nevada Test Site and Bill Goodsmirk paid for it.

Ben and I flew into Las Vegas, had a typical steak supper where we could have a drink while we watched some ladies dance with no underwear. The usual thing.

He saw how curious I was, as I stared at the naked lady, and how she looked at me, smiling at me, almost dancing just for me, I thought. Apparently the lady knew him.

But Ben got us out of there rather abruptly.

"Why did we have to leave so fast?" I asked, not wanting him to know how much I wanted to gawk some more.

"Next thing you know, she'll come out here and get very friendly," he said, without much emotion.

Now that part I understood. I could not spare the cash. Terri and I were scrimping to pay back the loan we took to get a down payment for our new home.

And, Terri would know. She would just know, by the guilty look on my face. She would be very pissed.

I never did anything like that. But I was saving up. "Maybe someday when I am older" I thought.

We expected the next day would be a long day, so we really couldn't stay. We needed sleep to get up early.

The next morning, driving on the way out of town to the Nevada Test Site, we stopped at about 8 am for a hearty double hamburger breakfast at a well lit, rather big hamburger joint. The girls were already dancing topless. The hamburger was big, seemed about a pound, and tasted very good.

I was anxious to see the main attraction: the site where we detonate atomic bombs, test nuclear weapons, blow up nuclear explosives. My main reason for going here this trip is to examine the monstrous big hole an atomic bomb made, the Sedan Crater.

On the way to the crater, we drove by one after another, circular, collapsed dimples on the Nevada Test Site desert. Each dimple was about as big across as a football field. This was the tell-tale sign of the other way to do underground testing.

For this "other" way, they dig a 12 or 20 foot across hole, and then dig it a mile or two deep. Different holes, different sizes.

The hole they dig gets smaller as you go down. They line the hole with steel and concrete. They put the bomb at the bottom.

Along some of the pipe on the way up they put the electronics and things to illuminate with the bomb. Finally, they fill the rest of the hole all the way to the top with concrete and rocks.

Then they detonate the weapon. I don't know what happens if it doesn't detonate. Rumor has it that one or two didn't.

At the bottom of the hole, the bomb creates a 100 foot-across bubble, called a cavity, where it detonates. A 100 foot across hole doesn't just stay there. It's roof collapses. As the roof falls to the floor, it is like the bubble floats up. This keeps happening until the "bubble" gets to the surface.

The subsidence craters are the collapsed dimple left over when a deep underground cavity created by an underground nuclear weapon test collapses. The craters were shaped like a shallow cereal bowl, or the saucer under a coffee cup. But they are about 1

or 2 football fields across. The caked dirt cracked inside the bowl. We drove by one after another.

The scrub plants seemed to grow better in the bowl than on the desert. Ben said the plants probably grow better because the ground water moves through the soil better, after the bomb cracks the soil. The Sci-Fi movie people claimed the radiation did it, and would also make monster ants. I did not see any giant bugs. They were hiding and only came out at night, when everyone was in a bar watching naked ladies.

All of Nevada seemed to be parched, burnt, barren, but it wasn't. When we got out of the car I saw grasses, twig plants, stiff micro-bushes growing, slowly, but obviously growing. It was hot outside, and it was cold in the morning. The sky here was always blue. But the sky in the distance was always pale blue because one could see so far. Fifty miles was nothing.



Ntscrater3.jpg

<http://www.enviroweb.org/issues/nuketesting/hew/Usa/Tests/Ntscrater3.jpg>

We were standing in the hot sun.

I started to dart, but Ben Benjamin would not let me just run over to the crater edge and walk.

"Too dangerous." he said.

"Radioactive?" I asked.

He raised the level of his voice with alarm: "No. It can still collapse."

"Really?" I ask, like a dumbbell.

"You can drop 40 feet straight down and get hurt." he snapped back, trying to keep me from being impulsive like he has seen me do before.

"These things will collapse for no reason, years after the shot," he added as he stared somewhat off into the distance, as if remembering his old days here. His mind was clearly off somewhere.

"Like falling off the roof of a 4 story building and landing on the sidewalk. You go splat," he said, bluntly.

We got back in the car and he took a detour from the plan and drove me to the site of the "ground zero" for some of the first airburst shots he helped photograph.

He drove the car right up to the flat, target area in the desert. He knew just where to drive to get around the metal cable barriers hanging across the dirt roads to the ground zero areas, to keep other people out.

Around the ground zero they had set up buildings and houses and vehicles at various distances away. And then they detonated an atomic bomb in the atmosphere and watched what happened.

"It blew it all away," he said, as we wandered around, somewhat aimlessly.

He didn't complain or stop me when I touched the bent rebar of a broken concrete building. There wasn't much to see or touch. I had seen a whole lot more debris in some New Mexico ghost towns I had visited. I guess that is what the bomb did. Cleared things out.

"Is this radioactive here?" I asked.

"Probably a little. Not much," he said slowly, as an afterthought. From the way he walked and wandered, I could feel how this had once been a site of excitement, exhilaration, commotion, activity, voices, people doing things, Grand Things, earth-shaking things of cosmic proportion.

And now, it was just dust on a desert.

He drove us off towards another canyon with more tunnels where they had shot off more bombs. On the way I saw a green splotch in the hills to the North. It looked like a mile away, but it was about 8 miles. We took another detour.

"That's a natural spring. Artesian. It always runs." he said.

"You mean in this desert?" I asked.

"There's water here. Every once in a while. The natives knew exactly where it was." he said.

Sure enough, as we got up closer we saw the green up close, a spot with a dozen green bushes as tall as Ben, and a trickle of water oozing along a 50 foot stretch of an otherwise dry gully. Green water-plants hugged the ground along the water.

About a 100 feet from the water was a 1920's vehicle engine attached to the front part of a vehicle.

"I was gonna come back and get that engine some day," Ben mumbled. He liked antiques.

We left the water hole and headed back to the canyon that had some used-up bomb tunnels.

In the car, Ben explained to me how one can even be 3 meters, 10 feet, from an atomic bomb and not even get much radiation.

"It only takes 10 feet of dirt between you and the bomb to shield the radiation." he asserted.

Then he casually commented "of course the shock wave is pretty strong."

He always got a kick out of using the same phrases the physicists used: He said "It turns into plasma."

Me The Graduate Student explained it to me, silently, as we drove to the next destination. Silently I said to myself, "Of course it does. The 10 feet of dirt between you and an atomic bomb does not mean you live through it. As soon as the bomb goes off, concrete and dirt moves outward at about Mach 10 and compresses, squeezes, almost instantly. The super friction heats it up so much it turns into white - purple hot more-than-boiling white hot vapor. Vapor more dense than rock. Sure, for the first few microseconds there is no radiation."

His words were still a surprise: a few yards of dirt stops atomic bomb radiation.

The bomb tunnel in the canyon was locked up tight. We were not suited to go in anyway. We never even got out of the car to see it.

Our driving out of that canyon reminded Ben of an atomic bomb that deliberately blew out of a tunnel.

"They used an atomic bomb to make an atomic bomb cannon." he said, one hand on the steering wheel, pointing to the side of the canyon we were in with the other.

"What did they do?" I asked, expecting a short story.

"Well, they shot off a small atomic bomb inside the tunnel on one side of this canyon." he started to explain, slowing his words as he looked around, to find just where it had been.

"I don't see exactly where they did it here." he continued, looking around at what was clearly not familiar anymore.

"It's been a while," explained, excusing the fact of his not being able to point right to the tunnel.

"It shot the projectile out the tunnel and hit the other side of the canyon." he said.

"Of course. what you expect?" I asserted. I believed him and could not imagine what else an atomic bomb would do.

"What scared the hell out of them was that the didn't curve like an arc, it went straight, straight across the canyon." he explained.

"Did they ever make a cannon out of it?" I asked.

"Well, if you like dragging a Mountain along." he replied.

"The problem is that you have to use a mountain to contain it." he explained. His clear and simple explanatory sentence lacked that sarcasm his Ph.D. colleagues liked to use.

He left me to figure for myself that a one-shot gun that weighs as much as a mountain would not be worth much.

Ben was finally taking me to the SEDAN crater, like I wanted.

SEDAN was an atomic bomb test to learn how to dig the biggest possible hole with an atomic bomb. Both the Russians and the USA bragged how our newly discovered atomic explosives could dig huge canals cheaply. Bigger than the Panama Canal. Fast. Easy.

The old ones actually thought they had discovered something better than dynamite with which to dig earth. They did not consider the radioactivity. Small detail.

For this SEDAN test, they buried an atomic bomb as deep as the calculations said they should. It was buried just deep enough to dig the biggest hole possible using a typical nuclear explosive. This was the big event.

I almost couldn't wait.

There wasn't anybody else here on this desert that we could see. It seemed we could see 20 miles of road easy. This was the Nevada

desert, and this day's visibility was something like 100 miles. We were the only ones driving around this part.

Ben casually drove up to what looked like a hitching post for horses at an unpaved, sandy parking lot. Apparently this site was so unimportant that they just left it unpaved, just sand. I could not see any real signs, professional signs, anywhere to guide anyone. I saw only one professionally painted sign that told how deep the bomb was, how powerful it was, how big across the hole was and how much dirt was blown out. Raw engineering data.

"Well, here we are," he said, blandly.

Ben's bland comment matched my first impression of this site.

Some sand dunes surrounded the crater, so I could not see into it even after we drove up. All I saw were sand dunes. We walked past a metal cable rope designed to keep a car from driving too close.

We peered over the dunes and into the crater. It was a puny hole no bigger than a couple hundred yards across. It was only a few football fields across and only 1 or 2 football fields deep. It seemed like someone had driven a caterpillar tractor down into it and left it there. Ben said that was an accident.

Terri and I and some fellow graduate students had walked into a bigger hole in Toledo, Ohio, looking for fossils, where they were excavating Silurian and Devonian mud to make cement.



sedan3.jpg

<http://www.nv.doe.gov/news&pubs/publications/historyreports/news&views/sedan.htm>

This was no big hole at all.

I guessed the reason Freeman Dyson proposed to use atomic bombs to propel space ships was that he saw everything I just saw, all these tests. I wondered if he was impressed or not at SEDAN. I wasn't. This was no big deal at all.

I found out from my radiation badge reading after we got back to Albuquerque that I got a radiation dose from the dirt, but apparently not much.

As we left and for weeks after I got back, I felt it and didn't say it:

"The bomb is *not* that Almighty Powerful."

CHAPTER 6

Epochal Events

Make No Long Term Plans

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M:\azinc\PROZX\To Inhabit The Solar System\ CHAPTERS

It was early 1970's in Albuquerque, New Mexico. The nuclear weaponization facility hired some highly perceptive, truly smart people who thought completely outrageous things and said them. I was taking a break and had walked down the hall to visit one of them, Gus Simmons. My office was now in the building where Physicists worked, and where the important Vice President had his office. My status had gone up.

One fourth Native American, three fourths Outrageous, Iben Browning, another one of them, was there with Gus. Iben startled me by opening a conversation with a characteristic punch line:

"If we bomb the center of Russian cities, we destroy their whole economy. If they bomb the center of our cities, they do us a favor and clean it out."

"What?" I retorted, taken by surprise.

"In the US, all the productive people flee the city and move to the suburbs. The center of the city is left to the ghetto poor who can't afford to move. Then the city passes absolutely fair and equitable laws to share the wealth with all the non-producers, the poor and stupid. Any productive person who stays, pays for it"

"I didn't know that's what happened. I thought it was the ghetto that made the city a bad place." I said.

When I was a pre-teen, union workers and businesses moved out of Cleveland and went to the suburbs, like Parma and Berea and Chardon. The Ford and Chevy plants moved out there, too. Everything productive fled the center city.

"Well, isn't the center of the city where you find all the hospitals for the destitute and penniless. Isn't that where the bums go for free food?" he remarked.

"In Russia, the Communists have to control everything, so they put everyone in the center of the city." Iben went on.

I meekly commented I thought it was because of the Siberian cold. I thought the Russians lived as close as possible to each other because they wanted the shortest distance between warm spots.

This was the first time I ever heard such heresy about the fair and humane social programs, and nuclear war, or about how or why Russians were concentrated in shabby apartments in the center of cities.

"They will never have a nuclear war with us," Iben assured me.

"The ultimate decay of a culture is civilization," he had said in his office in the suburbs when I had visited him there on some kind of official business.

"All the great invasions of history were caused by hungry people from the North going south, for food," he had said. "Climate drove history."

I never checked it out, but I guess it was true.

On another different day he had said "You have to let the diseased part die." He was asserting the ultimate in anti-bureaucracy.

He was referring to social programs for animals and people who are in a bind for some reason of their own doing. Skills becoming obsolete, like taking care of horses, making typewriters, taking dictation for the boss. Or like persisting to live in places where hurricanes flood you, rivers overflow into your house, or ghost towns from the coal mining era where there is no work and won't be.

"A bureaucracy is designed to keep all the diseased parts alive," he explained, in more detail, "no matter what the cost, even if it kills the organism."

"The Ultimate Act Against Nature is keeping a species from going extinct."

"Interesting," I thought, as I mumbled the words loud enough he could hear, and as I stared aside for a moment, realizing what he had just said.

"I like the Condors," I said. "I'm glad we didn't kill off all the buffalo." I didn't agree with him every time. But he sure made me think.

Iben Browning was there, working with Gus on something. They both took a break to talk with me.

He must have saved up sound bytes to startle me. Every time I met him he had a new one.

----- Epochal Events -----

The most intriguing concept Iben and Gus ever came up with was the story about Epochal Events.

Gus had just been promoted to a Department Manager of the Math Department. Bob Kadiddlehopper, my boss and also Department Manager, had an office next to Gus.

Having wandered into Gus's office because Iben was there, I had remarked to Iben and Gus how the exponential explosion of discoveries and technology during our lifetimes had changed everything, forever.

"No. Discoveries aren't going *exponential* at all. They're constant, but very frequent," Iben said.

Gus smirked, tracking my facial expressions as Iben baited me.

"Don't make any long term plans," Iben warned, as if he knew something, and poking me in a direction of ominous fear.

They were up to something. I could tell by their faces. I had come in and interrupted just when they had become excited about something.

"Epochal discoveries are happening so fast that everyone alive is destined to be as mixed up and confused as teenagers for their whole lives, and I can prove it." Iben asserted.

"And it will be that way unless almost everyone dies," he continued.

"What does everyone dying have to do with discoveries?" I asked.

"Discoveries change all the rules," he replied, with a smirk.

"I know that. What's it got to do with everybody dying?" I pressed him.

Now both he and Gus Simmons were both smiling, watching me get hooked. They had discovered something and they just had to tell me so bad they were about to pee their pants.

"It's not exponential. It's a constant number of man-years between discoveries," said Gus Simmons, the newly-promoted-to-manager, right wing crew-cut, left wing beard-to-the-belt-buckle mathematician magician lock-picker.

Now that was different. They were talking about the rate of discoveries. Whenever it would come up, everyone, without exception, would say "Its accelerating, exponential."

But, the pace of discoveries is actually a constant, they say. I had thought that we were in a truly unique period of human history, an absolutely new era of sudden, exponentially growing, explosive world changing discoveries. But not quite, they said. They captured my attention.

"If you plot the number of man-years between discoveries, it's a constant, something of order 50 to 100 Billion man years," said Gus, very mathematically, precisely.

"Man-years?" I asked.

A man working for a year is a unit of management-speak. That is like "hours" to a mechanic, like "4.5 hours to fix the brakes."

For people in the technical business it typically takes a team of people to do things, and it typically takes lots of people and many months or a year or two to do a multi-million dollar project.

Gus just learned about the unit to measure the human effort needed to do something. Being newly exalted and anointed as "Manager" of the Math Department at Sandia Laboratory of the Atomic Energy Commission, he learned "man-years."

Iben Browning was a Zoologist by training, so he had a propensity to classify things. "I was walking up the stairs of the Smithsonian in Washington DC, and along the railing on the wall up the stairs they had a chart showing the 'Ascent of Man' from the beginning of human history till now." he explained.

"At the bottom of the stairs they had the invention of fire. Then they had the wheel, the discovery of agriculture, writing, and on up the stairs. Under each invention they had the number of humans alive at the time. So I just wrote down the events and the number of people on a piece of paper. When I got to the top of the stairs there were a lot of events, like the printing press, steam engine, telephone, telegraph, computers."

Gus then said "I wondered how many man-years it took to discover something that changed everything. I expected it would take fewer man years the more we knew. So I plotted the number of man-years it took to discover an epochal event."

Then he paused, looking right at me, waiting for me to calculate the answer.

We are technical types. We will all calculate, as a reflex action. We all expect that the more we know, the less work it will take to discover things, and get rich.

"It's exponential," I blurted out without thinking. Then I realized they had just told me it wasn't. I looked somewhat stupid.

Gus kept looking right at me, didn't flinch, and stated the observation:

"The number is something like
50 to 100 Billion man-years."

"Amazing," I exclaimed. A constant, I thought, not exponential. The discoveries aren't exponential, like we thought. They are a constant.

"So when is the next one?" I asked. And they both laughed out loud.

"Everybody ask that question." said Iben.

"Well, it's pretty hard to predict the future. You never know." said Gus, with a tone of voice that revealed he was not as sure as he was before.

"Can't you tell from what we see bubbling up now?" I asked, a bit clumsily. "Like computers?"

Slightly frustrated, I asked a different question: "How do you precisely know what an epochal event is and when it happens?"

One of them said "You can't tell until you look back and see that it really changed the culture. When all the rules are changed, then you can look back."

"Ok, what was the last one?" I asked.

Either I found a weak point, or they were being scoundrels. Neither of them could come up with anything definitive. Atomic bombs? Nuclear power? DNA molecules? Computers? Jet airplanes? They were arguing between each other about what was and what wasn't.

The Transistor stood out. A Man on the Moon stood out. Those were recent. I don't know how the Man on the Moon changed things, but I agreed it sure was magical.

TV only came up as a progression from the telegraph, the telephone, radio and movies.

I said "Drugs, I bet that's the next one."

The druggies all seemed to be having a really culture-changing good time. Timothy Leary started a revolution where people were having 4 dimensional experiences, synesthesia experiences, experiences that we only read about when Catholics described what the Saints experience, and 12 hour orgasms.

They didn't even respond. Neither Iben or Gus gave a damn about drugs.

Then I said "The Pill," because it totally changed the rules of family, dating, behavior. Pregnancy was the thing that forced people to be monogamous for at least as long as it took to raise the children.

"The Pill and Penicillin," I quickly followed up. Penicillin kept the venereal diseases from causing a problem with sex.

None of us could pinpoint the very most recent epochal event.

Then Gus explained his mathematical point again: "There are about 4 Billion people on the Earth. At 50 Billion man-years between epochal events, that means every 12 years something happens to totally change the rules. At 100 Billion man-years, it's every 25 years."

I could see this in a flash. All 4 billion people on Earth working a living for 25 years is 100 billion man-years.

I could see why cultural and religious "truths" would seem to be true for so long.

When there were only 10 million people on the entire earth, like there were during Roman times, during Jesus or Buddha or Confucius times, and 25 billion man-years per Epochal Event, one could wait 2500 years before something would make Jesus and the Bible wrong, or Confucius wrong.

One could wait 10 lifetimes with no challenges to our way of life, and no changes to Truth.

That seems to be exactly what happened.

"So just when you get things figured out, everything changes." Gus said, referring to right now, today, his life now, and dismissing any historical significance.

If you care about right now and not history, then the Epochal Event theory explains why we are destined to become mixed up every time between 12 and 25 years go by.

If you care about history, then you see why Epochal Events like DNA, radioactive dating, 500,000 years of ice layers, microscopes and telescopes flatly contradict the Bible. You would see how nothing contradicted the Bible or the Pope or religions at all for the first 1,500 years after Jesus. But epochal events eventually changed the rules.

Iben and Gus, focused only on "right now" and not on the principles and philosophy of Life like I was, had just explained mathematically why we would be destined to be just like a teenager who "can't seem to figure out the rules."

"Wow." I said, bright eyed. "Every 12 to 25 years you have to start over figuring things out."

"So if you don't keep looking out for the change, you will be hopelessly out of touch. It's never-ending," Iben explained.

He sat there looking right at me and explained like he was explaining the workings of a car.

Gus said "Those who don't change become complete anachronisms."

That seemed to explain preachers and Italian grandparents pretty well. They all seemed to hold fast to the principles they learned when they were young, to their Rosaries and Bibles, Saints, devils and angels, or whatever their stern and overbearing parents taught them long ago.

I could see for myself how even only moderately old smart people were even getting things dead wrong a lot lately.

My grandparents sure didn't know very much. They sure thought they did. And those old and arrogant, authoritarian Catholic priests and the Bishop of Cleveland didn't know much either. When we moved to New Mexico, we listened on the radio to

those Bible Thumpers out of Texas. What they said sounded just simply uneducated. And they talked like they had a speech impediment.

My father thought he knew a lot, and he was only 2 generations out of step. He never changed from his youth. When I was a rebellious young teenager he and I got into an argument and he told me "When you get older you will see that I was right."

I was waiting, waiting for him to be right, and it never happened.

"So that means, you will be mixed up every 20 years, or 5 times per lifetime." I said.

It was startling. Everyone around me did seem to be mixed up. This explained it all. I saw it in a flash.

**when it became
less than one lifetime ...**

Great turmoil happened all over the world when the time between rule-changes got down to one human lifetime. Sometime during the last century or two, something fundamental happened. The time between epochal events decreased to less than about one or two lifetimes.

It was not that way at all, just 300 years ago. All those old cultures, like China's, Japan's, India's, Russia's culture. All focused on long term plans. Plans that could take 100 years. It was not that way 1000 years ago.

And they were Dead Right, as long as the time between epochal events was 100 years or longer, the longest human lifetime. But the time between epochal changes isn't greater than 100 years. It's 12 or 25 years. Their time constant is now wrong. Dead wrong.

During the mid 1800's any half-awake person could experience for himself that the basis for some fundamental rule of his culture was no longer true at all, completely wrong, period.

Revolutions appeared, everywhere. American Revolution. The French Revolution. Bolshevik. Communist. It even started earlier, with the Protestant revolution.

This Epochal Event thing wasn't just a science thing. It related directly to Right and Wrong.

How did this relate to their job of weaponization of nuclear explosives?

They were deciders in one of the most prestigious laboratory systems in the world. They were in the Think Tank. Their job was to figure what to do next. That's what Tom Burford's whole

Systems Analysis Directorate was all about. They got paid when we figured correctly on what to do next.

Strategy above everything. That was one of Gus Simmons's principles. We were getting paid for Strategy.

All of us, Gus Simmons, Iben Browning, my boss Bob Kadiddlehopper, his boss Burford, we were all part of planning long term research projects. Like Fusion. Or Space. Or engineering projects, like spy satellites, or hyperfast missiles, or android robot-delivered atomic bombs.

The Lesson was:

"Make no long term plans."

Never plan a project that takes longer than an Epochal Event.

If you do a project that takes 40 years to finish,
*no one will give a damn
when you actually succeed
beyond your wildest dreams.*

There goes lifelong visions.

The Epochal Discovery is that the Short Term gains win over Long Term strategies, nowadays.

Short term only. New. Terrible. Troubling. Upsetting. Heresy.

"Make no long term plans."

If I would succeed at some long term plan, nobody might even care, because some epochal event would happen between now and when I got there.

"Holy Cow," I thought. "That's Epochal."

Many times after that little Epochal Event get together I would try to reproduce their data. I would get a fact here, a data there, but I never got enough to check their math. I wondered: how right were they?

It did not matter how right they were about the exponential part. All that mattered was that multiple epochal changes are occurring during my lifetime.

**The epochal changes
make every lesson of History
and every Truth of Religion
suspect.**

That is epochal.

- NERVA at Jackass Flats

Encounter With A Nuclear Rocket a personal epochal event

As a side benefit for being so interested in space travel, my boss's boss's boss, Dr. Tom Burford, encouraged the atomic bomb testers tell me anything and everything related to making and using atomic explosives for propulsion, including the Top Secret things. Burford knew I might use them in a starship. The word somewhat got around.

An atomic bomb test director named Dr. Mell Merrit introduced me and another bright eyed, bushytailed Ph.D. named Dr. Bill Bishop to a rocket that would take people to Mars. He gave the two of us a personal tour of Jackass Flats, Nevada, where the key, nuclear rocket work was done. It was just down the street a bit, so to speak, from where they had detonated gigantic atomic bombs in the atmosphere and deep in underground tunnels and holes at the Nevada Test Site.

The nuclear rocket project had just been abandoned and stopped. The nuclear rocket building had just been closed down. Mell Merrit got us into the abandoned building and let us see the rocket.

Mel's exact words to Bill and me were
"that's the rocket that could take us to Mars."

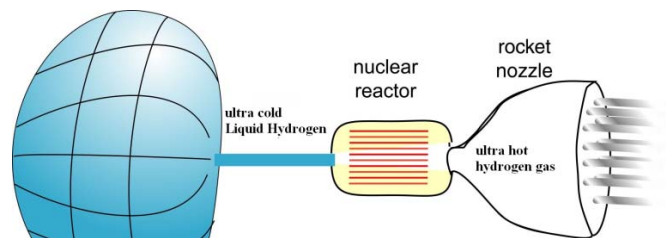
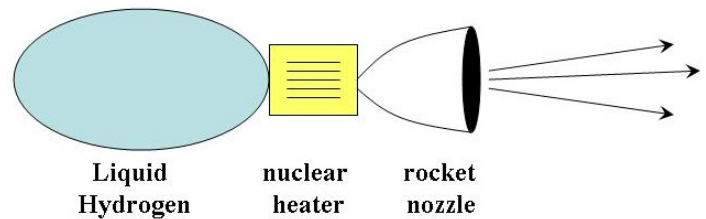
When I saw the rocket on the test stand, I ignored the "radioactivity" warning sign and ran up to the rocket itself. I tried to wrap my arms around this nuclear rocket. It appeared to be so small I actually imagined I might be able to get my arms at least half way around it.

I should not have run past the radioactivity sign like that. I got a small dose of radiation. But it was worth it. I was a bit eccentric anyway, before that. After all, that rocket could have taken us to

Mars.

The rocket was called "NERVA". People talk about this rocket program to this day. This rocket used hydrogen propellant. A nuclear reactor heats the propellant to a temperature where things would glow brighter than the filament of an old fashioned, incandescent light bulb. The propellant boils furiously and almost explodes into a hot vapor. The propellant vapor is guided directly into a rocket nozzle directly attached to the nuclear boiler.

Simplest Rocket Ever



This was simple.



A small nuclear reactor powered this NERVA rocket. NERVA used liquid hydrogen propellant.

Instead of atomic bombs, this rocket used a more tame form of atomic energy, a nuclear reactor. The engineers made this rocket and made it work. This was practical. This would not take us to the nearest star, but it would take us through the solar system. The NERVA really could be practical because they actually tested it at full power.

Never mind that there was *zero* liquid hydrogen in space, rendering it not practical enough for us to inhabit the solar system. with it. No gas stations for it. Ignore that.

Seeing and touching this NERVA rocket was an Epochal Event for me. Typical for Epochal Events, it would not be obvious for a long time.

CHAPTER 6

e-beam phasor

Getting Fired Into A Real Day Job

Another Phasor Beam

They kept wanting me to work on phasor beams. The second phasor beam was a particle beam. The engineers who made the particle beam accelerators thought they had a better idea than the scientists who made the lasers. I got to analyze that one as well. But it did not work out either. For all kinds of reasons, the beam was too weak, the beam would not go straight, and the beam would not do as much damage as they wanted. I had to laugh when I heard that a beam generator would take so much power to operate that the lights would dim in the part of the state they would test it.

When we wanted to put the thing into space, the power supply would be heavier than at least 10 space shuttles. It would be 100 space shuttles heavy if you believed the engineers instead of the scientists. And the beam would not go straight, either.

However, I did learn a valuable lesson. The lesson would be so valuable that it would be the key to making a simple rocket to let us inhabit the solar system. I would use the extremely valuable lesson for knocking killer asteroids and comets from colliding with Earth.

I did not know that it was a valuable lesson then. No one likes to learn a lesson. We want things to work out, not to give us a lesson.

The lesson was that if you are delivering a blast of energy to something, to make it blow up and knock the target to bits, then there is an optimum way you should do it. This part was obvious.

More precisely, you don't want to do heat up the target too slowly, or it will just slowly boil and not blow the target up. Like the face doctor using a laser to burn off a mole or pimple: the mole comes off but your face does not blow up. This was obvious as well.

Not so obvious and most important, you don't want to heat up the target too fast. The answer is not like the rocket equation at all. It was supposed to be, but wasn't. That lesson was contrary to intuition and unexpected.

If you heat up the target too fast, the surface blows off at very high speed. However, too little of the surface blows off. The blast is too small, and the bad guy gets away. And the bad guy shoots back with a real rocket that blows you to bits.

Eye doctors do this when they do Lasik eye surgery. Their eye surgery laser deliberately heats up the target with too much energy too fast. The laser blows off just a layer of molecules off your eye lens surface. The molecules become very energetic and move very fast when they leave your eye, but they don't blow out your eye. They don't even bump your eye. You don't even feel it. For you, that's good. For a rocket, that's bad.

The lesson is that if you use your precious energy packet to blow up just the right amount of target, then you cause the biggest motion and commotion in the unfortunate target. Contrary to rocket

scientist intuition, you get the biggest bonk with only a medium atom ejection speed, and *not the maximum speed*.

Another thing I learned was a good trick if you need to shove an asteroid out of a collision path with Earth. The clever trick was to use the target itself as the blasting mass. All you need to deliver is a blast of energy. The fast version of Dyson's starship did that. All the phasor beam weapons deliver just a precious blast of energy, but not mass. The energy can travel at very high speed, such as the speed of light. But if you could afford a slower speed to deliver the energy, you *could* use energetic mass to deliver the energy.

If you were a space cadet, you could use this to save the world. You would use the mass from near earth asteroids and near earth comets, already in highly energetic orbits in the sky, as your energy source. You will move them a little, and then save the Earth from total disaster. It will be much easier said than done, of course, because I am a physicist who is telling you what you should do.

The phasor beam projects were going so badly that I wanted to quit. I was so vocal about it and such a complainer, and did my job so poorly, that my boss's boss fired me off the job. His boss, Dr. Tom Burford, had gone back to Bell Labs and could not rescue me.

Even though I had been nominated to and voted in as the President of the New Mexico Academy of Science, I was still fired. I did a bad job at that as well. I was simply too much of an Aspie.

I went away completely depressed and believed I had no skills and was worthless.

- **spy satellites**
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Spy Satellites, Another Space Agency of the United States

I finally got a regular day job, as a spy from space.

His nose was big and wrinkled. His coarse laugh and blunt smile fit well with his thoroughly bland, plain, ordinary clothes, no tie, with absolutely no fashion anywhere in his appearance. No pretensions at all. Thinner, taller, just like an old fashioned engineer doing a job.

Dave Henry's Spartan metal desk in a small office with no windows, with documents and papers piled neatly everywhere, all suggested no signs of any highly intellectual activities. No interesting trinkets of space hardware on his shelves. No fancy wood conference tables. I sat in the uncomfortable, metal visitor-chair next to his desk. His office was so small office only a single chair fit next to his desk.

This geek engineer was completely unlike those highly intellectual physicists I was in the process of abandoning.

He was interviewing me for a job.

We were deep inside a single story metal building the size of a football field. The light-beige-painted, metal wall hallways went north and south, east and west. A perfect grid. I had been working at the southwest end somewhere. This was at the north east middle end, somewhere.

He posted a job for something related to spy satellites, little robot space ships that monitor treaties and watch atomic bomb tests.

The job description he posted wanted someone who could figure algorithms, computer procedures, for a space system. I knew about these guys. I had met their boss, and I knew rumors about their satellites that spied from space on communist atomic bomb tests in the atmosphere.

"Are you the same guy that did those algorithms?" he asked, with his loud, deep voice. He reached into the bottom right metal drawer of his desk and pulled out a document I had written about 8 years earlier.

"Yes, that's my document." I replied. I knew we had distributed it to everyone we could think of who could possibly use the algorithms.

In the document he pulled out I showed how to compute sine's, cosines, tangents, logarithms and exponentials without having to use long chains of multiplications and divisions. That is quite a trick. All you had to do was use a handful of simple additions and subtractions, and you would get a 10 decimal accurate trigonometry

function. This was something one could do very easily with simple integrated circuits.

In my document I had explained how to use simple electronics to implement the these methods into portable devices. It was very similar to what I thought the Hewlett Packard "hp-35" calculator did. I didn't know what the calculator did. My algorithms where sure easy to implement.

But it seemed that nobody ever used the algorithms, or cared. People thought it was elegant. That's all. I always thought it was a shame nobody used them.

"We used some of those algorithms on a piece of hardware." he said.

"What?"

He stunned me.

"Wow weeeee." screeched several voices in my head. Elated was the only thing I could feel. Nobody ever gave me credit for using anything I had ever done or written in my entire life, except here.

And they didn't even tell me or ask me about them. They just used them.

I knew immediately it meant I did such a good job and wrote it so clearly that they could just go and do it, like they did.

I wanted him to give me the job.

I didn't understand that all he wanted to do was get a real job *done*, with a pressing *deadline*.

I never encountered his type before, one who did not want to talk about it or ponder its significance. I never met a physicist who had a *deadline* to do something real.

But I started in on him anyway, the only way I knew how, to make him feel proud about his work.

"You know, Curtis Hines said that the satellites are the reason we don't have an atomic war." I remarked.

"Yeah? Why ' zat?" he responded, in his dullest known mode.

Dave Henry was just not very interested in philosophy or feeling good. He was a man with 2 first names.

It just didn't register that he didn't care.

"No Surprises." I started with the conclusion. "You don't have to worry about any surprises." I began to explain.

He was supposed to be thinking strategically. I assumed he was trying to think of ways to keep the super powers from starting a battle. I wanted to have a conversation about how this is really a wonderful, good, positive endeavor he is engaged in. But he just didn't give a damn.

"We got a launch date to meet. Do you mind overtime?" he responded.

His team had a satellite that had a real launch date, and Dave Henry needed some people to finish programming for its data stream.

I still didn't get it.

"The other guys don't have to defend against the maximum threat if they can see your real threat and how it isn't that bad." I explained, speaking directly into an intellectual vacuum.

"We have to launch this thing on a pretty tight schedule." he replied, as if I didn't say anything.

"You can get comp time. We can't pay you over time, you're salaried." he explained.

I finally got it. "Comp" time is "compensatory time," where you take off on vacation for the same number of hours you worked extra. We all know, that never happens. My kind and his kind think work is play, a hobby. We forget which is when.

"I work all the time anyway." I mumbled.

"It'll be fun to do something real." I commented without thinking first, and unintentionally revealing that all the other things I had done were not real.

He didn't get that part, or, he didn't care. I could see that he felt like he was scoring a high-powered physicist.

He quickly led our conversation back to discuss something that required Secret Restricted Data, Q Clearance, where we talked about the details of what an atomic bomb exploding in the atmosphere looked like to a satellite.

I commented about "catching commie pinko rapist atheists trying to pollute our atmosphere," with atomic bombs, hoping he would laugh.

His only reaction was to ask
"How soon could you start work?"

Then he said "You want this job?"

"Of course, yes, immediately, right now, can I start tomorrow?" screamed the ecstatic voices in my head. But all I could do was mumble: "Yes. It looks interesting."

Of course I wanted the job. It was the only thing the whole of Sandia labs did that really stopped atomic wars.

I could not believe it. I got the job, just like that. And, they actually already used something I had done.

All the way back to my office I was fantasizing. "This is real, a real job."

An emotion rattled repeatedly in my mind that was the feeling of finally doing something instead of nothing, thinking, figuring, showing how things don't work.

I could hear my voice saying to me "This is real, with a real deadline and real hardware that really has to work."

It was also a huge compliment to me. They implemented some algorithms I wrote about.

I was elated that something I did was actually worth something. All that time with the Star Wars guys and with the phasor banks and laser photochemistry guys was all bull. All the space travel stuff was fantasy.

This was real.

I finally found what I had been looking for.

I learned something, too.

Question: How do you pick a topic that people beg to hire you for?

Answer: Pick something they really want done *now*.

Monitoring Treaties

I felt so good about this job. A couple of years earlier I had helped trying to find ways to monitor atomic testing treaties. I really did know something about what we were trying to do. I wasn't just a physics nerd, I thought.

One time Dr. Sam Stearns connected his PDP-8I computer up to an "analog to digital converter." His computer was really compact. It was only as big as a refrigerator.

"It converts the computer signals back into sound." he told me. I had never seen a device like this before. That is what I like about working at a National Laboratory. They get modern devices like this to play with.

I had helped him get some digital tape recordings of seismic signals of earthquakes and some digital seismic signals of nuclear weapon tests.

"If we can tell the difference between an underground nuclear test and an earthquake, we can put that into the treaty." he said.
"Perhaps we could limit underground tests."

"What do you think they would sound like?" he asked.

"I don't know." I replied, not realizing I was acting on queue.

"Listen to this." he said, as he played an hour of the Valparaiso Chile earthquake seismic record, digitally speeded up so the whole thing played in 8 seconds.

"Wow!" I blurted..

He played it over and over several times.

It sounded like some plop sound mixed with the sound you get when you bend a long wood saw, sort of a long boing. And then, near the end of the digital record, we heard it start to repeat. The signal had gone around the world once and was repeating itself. During the time while this signal was happening, people were dying in the earthquake.

Every time I heard it I imagined people being buried and smashed, crushed by a roof beam on their chest, not able to breath, slowly suffocating, dying in extreme pain, maybe with blood dripping out of a pressurized leg sticking out of a crushed building too heavy for emergency crews to lift.

Never before had anyone heard the sound of an earthquake, speeded up.

Then he played the sound of an underground nuclear weapon test.

"Bang!" it went. Exactly like a shotgun blast.

He played a few other nuclear weapon underground test signals.

"Bang!" they sounded, every time.

"Sure is easy to tell the difference." I commented the obvious to Sam.

"How would you make a program to recognize the difference?" he asked me. That was the challenge.

"I don't know." I replied.

Neither did he.

The 1960 Valparaiso Chile earthquake was a magnitude 9.5, the biggest ever recorded.

"That was an order of magnitude more energy than any nuclear weapon we've ever tested." Sam said. It was also the largest earthquake ever recorded. It was trivial to tell the difference.

"Do you think you can tell the difference between a very small earthquake and a small nuclear test in Nevada?" he asked me.

"I don't know." I replied. That was a hard problem.

I went and did other things. He gave me a copy of the sounds on a reel to reel tape. The tape got lost in a move.

This spy satellite job was definitely different because we knew exactly how to make it work.

But I did go away from Sam Stearn's digital earthquake sound with a mild emotion permanently embedded in my feelings:
*an earthquake bigger than any atomic bomb,
really happened to Valparaiso, Chile.*

My Office

My office was an isolated desk in the middle of a long, old, trailer that was just one, long room. Airtight against the weather, obviously very used, but clean. Nancy Ruiz had a desk at the north end, with a filing cabinet and one of those smaller, metal leg, dark plastic top tables behind her. This trailer was connected to another trailer like just like it, with Dean and his secretary as the only occupants. Dean did something related to the Nevada Test Site.

Both of our trailers were out there in the mud patch just outside the main building. Wood boards over the mud made a path. Mud happened nearly every other day during the late afternoon summer rain.

Emery Whitlow was at the other end of our trailer. He had another whole table for tool boxes. On another big table he was working on real space hardware.

Each space hardware box was about as big as a microwave oven. Each box of things, mostly electronics, seemed to have wires and slotted cards and tiny electrical parts jammed full. There seemed to be no extra space in any box for anything more. I guessed that was space stuff for you. Every nook and cranny counts.

On the big table between he and I was a single element heater plate, designed for the chemistry lab. It was perfectly flat and about 6 inches on edge and half an inch thick. It had a dial on it, for very accurate temperature control. That's where Emery cooked his lunch.

Nancy and I were waiting for our new offices in the main building, 30 feet to the east. But Emery was exiled here, literally.

"I'm exiled out here, you know," he said, with a forced smile, but confiding in me. I had befriended him immediately. I liked the way he worked, so meticulously.

"Why are you exiled?" I asked.

"I mouthed off to one of Brick's high level colonels," he said, now somewhat boasting.

He actually told a U.S. Air Force officer, customer, some honest, highly critical but inappropriately timed truths about how the hardware was put together, the management, the Air Force "weenies" as he called them, and general disgruntling.

"Wow, you didn't get fired," I said, astounded, and revealing a fear typical for Sicilians.

No full blooded Sicilian (myself) would dare confront the bullheaded, stupid, loud mouthed violent despot elders, authorities, who would break your arm or shoot you for that kind of insolence.

"Besides, it was true," he asserted, this time gritting his teeth, wincing, still angry.

It wasn't the first time. He mouthed off for the N-th time, one too many times. Brick Dumore, the boss-boss, told him he had to stay out of sight, period.

"So, why didn't they fire you?" I asked, wondering how he got away with it.

"They need me to put the hardware together and make it work," he replied, calmly.

They couldn't fire Emery because

1. he was too skilled,
2. there weren't others to replace him, and
3. he climbed a pole to defuse a live atomic bomb for them.

A live atomic bomb? Defused it?

¿ ¿ ¿What???

Nancy was supposed to be putting the whole software picture together for this satellite we are working on. I was supposed to figure out how to calculate the location and size of the atomic bombs our new spaceship hardware would see from space.

And Emery Whitlow defused an atomic bomb.

Emery's "152 Atomic Bombs" stories

Emery's nickname was "Shorty." I knew he was short. But I didn't like those derogatory nicknames. I never did. That is something out of the cruel past.

I always called him Emery, and he liked it. Respect. He really liked that.

Emery Whitlow saw 152, atomic bombs go off. He was there. Doing all kinds of things for the tests. At the Nevada Test Site and in the South Pacific. Underground tests, atmospheric tests, tests in space. He saw big ones, monster Megaton bombs, and small ones.

He told me how one time an atomic bomb at the top of the thin, radio antenna-like metal tower wasn't quite working right. It would not detonate.

??? Atomic Bomb did not Detonate ???

When they pushed the button, nothing happened. The Atomic Bomb did not go off.

When you push the button, at least the high explosive in the Atomic Bomb should explode. But it did not. That means the wires are not connected right or shorted.

Somebody had to go up to the top of the tower to find out why, and fix it.

So, Emery got into the small metal cage and the electric pulley hoisted him up. At the top, the automatic turn-off switch that stops the electric pulley motor didn't work. The switch was broken or stuck.

The motor tried to keep pulling the cage. The tower started to bend.

"I was yelling at the top of my lungs down to the crew, to shut it off." he said.

Eventually they did. Then he got out of the cage, high up in the air, one foot in, one foot out, stretching to do something.

The 4 prong connector to connect the "fire" cable was rotated 90 degrees. The wires were wrong.

Somebody had jammed the connector in even though the holes were the wrong size. He un-jammed it, put it in correctly and got back down.

Then they detonated the atomic bomb.

"Weren't you scared?" I asked, suspecting Emery was pulling my leg and telling me a tall tale.

"Nah. You wouldn't feel a thing." he casually replied.

From the way he said this, I was sure he practiced this a hundred times on a 1000 wide eyed people just like me.

I figured it was true, if the atomic bomb goes off, you don't even know it.

I figured that you are vaporized within microseconds. It takes about 1000 times longer for the nerves to send any signals through your brain. Your head would turn into vapor before your nerves could begin to send a nerve signal that something hot just turned on.

So, you would be there, and then suddenly, not.

That was unexpected, but interesting:

"They aren't going to fire someone who re-connected a dud Atomic Bomb for them, and, on top of a skinny metal tower."

Emery's Rats and Killer Crabs Story.

One day before lunch he told me about how they were in some tents in the South Pacific, getting ready for a multi-megaton atomic bomb test.

"Was it fun out there?" I asked, hoping he would say "naked women, free sex."

"We sure ate good," he said.

"We were in these tents, big enough for at least 4 cots and 3 hanging lanterns, getting ready for a test." he said.

"How far away from the bomb?" I asked.

"Far enough," he said, and continued on because he had a story and wasn't going to let me distract him this time. I had distracted him many times before.

"During the middle of the night we heard a loud screeching," he began, starting to smile, and clearly recalling something he liked.

"Repeated, loud screeching all over the place," he said, with a bit of glee.

"I turned on the flashlight and all me and my tent-mate see are these big, monster rats, crawling up whatever they could as high as they could, inside our tent," he said, the punch line, as he watched my eyes get big and my expression reward him for persisting.

"What did you do?" I asked, wondering if he got bit, or his tent mate got injured.

"Aw, we grabbed a broom handle or something and whacked em." he said, somewhat ignoring the question.

"Outside, the rats were trying to escape huge attack crabs, crawling all over the beach, with legs covering 3 feet across," he exclaimed, showing me with his arms how big the crabs were. His arms indicated 3 or 4 feet across.

"These damn crabs were grabbing live rats in their claws, crushing them, and the rats were screaming," he said, asserting another good punch line.

I could not believe it. The crabs were eating rats.

"We ate some of those crabs," Emery said, using a satisfied hunter look as he told me.

"The guys on the ship wanted some, and we gave 'em some," he said.

"They tasted pretty good," he said, concluding his South Pacific, terror-in-the-night sci fi story about atomic bombs and killer crabs.

Emery's In The Atomic Fallout Story.

His Nevada Test Site story scared me.

"Did you ever see an atomic bomb up close?" I asked. I asked every one I could about their atomic bomb experience.

"Closer than you would ever want to be," he replied.

I expected he would say he was one of the guys they put in trenches, too close to the bomb, during the early test days.

"We were in a pickup truck at the Nevada Test site just after they set off one of the smaller A-bombs," he started to explain.

"I was in the passenger seat. I noticed the Geiger Counter was 'pegged.'" he explained.

"Pegged" meant that the needle of the meter was all the way to the right, like a speedometer at maximum. The Geiger Counter was a device about the size of a quart of milk and clicked when a radioactive decay particle happened to go through the Geiger Tube. The meter told them how many "rads" per hour, or per minute, or per second, depending on the sensitivity "gain" setting of a dial on the little box.

"Hey, this thing is pegged, I told the driver." he said.

"What did the driver say?" I asked, on cue. He set me up.

"Turn down the "gain". It's too sensitive." he replied.

That's no way to run things, I thought. This is radioactivity, not noise or fumes.

"So we kept driving. Then I looked down and the thing was still pegged. I said 'it's still pegged.' He said 'turn down the gain.' ok, I said."

"Then what?" I responded, on cue again. Even I can understand this. The meter is reading more radiation than the Geiger counter is able to measure. That's way too much. They are in real danger.

"It's still pegged. So I asked him, 'What do we do?' And he said 'step on it.'" "

Emery said that with a laugh, as he delivered the punch line. He must have rehearsed one a hundred times, too, on gullibles like me.

"Step on it" means "step on the accelerator and go faster" to get out of there.

Marvelous delivery, marvelous punch line. But I didn't laugh. He expected me to laugh.

"So, did you get any radioactivity?" I asked. I was as serious as hell. This was not funny.

He saw I was more interested in him than in the adventure. Apparently, this was not the response most people gave him. I cared about him, not his misfortune.

His face turned serious. He paused. He leaned to the side a little. His gritted his teeth, something like a forced wide smile, and I think he didn't know he was showing his teeth like that.

The joke left his face and something distant took its place. With a sadness and frankness and a low tone he said "Yeah, we got some." That was unrehearsed.

He then told me what happened.

"Well, the wind shifted. We were in the fallout."

"They lost the records," he continued, then smiled a half joke, half dead serious, "probably on purpose."

He looked down, he looked up and he said "They figured I got 75 rads."

There was some silence between us. I recalled that 150 rads is the beginning of lethal doses.

"Did it do anything to you?" I asked.

"I don't know. I was always mean." he laughed.

Then his face got that distant look again. He looked down and then back at me. He involuntarily showed his teeth again.

"My daughter ..." he explained, calmly, frankly, because he said something that made me stop, cry inside, and want to yell to everyone what he told me.

We didn't talk about it much more.

Emery lost his only son, a volunteer, front line medic, in Vietnam. He died as he was trying to carry a wounded soldier away. Tears kept coming to his eyes. My eyes, too.

Emery's Nuked Crows Story

On a different day in the Exile Trailer Emery told me another Nevada Test Site story, about the crows.

"They were about to shoot an atomic bomb and we started the camera's rolling. At the same time some crows were flying toward the camera box. Then the bomb went off. This one crow looks back, and you could see he was wondering 'what the hell is that.' You could see his tail feathers go up."

"What happened?" I asked, like a dummy that I am. I don't follow jokes that well. I'm and Aspie. I take things literally.

Emery smirked a little, stopped, and then loudly clapped his hands,

"And then splat!"

he laughed.

After the hand-clap, well rehearsed part, he answered my question, wondering why I asked:

"Well, he smashed into the camera. They were gonna sit on it."

Everybody who hears this knows that bird gets smashed into the camera.

The A-bomb Burned Up On The Launch Pad

"You know we launched atomic bombs from Kauai," he said, smiling the way he often did when he was about to tell a 3 sentence short story with a sarcastic punch line.

I had been to Kauai, and even passed by Barking Sands. I had heard Sandia had some people there doing something-or-other.

"Did you see that one go off, too?" I asked, because Emery Whitlow had seen 150-something atomic bombs go off.

"Naw. It blew up on the launch pad," he said, laughing.

He was so irreverent. But, rockets would blow up on the launch pad all the time. Most of the rockets we watched on TV when I was in college blew up on the launch pad. It was always exciting to watch. Fire and excitement all over the screen. Reporters getting all excited at the excitement. Rockets always tended to blow up on the launch pad.

"One of our chicken-shit, scardy-cat engineers was so frightened when they pushed the button to destroy the rocket on the pad that he started crying."

He paused for a second, carefully looking at me to relish every surprised expression I might emote, and then added, laughing like a seasoned atomic bomb worker,
"The atomic bomb fell on the ground and started burning up."

Emery paused a moment to let me picture how an atomic bomb the size of a color TV set would drop on to the launch pad and catch fire. He expected me to get scared. But I knew better. If an atomic bomb is asymmetric, it will fizzle 100 percent of the time. It has to remain painfully and precisely the way the designer designed it, or it won't work at all. But Emery didn't know that I knew that.

He expected me to be all afraid. He expected how I would imagine how it could turned the entire launch area into a hole the size of 3 football fields and could have vaporized the control room and all the scardy-cats in it.

"He was crying and sobbing like a baby." Emery continued, mocking the guy.

"He was so afraid he was going to be blown up and killed."

I thought it was a bit funny and laughed.

When Emery saw me laugh instead of getting scared, he remembered I knew about bombs, and immediately added, laughing even more, "He wouldn't have felt a thing."

Emery must have recalled when he told me about the time he was on that tower all by himself and fixed the connector that was supposed to trigger the atomic bomb that didn't fire.

Six months later, as I walked from my office to my VW in the brisk evening cool of the New Mexico desert, a blank voice in my mind said

"They didn't fire him because he sat with atomic bombs."

The New Offices, Inside

I had grown to like the seclusion of the old trailer. But was moved to another .

Dave Henry was in the hiring mode. Everyone he hired had to wait in the unclassified area, outside a tall fence, until their clearance came in. Their desks were packed together in an old trailer on the other side of the building.

He hired a new Ph.D. fellow with a strange name, "Round Tree." I thought the fellow would be a Native American when Dave asked me to interview the guy. Some American Indians were supposed to have names like that. And I could not imagine a Native American wanting to work on computers, let alone get a Ph.D. in it. But he was a regular Texan with no accent.

Dave also hired some technicians. One of them, Stan Dutler, was assigned to work with me. Other people in the Lab had hired some female computer people. All new hire female's desks were packed in the same, old trailer while they waited for their clearances. They were young, thin and pretty. And they were smart. I tried to talk with them every chance I could. Too soon they all moved to somewhere in the Lab.

And then we all moved, including Stan, to nice offices on the inside. Everyone except Emery Whitlow.

Our whole team moved into nice, pleasantly crude office spaces inside the building. The room was big enough for 10 or 15 of us to share. Some of us, those with higher status, had a sturdy, new, chin-high wall to separate our desk areas. The room was warm in the winter, cool in the summer. My desk was a nice metal desk, with a clean plastic surface.

I liked the secluded hiding place around the corner I had chosen, deep in the rear of the room and around the bend. No one could see me if they wandered into any of the 3 doors to the area. I could focus entirely on the spy task: the flash location transformations. Those transformations were as tricky to solve as it sounded.

Dave Henry's office was out in the main area. Dave had lots of room in his office, compared to his other offices. Now he moved up to an office with no windows, big enough for a small metal table and three chairs. Neither his table nor desk nor walls were cluttered with anything.

Lena Valerio, his secretary, had her desk just outside his door. She took care of all of us.

A door connected our space hardware guys and their lab to our room. I always enjoyed walking past oscilloscopes and wires and tiny parts being put together on tiny boards, like a miniature city.

Dr. Don Rountree was furiously making software around the corner from me. Rountree was a very competent software Ph.D. His part of the satellite would unpack the bundles of data into neat little time-stamped bins, so the rest of us could work with them.

Stan Dutler was working furiously, implementing a fast computer code I designed to keep track of bright spots, such as the huge number of sun glints and reflections shining into our spy satellite view.

Don Summers, the mathematician, was helping me with the location transformations. He and I had to do the math to assign a location to any bright spots in the field of view.

Don Summers printed in the old fashioned style, on that wide computer paper with the holes on each side. He wrote those equations starting all the way from the left margin and continued all the way to the right margin, 15 inches away, and then continued on the next line, and kept on writing equations till he filled two or three sheets. Never made a mistake. Stunning work.

Sometimes, some said "always," he would not use deodorant or take a bath. I didn't ask. I didn't know. His soiled shirt overflowing his belt, his soiled pants with a nail-sized hole above the knee, his dirty mustache and his awkward, sometimes crude, blunt humor annoyed my wife and most females. But I didn't mind. He did stunning work.

Don Summers was worth 3 or 5 times what I was worth, and he only as a Masters Degree. He owned airplanes and hangars and threw people out his airplane half a dozen times on most clear Sundays.

I was happy. We were working with a real deadline, a real launch of a real robot space ship. The space ship hardware would look for real atmospheric explosions in the very atmosphere we really lived in. Our software would locate the fireball, calculate how big the bomb was, and tell on them. Someone in the Pentagon would eventually get our data.

If it wasn't too classified, our classification people would release the data and someone would tell the Media, Jane Fonda and the rest of the anti-war people that some bad people were shooting dirty nuclear weapons in the air we breathe.

This was important stuff.

Most of all, it was real. When we would issue an event report, Dave Henry told me it could go directly into the Pentagon and wake up a General in the middle of the night. If it were a real nuclear weapon detonating somewhere it shouldn't be detonating, like in anger, we would sound the alarm. Testing big atomic bombs at a nuclear test

site is one thing, but using them in anger, blowing up cities, is completely different.

This was quite different from the research things and wild idea things I had been part of. I had abandoned working on the reaction initiators for external burning hypersonic vehicles. Those vehicles would look and act like flying saucers in the distant sky, if they would only ever work.

I had abandoned phasor banks, which I showed would not work.

I had abandoned doing anything for the New Mexico Academy of Science, of which I had been President.

Nobody seemed to bother us with such nonsense. We were working furiously on the software.

Computer terminals appeared. One terminal was near me. I got to use it any time and any way I wanted, my own personal computer terminal. I felt important. I could program the main computer instantly. This was real luxury.

We were really doing it, getting ready for a launch.

Dave Henry at ground zero

"Did you ever see an atomic bomb go off?" I asked Dave Henry. I was turning over every rock, asking every older guy I met at this lab the same question. I wanted them to tell me stories about atomic bombs. We will never see these things again, I hoped. So everyone who ever saw one was walking history.

"I was at ground zero." he boasted, and smiled.

"How can you do that?" I asked, knowing that there must be some trick. I never heard of any bunkers directly under the atmospheric tests. The ground motion would smash him against the ceiling or wall. I imagined him sitting at his desk, and then the concrete ceiling would be going 200 miles per hour, straight down at him. And then splat.

"I was on a ship. Directly under ground zero." he asserted, teasing me.

"Ok, how?" I asked, stumped. I knew it was a trick. It had to be.

"It was 70 km overhead. In space." he said. It was a nuclear bomb test shot in space.

"Wow. Did you hear anything? What did you see?" I asked. Instinctively I started in, looking for any description one can get from these him. All the oddball things. Anything.

"Yeah. As soon as it went off. I heard a pop." he said, as he flicked his finger off his thumb, like a "pop."

"I got to watch it. Nobody else did." he boasted.

"How was that?" I asked.

"The sailors were instructed to go inside, under cover. But I was not in the military. I told them I had an experiment on that test and I was going to go out there and watch. I was a civilian. So I went out."

"Then what?" I asked.

"The sky lit up."

"It filled the whole sky." he said. At 70 km altitude, there was no fireball. The whole sky above him did light up, especially because he was directly below.

The atomic bomb was in space. There was no fireball and there was not shock wave. Just light.

That's why his nose was crooked. He was directly underneath an atomic bomb.

He didn't get any radiation, either. The air between the ground and space was about the same mass as 15 yards of water.

I remembered what Ben Benjamin told me: "Only 3 yards of stuff and you get no radiation."

Dave Henry was completely safe, and he knew it.

"Did you see any others?" I asked.

"Yep." he said, with a smile.

"I watched the atomic cannon go off." he continued. The other guys were ordered to stay inside the trailers. They were military. I wasn't. So I stood outside."

"What did you see?" I asked.

"I was three miles away from the detonation." he responded.

"You don't want to watch when it first goes off. So I kept my back to it. Then I turned around and watched." he said.

"What happened?" I asked.

"Nothing much. I saw the fireball."

Three miles away seemed a bit close. I bet he was farther than that, but the AEC was definitely known to put people too close to those bombs. Or, that atomic cannon must have shot a very small atomic bomb.

The Greenpeace and anti-nuke friends had something wrong. It was like they could not figure or compute. They got the radiation part wrong.

I needed to know the truth about radiation. I needed to know to get off this planet.

They cheated us with radiation scares. Where were the monsters? Where were the sick people dying all over the place?

This was after Chernobyl. And it was after Three Mile Island. The anti-war people I felt aligned with failed me.

This guy was at ground zero twice, and he had the crooked nose before either.

I felt cheated and resentful:
Greenpeace lied to me.

I know many people who prospered after getting scary close to nuclear things.

Dim Light of the Atomic Bomb

He was so proud. Dave Henry pulled out a beautiful, full-color, pretty-color map of details of somewhere in the swamps along a South American equator. He unfolded it across a conference table near my desk. His crooked finger landed "right there" on a lake, such a pretty blue lake, on that expensive map

"You don't want to wake up the Pentagon with a sun glint." Dave said, beaming.

"That lake was reflecting right into the sensor," he said, crunching his vowels and consonants as if the sun's reflection were alive and the lake was helping it.

"If we didn't do our job so well, this would look like a 200 megaton bomb."

That was not some random big number he quoted. It was the real number that our sensor would have shouted.

He was really proud.

"You just make your algorithm exclude anything that comes from where the sun is making glints," he said, holding out his left hand's crooked long fingers like he was holding an imaginary earth and pointing at an imaginary point with the other hand's crooked index finger, jabbing at the glint region.

I tried to imagine the earth like a smooth, blue, shiny small basketball held in my hands at arms length, with our satellite about where my eye was. That was about the right distance.

I started to panic. This was not an easy geometry problem.

"It's kind of tricky," he declared, smirking a bit, with the satisfaction of knowing that he beat the glints.

Well, I knew damn well it was tricky. I knew he was smart, and that he did figure it out all by himself, for a different satellite. It was one of those geometry problems that could keep me up way too late.

All sorts of mathematical transformations relating the angle of the sun, the space craft rotating in the black of space, and the somewhat pear shaped Earth somewhere underneath, with the curved oceans, all had to be figured so we could tell where glints would be.

To Dave and I, this was a puzzle. How do you make sure you don't report a sun glint?

To us, every bright flash could be some evil terrorists trying to hide their test of a nuclear weapon. So, we better not miss one.

On the other hand, we had to make sure we didn't wake up the Pentagon with a false alarm.

Those glints created buckets full of false alarm candidates every day, all the time.

I realized I didn't much care about the false alarms.

I thought to myself, hoping Dave would not see my lack of real interest, "If a 200 megaton bomb hit, we would not need a satellite to tell us."

"After all, the sun is a Trillion-Zillion ton atomic fusion bomb." Dave Henry would say, repeating the description that cast our beloved, Greenpeace Sun, the Mother of Life, as a dirty, war-mongering nuclear fission bomb spewing killer subatomic radiation all over Earth.

"Of course, the bang meter will tell you for sure if it was a nuke," he said.

"So, why don't we just let the bang meter do the work?" I asked.

"Go see Gary Masters. He'll tell you what to put into the software," Dave instructed.

I didn't quite understand.

Gary Masters was the expert on a particular sensor that triggered the satellite to wake up when someone shot an atomic bomb, and would determine if it was a nuclear weapon or not.

So, I went out to the engineer trailers to go find Gary Masters.

The satellite hardware guys worked in the trailers. The steps were muddy and dirty. The trailers were attached together to make bigger offices. They had been painted white once, probably 15 years ago. But these were trailers for engineers, so half broken steps and dirt and unpainted boards for a sidewalk over dried mud puddles were ok.

On the other hand, on every shelf, on every desk, in every cabinet, I saw at least one and typically several, clearly expensive, interesting-looking pieces of hardware, carefully resting or waiting for more work. All the hardware was absolutely professional and perfectly engineered.

The engineers handiwork was truly fine art. This was Sandia National Laboratory.

Most of the hardware things were box shaped, and most had metal box shaped parts attached to more box shaped parts. Wires and expensive looking connector cables and sockets were attached. Some had shiny plates and obvious 1 inch square windows attached with shiny brass or stainless steel screws and carefully milled stainless steel or aluminum puzzle pieces.

Sometimes the sensors were round like a quarter or dime. Sometimes they were flat sheets on what looked like dark glass.

Some cone-shaped things were painted the blackest black I ever saw and were just there as sun shades. They looked like totally black megaphones covering a hole in the dark bottom of the box.

I ran into John Mitchell first. His office was just as primitive as the other engineer offices. The floor was worn down to the wood in the often-walked-on places. The plastic and rubber floor mats were worn and dirty. The windows were almost as dirty, splashed with dried mud from the dust carried by wind and wetted by summer rains.

John collected refined trinkets in his office. He had more space hardware relics and paper posters of space programs than most others. He got around more than others. He got to talk with the Air Force brass.

Some of the poster pictures had our hardware drawn in.

"Why is it called a "bang meter?" I asked John.

Immediately I realized this was a dumb question. It measured the "bang." So they call it the "bang meter."

John Mitchell smirked.

"It's not "bang, it's bhang." he said.

"Long ago, during the days when the AEC shot atomic bombs in the atmosphere, some weird scientist weenies just like you invented a "Bhangmeter," " he joked, poking fun at physicists.

"When they first made this device their bosses said it was so crazy they must have been smoking bhang." he explained.

Bhang was the India-person slang word for marijuana.

He described something secret about it.

And the UNCLAS part was that a Bhangmeter measured squiggles and blips on the light signal. If one looked at the signal carefully enough, all the real atomic bombs had a certain set of almost unique squiggles and blips. High explosives, sun glints, and meteors did not have those blips.

There were meteors and sun glints, and both could look like atomic bombs to a satellite camera.

"We stare at the whole earth, waiting for a bomb to go off," he said.

"As soon as a bomb goes off, the light triggers the Bhangmeter."

"So it's straightforward," I blurted out. I wasn't quite sure why they sent me here.

"But you probably won't see the bomb going off. The earth is too bright," he said.

???Earth brighter than an Atomic Bomb???

Confused, I asked, "So how do we know when to start the Bhangmeter?"

"You gotta talk to Gary," he said.

I guess everyone knew that Gary Masters knew everything about it.

I continued on into Gary's office. It was primitive, too. Same engineering surroundings as the rest, but neat. Perfectly neat. Clean. Not one thing out of place. And he had some kind of art tastefully placed on the wall.

"Is it really that hard to see a bomb go off from space?" I asked Gary.

To Gary Masters, the question itself was stupid.

"Of course it's hard. The earth is bright."

"But a nuclear weapon makes an extremely bright flash. Can't the satellite see the flash?" I asked, puzzled even more.

Even modern school children know that the flash of an atomic bomb can blind you instantly. Everyone I ever talked to who saw a bomb goes out of their way to explain how bright the light is. Everyone knows how the light of a nuclear weapon is so bright it even makes mountains in the distance look white.

"Sun's pretty bright in the daytime," he said.

Gary Masters saw that I was intrigued by the whole idea that an atomic bomb is nothing, compared to the whole Earth. But he still seemed a little annoyed, maybe interrupted from something important.

"The sensor that alerts us to trigger the rest of the hardware has a hard time deciding that someone just detonated an atomic bomb" he asserted, making sure he forced me to swallow this strange new fact.

"When you're staring at the whole earth, a measly megaton bomb is not a lot of extra light."

Gary knew how to make the light sensor that would trigger only when a sudden flash happened, even if it was just a little flash somewhere inconspicuous on a bright earth.

"So, how do I know the flash is not a bomb?" I asked.

"The Bhangmeter signal tells you it's not a weapon."

"So, why don't we just use your sensor every time. Forget about figuring where the sun glints are," I asked.

I really didn't want to do that geometry problem of figuring where the sun glints were. Dave thought that was fun. Not me.

In the driest tones of voice, with the least amount of glee, and with the "why are you asking such a dumb question" nuance in his facial expressions and word inflections, Gary told me "The Bhangmeter doesn't work so well when the bomb is too small or too big, and when it explodes high in the atmosphere."

That's all there was to it.

He had the problem all worked out. I took the data and the Bhangmeter lesson and went away.

Even though I thought the flash of an atomic bomb would be extremely bright, it wasn't.

From a satellite in space looking at a daytime earth, the light of an atomic bomb, or a meteor, or the sun shining off the ocean, they all looked close enough alike that I had to do hard work.

I had to go back and talk to Gary again a few times, to get it right. He always seemed to be more difficult to approach. He seemed defensive. He didn't seem to emote that glee that Tommy Thompson had.

He lacked that puzzle-solving smile that Dave Henry had. The tone of his voice seemed to say "why are you asking me?" and "why are you interrupting me?" or "what do you want?"

That was curious, because he was one of the most cordial engineers I knew.

And he would help whenever he could. His mannerisms were a puzzle.

The bomb light was a puzzle. All the movies and all the TV pictures of an atomic bomb going off portrayed it as the brightest thing anyone ever saw in their entire life.

Everyone I talked with, no exceptions, personally told me they saw things even when their eyelids were closed when they watched an atomic bomb go off. Everyone said the light was extremely bright.

It was a Secret how well Gary could detect atomic bombs, during the early 1980's.

I thought it should be a secret forever.

"We're trying to catch a sneakin bomb tester," joked John Mitchell.

Obviously. We didn't need a satellite to tell us if someone used a bomb like that during a war.

TV news camera's were everywhere in the world, and so were telephones. The satellite would be the last one to dial 911.

The lesson of the puny bomb flash stuck.

I was learning. What is big to us, is puny to Nature. The bright flash was not so bright, by comparison.

Walking down the hall, for a drink of water and a break to the bathroom I talked quietly to myself:

*All that rattle and babble about the flashing light of a bomb,
the sun glints, meteors.*

"Dumb question" he says, with his face and his voice. Maybe.

*200 megatons goes off in the jungle and nobody phones it in?
Bull.*

I guess only one thing's for sure:

if something as big as a nuclear weapon goes off, you might not see it from space.

UFO's of Several Kinds

Charlie Zaffery told me "We see things we can't explain all the time."

Charlie's real name was Efstratios.

"Why do they call you Charlie?" I asked.

"Because nobody can speak Greek. That's my Greek name."

In a trailer full of paper, volumes of computer printout paper, bound in thick, really thick, 6 inch thick reams, with several desks and several tables and many bookshelves full of paper, and with charts everywhere. This was Charlie's place. He shared it.

Such a nice fellow, so friendly. And smart.

This was a most shabby trailer. It seemed that the clothes these engineers wore and the places they worked in matched exactly what people said about them.

Dirty floor. Torn floor coverings. Wires everywhere. Lamps held on the desk with C-clamps and tape. Power cords. computer terminals. Broken window latches. Torn mats on the stairs. Wood walkway boards dipping slightly into the mud path between trailers. Amazingly crude.

Most of what Charlie did was Secret.

"When they don't know what to do with the data, they give it to me." he said.

"I put them into the Zoo."

"What kinds of things?" I asked.

"Some of it is just space radiation." he replied.

Radiation? From space? He surprised me. I thought space was friendly, except that it had no air to breathe.

I began to focus on a new concept, and repeated it to myself as I walked down the hall:

Space is Radioactive

"Sometimes it's the Van Allen Belts." he explained, referring to what disrupted some satellites and data.

"Sometimes the sun showers the satellites with high energy electrons."

"Can't you shield it?" I asked.

"Apparently not. That's not my job."

"How bad is it?" I asked.

"I don't know. Ask Brick." he said.

So I did, as soon as the opportunity came by.

One week Merry Peterson and I watched as a computer group working for some other project in another building connected the first 1024 hypercube parallel computer ever.

That number, 1024, is exactly 2, doubled 10 times.

They had connected together 1024 little computers. Each one was soldered on to printed circuit cards. Each circuit was about the size of a playing card and as thick as 3 stacked quarters.

Astounding though it seemed, each card was the equivalent to an entire PDP 8 I computer. Just a few years earlier, that computer would not fit into a microwave oven.

The computer cards were jammed into a box the size of an old fashioned, living room, tube TV, and wires were sticking out of the box connecting them to each other, so many wires that it looked like hair.

Rather amazing to us. So much computer power in so small a space.

Merry Petersen and I both got the idea that we should use a few of these in our space craft.

The occasion to see Brick Dumore arose. Brick Dumore was the boss of all the space satellite groups.

They called him "Brick" because his face would get red as a brick when he would get even a little excited. Herbert was his real name. His nickname was obviously a vestige of the cruel times when people called each other by nicknames, like "Shorty." He was shorter than me and walked straight as a rock statue.

He walked like the boss. Even though he acted firm about all kinds of things, he would still smile a lot and made common sense every time he opened his mouth.

I found him very easy to approach. His arrogance factor was missing. "Firm as hell, but not arrogant," I thought.

He was the Department Manager, the Boss's Boss and the guy who gets Big Bucks. Emery whispered to me one time "He is getting \$83,000 a year." That's when the rest of us were only making \$32,000, so that was a heck of a lot of money.

Brick Dumore took us aside and made absolutely sure we understood The Word. He was being very stern and unyielding, almost unwilling to think of new ideas. This was not like him.

I knew it would be ok because his face did not turn red as a brick at all. Brick said that shielding these things was too hard.

"Can't I just wrap some tantalum foil around them?" I asked.

During physics lab I had stopped some x-rays with just a thick tantalum foil.

"Now let me just tell you" he started in, with the stern and clear intention.

I could just feel the intensity of the message he was about to lay on us.

"To shield that radiation," he started, pausing between carefully composed phrases,

"You need massive tantalum," he said, heavily emphasizing "massive" by saying it slowly and dramatically.

"the hardware will need to be completely surrounded," he continued, and paused,

"by heavy lead bricks."

Surprised, we got the message clearly. The shielding would weigh a whole lot more than the satellite.

Back in physics lab I played with lead bricks and made lead brick houses to shield radioactive bottles. Lead bricks are very heavy.

"Space radiation is just powerful stuff, very penetrating." he explained, like a physics teacher.

He was explaining, not scolding. And he was adamant.

"Space radiation is very penetrating," he repeated, using different words.

We went away deflated, but not depressed.

I liked the way he handled us. I thought we were some of his best thinkers. He just told us the facts.

Once we found out how intensely radioactive space was, we began to understand why our engineers used what we thought were primitive parts, old parts, electronics that seemed to be at least 10 or 15 years out of date.

I recalled how I had been puzzled about why I could go to Radio Shack and get higher performance electronic parts than what they used in the satellite.

We went to visit the engineers again. They always had interesting things to touch and marvel at.

"Of course they have to be rad-hard," said the red haired engineer who caught rattlesnakes for a hobby and tanned their hides for his belt.

"Rad" meant "radiation." "Hard" meant hardened against the effects of radiation.

The red-haired one was designing an elegant thermoelectric cooler for a space sensor.

The other engineer in the room, a relatively young, maybe 30 year old, computer hardware designer told us "the charged particle causes a short circuit in the computer chip."

He was talking about the cosmic ray charged particle that went right through the satellite, and through his hardware. The one that goes through the whole spacecraft.

"You get a micro explosion. The burnt parts cause an electrical short. The chip's power supply makes a spark through that short that burns out a piece of the chip."

And that was that.

"So, what do you do about it?" I asked. I could guess. Redundant parts, probably.

"You have to have multiple, redundant parts on the computer chip, and a way to check to see which parts died." he said.

Strange. And both of them would not let me go. They wanted to tell me about why they could not use regular old parts like everyone else in the computer industry.

"We have to use chips that are rad hard." asserted the younger one.

"We can't use those low power devices. We have to use the bigger ones, the old fashioned ones."

I had learned many months earlier that we used the old fashioned ones. I always wondered why we still used those feeble chips that took a lot of electric power. Electric power was very hard to generate, in space.

I had thought that the reason was bureaucratic. I had thought the worst of our managers, that they demanded we use old parts because they were the boss, and they said it, and we better damn well do what they said, or else "you're fired."

The younger engineer then proceeded to show me the special catalog of rad-hard parts. If a part was not in that special catalog, it would probably fry in space. No engineer in his right mind would dare put a part in a space ship that would wreck the space ship.

Our department manager, Brick Dumore, said it in a pithy sentence: "Space is very radioactive."

Brick made sure I understood that fact in no uncertain terms. He knew I could figure out all the rest of the implications myself. He

knew I would go ask the others about all kinds of details. I was a Physicist.

The whole exercise taught me a stunning fact:
Space is radioactive.

"Damn." I thought.

This meant we were stuck. We could not use high powered computers in space.

If we wanted to use high powered computers, or to let us stay in a space ship for more than a week or three, we would need to surround the ship with tons and tons of shielding.

The exercise taught me a design lesson
*We need tons of shielding in space.
At least a ton for each square yard facing space.*

Meteors and UFO Bombs

Brick Dumore had told me
"Those meteors, they come
very
close."

He paused at "very." He paused at "close," as he looked at me with a smile that radiated "I'm confiding in you, because you have talked about this before."

"How close," I asked, "closer than the moon?"

His eyes lit up and volunteered, "Oh, yes."

I forgot that we were in a Brick Dumore's conference room. I forgot that we were just finishing with a small meeting. I forgot what the meeting was about. All I saw was Brick's expression. All I heard was that 70% of communication that is non-verbal. His face. How he stopped what he was doing and put himself into slow motion. How he focused just on me. The ominous moment captured my entire attention.

"How big?" I asked.

"Big Enough." he said. "Enough to do serious damage."

He emphasized "serious."

"How did you find out?" I asked.

"Oh, at a meeting. The astronomers got very concerned."

Then he seemed to shut off the spigot of data.

He acted like he had heard something secret and his eyes and his voice were telling me that some faceless people somewhere in an unnamed place knew something about how Nature did some things that were very dangerous, and nobody was saying anything.

And then he acted like he remembered that he was not supposed to say anything to anybody, and he just leaked it to me.

At first I thought "They are hiding things, like the flying saucer and UFO people said they would." Brick was definitely the kind to hide something if they told him to. If they would say to him "don't say anything to scare people," he wouldn't.

"How often do they come by?" I asked, pressing for more.

"Often enough. Go ask Charlie about that kind of stuff," he suggested, knowing that I would.

I could see he got control of himself again.

He knew me and my reputation for having a nearly insatiable curiosity. His suggestion was a blank check to ask Charlie anything, because Brick was the Boss's Boss.

"You mean they are keeping it a secret?" I asked. I kept probing.

"No, just our part," he replied. He resisted.

Puzzled, I went straight out to see Charlie.

Charlie Zaffery and Norm Blocker were in the trailer. The trailer with paper everywhere, C clamps holding half-broken light fixtures to a desk, with a ragged floor mat. The trailer with the dirty windows and wires and computer body parts piled up. This was Charlie's place.

Blocker was standing next to a desk, looking at the 15 inch wide, 11 inch high computer printout. He always seemed to be smiling, and his deeply coffee-stained teeth almost always showed through. This time his smile had an extra "I'm puzzled" feature to it.

Charlie was standing at his desk doing something with more piles of computer paper.

It was a nice, sunny day, as it almost always was in Albuquerque.

"Do you see meteors?" I asked Charlie Zaffery.

"Meteors are easy," he replied.

We then had a Secret conversation about how big and how often. The Secret was about how small a meteor we could see, and whether we had a satellite looking at any particular one. I blew all that off because I didn't care about that.

All I cared about was "Do I have to worry about being obliterated."

Then he explained the un-secret surprise part that I was looking for.

"Some of the meteors have as much energy as the atomic bombs we used on Hiroshima and Nagasaki, during the War," Charlie explained.

He told me how the meteors looked somewhat like a bomb going off in the sky. A nearby satellite sensor would see it. But he assured me we never reported them to the Pentagon in the middle of the night because Gary Masters's clever optical sensor device, coupled with a Bhangmeter, determined they were not atomic bombs.

"They have the same energy as an atomic bomb. But they're not bombs. They come from space." Charlie said, half impressed, half laughing.

I knew what that meant. It meant that the meteor fireball would be so hot it would vaporize anything near it, just like an atomic bomb.

"You saw them?" I asked.

"Yeah. They explode in the sky. But they're just not nuclear bombs," he said.

"I didn't see them, the satellite did," he said, correcting his imprecise statement.

Charlie often said things very clearly and simply. I always liked talking with Charlie.

The meteors Charlie was talking about were not that big. So it wasn't that awful scary. I was hoping for a whole lot more.

Since I was asking about it and seemed to be so interested, I got to be an occasional advisor.

The sensors saw some peculiar things and nobody knew what they were. These things went into the Zoo.

Charlie, Dick Spalding, Norm Blocker, Cliff Jacobs, they all got to look at the Zoo. The objective was to try and figure out what it was, whatever it was.

Not a single person ever postulated a "UFO." Not even one. Nothing looked like a UFO. The things in the Zoo were isolated, occasional blips no one could understand.

"So, how big are these bombs from space?" I asked.

"I d'uno. Like I said, like the bombs we used on Hiroshima," he said.

If that's all they were, I could just not get that interested.

I had been to the test site. I knew better. This was puny stuff.

If the meteors were big enough to wipe out everybody on Earth, now that would be interesting. I would definitely care about that.

But meteors only as big as atomic bombs?

That's nothing.

I blew this one off.

Brick was exaggerating.

Not NASA

Where was NASA?

I wanted to see a launch. Going to watch a space rocket launch and going to the Nevada Test Site to watch an atomic bomb had to be similar. They were exciting adventures someone else would pay for. I was looking for just such an adventure, and for a way to go on an exciting trip to NASA. If I would ever get to go to space, I had to get involved with NASA.

It seemed that Brick Dumore *never mentioned NASA at all*.

Nobody did. But many people talked about going to "the Cape," Cape Canaveral or Cape Kennedy, depending on who said it.

"How long have we been making these satellites?" I asked John Mitchell.

I was prodding him to tell me a story.

"As long as I can remember. Forever," he joked. "I don't know, 15 or 20 years."

Somehow his comment triggered an epochal memory. In 3 second a flashback, I remembered when I saw the very first satellite. It was 1957, when the Russians launched the first satellite ever to circle the world. It was such a big deal. They beat us. The Atheist murdering communists beat us.

About 5:45 AM on a cold, still dark morning in Alabama I looked for it. My buddy Pat Evans and I knew where it was going to be. He looked that part up. We were both looking up and walking on the sidewalk in single file towards the chapel. Then we saw it. I looked up at the dark sky as I almost always did, because at 5:45 AM it was so pitch black, clear and full of stars. I saw it move slowly, directly overhead, as bright as a faint star. I was walking on my way to the chapel with about 35 other 13 year olds at a Catholic Seminary in the unpopulated part of Alabama near the Chattahoochee river. The entire memory was vivid. That was about 20 years earlier than my conversation with John Mitchell.

I expected John Mitchell would tell me some story about NASA and Sandia.

"We even launch them ourselves." John said.

"We do?" I asked, a bit puzzled.

"We have a launch site out at Barking Sands, in Hawaii." he said, smiling.

He exaggerated a little. "We" meant a team at Sandia somewhat related to our group. Sandia launched its own rockets there, as well as others launching rockets.

What I didn't understand when Emery told the story of the atomic bomb that burned up on the launch pad was that Sandia had a launch site exactly at that site, along with whoever else launched rockets.

"We launch our own satellites, too?" I asked John Mitchell.

"No. I was just pulling your leg. Somebody else launches our satellite," John Mitchell said, laughing. "We just launch tiny rockets there."

"NASA launches our satellite?" I asked.

"Nope." He smirked.

Not NASA

Surprised, I asked what I knew could be a forbidden question.

"Who launches our satellites?"

"*Somebody else*," he said. He took great joy in letting me know only enough to let me conclude that "Some other unnamed entities of the United States Government" did the launching.

This was NOT NASA. This was Some Other Agency of the United States Government.

"*Hey. Exciting*," I thought.

Tommy Thompson

I walked around the corner and asked Tommy Thompson, "You mean you don't ask NASA when you are going to launch?"

White haired, happy all the time no matter what time of day. Never wore a suit, always smiling, calm, excited about the science, excited about the engineering. Respected, taller, smarter, he was the key analytic sensor inventor person for the whole space group.

I didn't even realize that I could have been his descendant as an analytic sensor inventor person if I wished. I never did realize it. If I did, I would have matured faster, and my future would have been way different.

"Naw. We check with them to see where all the junk in space is, so we don't hit any." he replied.

"You mean they keep track?" I asked.

"That's what the IRN number is. They know about how big it is and where it is. But they don't know what it is." he explained.

The IRN number was up to 7000-something. That meant NASA was tracking over 7000 things in orbit, most of it junk.

A piece of junk out there would not fall down because it was moving too fast. By the time it would fall as far as the earth's surface, it would have already moved thousands of miles past earth's surface. The junk was all in orbit. Our own little asteroid belt. Instead of rocks, our asteroids were bolts, space junk and rocket parts.

"Why don't they know what it is?" I asked, wondering how NASA could know it was in orbit around Earth but not know what it was.

"They don't have the right clearances." he joked.

"Don't we have to use NASA rockets?" I asked.

"Naw. Sometimes we use their launch pads. Sometimes we launch from the other site."

Other site? I didn't know there was another launch site.

Back at my desk, working the coordinate transformations for a satellite sensor system, I looked up, stared right through the walls of the room as I thought about what these guys told me.

I have been working with OTHER space agencies of the United States Government.

more than one.

NOT NASA.

I now realized these guys might not care if I found a way to take 100 people to anywhere in the solar system, or to the nearest star.

I was not able to figure out what to change in my life to get to do space travel, so I had to let it go. I did need to find out more about what these "different space agencies of the U.S. government" wanted us to do.

Brick the Boss

Brick Dumore explained to me just how serious we took things.

"What happens if you aren't ready?" I asked Brick one day.

I was half kidding, half just curious. After all, we were working late every day, and the software was a whole lot harder than we thought, and we were hiring people to help us catch up.

A stern look came over his face. All seriousness replaced any smiling traces. His face got as red as a brick.

"If we miss a launch date," he said, authoritatively, and in a steady, low, firm voice, "they will put lead bricks in our place, to make sure the space craft is still balanced, without our hardware on it. Then they will launch without us. And they will never let us launch another thing."

**"You don't
ever
wan tuh
do that."**

he said, emphasizing every word as he looked right at me, not accusing me, just making sure I understand very clearly and in no uncertain terms.

"Boom" went the big, 50 ton sledge hammer, as it hit my attitude and changed its shape from whatever something it was into a flat thing, immediately. I guess I got the message.
"Don't Miss The Schedule."

The other message was clear, too:
"Don't Joke With This Boss."

These satellite people were dead serious about the schedule and dead serious about making things that absolutely worked.

This was no Phasor Bank. I found that completely comforting. These guys were absolutely serious about making real things, not just studies.

Little did I know I was hitting a nerve, a sore spot.

But Brick liked me anyway. I was curious about everything we did, always trying to figure a way to make something work better or do something we could never do before.

Standing in Brick's conference room, I started at some artistically interesting, black and white, 2 ft photos of some kind of electron microscope image of something curly. Electron microscope pictures were always so interesting.

"What is this picture of? It looks like the filament of a light bulb." I asked Brick, as I pointed to one of several photos hung on the wall of one of the conference rooms. He had them where anybody visiting with no clearance could easily see them. They could not be all that much of a secret.

Perhaps the details are classified. But, this part is not. His face got red again. Then he told me, and some of what he said about a particular sensor design was classified.

The UNCLAS part was something like "two launches in a row the filaments on some lights burnt out, on our hardware. VERY embarrassing."

The lights were part of some of the hardware that illuminated the readout on a sensor control. When the lights burned out, the position of the sensor became unknown, in space, on some very

expensive, very important satellite. It was like loosing 3 cylinders of a 4 cylinder engine.

We then had to use other means to find out which way the sensor was pointed, and the "other means" did not do a very good job at all. We looked bad. Since Brick was the boss, everything landed on him.

He was clearly speaking frankly to me, relating to me what we must deal with.

"We thought we had it fixed, and it happened a second time. There was some pretty high anxiety, that sinking feeling."

He was so honest about a very embarrassing, very visible, very expensive and unfixable failure.

"Oh yes. They understood. These things are very hard to control. But they were not happy." He smiled a bit when he told me, as he looked directly into my eyes.

He met the launch date, even if it meant partial failure.

I guess he was right. Everyone I knew, me too, did the opposite: We keep saying "wait" while we get it perfect." But all they wanted was "now."

I didn't expect this lesson:

Finishing *now* beats finishing perfect.

Why were we so interested in having our satellite tell us exactly where the bomb went off? Why were we so interested in being able to detect more than a few atomic bombs at once? Why did these guys not give a damn about NASA and space travel? Who were we working for?

Overtime at the Antiwar Activity Center

We worked overtime and over lunch hours. All I saw for a solid year was my desk at work and the path to my car. After work I would come home, have supper and crash on the couch.

I would come to work at my desk in the far, back corner of the room, hidden from noise and the line of sight of people, and work continuously for hours. I didn't have much time to talk with anyone. I would usually eat lunch at my desk. Our whole software group was too busy for distractions. We even worked over the Christmas break. I had never done that in my life, unless one counts homework during college as work.

We were partly in this bind because the satellite sensor didn't work as simply as Tommy Thompson the designer intended. He had redesigned the sensors so the job of pinpointing atmospheric nuclear explosions would be easier. But a minor detail of the design ruined his plans. I had to make up for the minor detail with

tediously figured software. This damn thing was complicated. It was not so easy as we wanted.

We were on a mission, to keep atomic wars from happening. The better we could make this satellite, the harder it would be for the Bad Guys to have an atomic war and win. This was the Ultimate Antiwar Activity Center.

Terri, my wife, had called me several times at noon to come home for a quickie. I laughed. I suspected she was serious. She caused intense daytime daydream fantasy distractions while I worked. I liked that. But I didn't go home for the quickie. That was very stupid. A dumb thing to not do. Terri never let me forget how I didn't come home for a quickie. Other guys bragged how they went home. Maybe they didn't have a pressing launch deadline. Why was I so dedicated to a satellite sensor?

"I should have gotten a lover." she said.

No satellite was worth that much dedication. But I didn't know it. I was dumb.

Marylee also called me a few times, wanting me to have lunch with her. She provided an additional, occasional daytime daydream fantasy distraction. I fantasized that she wanted more than just lunch. If she had called during my previous job, I might have snuck out, but I was too much Aspie to do more than just lunch. Aspies are notoriously faithful.

I fantasized on occasion that I might have done the naughty thing with someone other than Terri. However, Terri would definitely have known if I would have, because of the un-hidable, guilty expression I would have had on my face.

So I told Marylee the truth: "I can't spare the time to go visit you."

"Even just for lunch?" she asked.

"We are extremely busy," I replied.

And that was the truth.

Stan Dutler and I were trying to make the sensor do what Dave Henry wanted. I created the algorithms, he wrote software. What Dave Henry wanted us to do seemed to be a little strange. He wanted us to be able to track more than many simultaneous atomic bombs going off.

The hardware looking out a telescope at the whole earth would produce a lot of digital signals when something flashed like an atomic bomb. The satellite would relay the signals down to a computer we were programming. My program was supposed to decode the signals and figure out exactly and precisely where on earth the flash originated.

Dave Henry explained everything so clearly. Twisting his face with glee and using an engineering tone of voice indicating he was completely entranced as he explained:

"Your main job is to find out exactly where the bombs exploded."

I could understand how it was a fun challenge to find out exactly where, but why "exactly" where? I knew the secret number describing exactly what "exactly" meant. But I was a bit puzzled: if someone detonated an atomic bomb over your city, would you care exactly what part of town it hit?

And I did hear him say "bombs," not "bomb."

I asked Dave Henry "Why would anyone care exactly where they tested their bomb?"

"The hard part is doing that when there are 100 bombs going off," he replied.

I stood there, trying to act like I was following, when I wasn't.

¿¿ 100 atomic bombs all at once ??

"Ya wanna know if it hit far enough away from our missile silo that we can still use the missile inside" he said.

"Ohhhh." I said, as I finally realized what we were doing.

Now I really understood my job.

He did explain once that it was all nice and wonderful that we could catch anyone testing an atomic bomb in the atmosphere. That's what everyone outside the secret fence thought was the reason why Congress paid the bill.

When we would catch someone testing a nuclear weapon in the atmosphere, someone in the classification group would declassify some of the data. They would try to have someone tell Jane Fonda and some peacenik protesters from University of California at Berkeley, and the protesters would go protest that the communists are being bad, making global mass murder weapons and polluting the atmosphere with their bombs.

The real reason was more war-like, like war monger-like.

"We want to know precisely how bad we got hit," he explained, wincing his face and pointing his crooked fingers at an imaginary map. Then with both hands poking all his long, crooked fingers down at some imaginary globe, he continued with a wince "even if it's raining atomic bombs."

This was not just the peace keeper device Curtis Hines was so proud of. This was a war machine.

"Where do you think they will shoot their bombs during a real atomic war?" he asked.

I knew the answer to that one. I had worked in a super secret think tank, in the Systems Analysis Division with Bill Goodsmirk. I

knew that scenarios had the Commie Pinko Rapists shooting all their atomic bomb missiles at us all at once. Thousands and thousands of them hitting all the United States missile silos, all within minutes. They would hit us so fast we could not retaliate.

Wow. " ... *shooting all their atomic bomb missiles at us all at once* ... "

We really were in a cold war.

I knew that IF the Commies would NOT shoot all their bombs at us at once, then at least one of ours would survive and shoot Moscow.

At the time, I thought that those Commies didn't know how fierce we were. Garth Gobeli told me he would fly a megaton bomb in a private airplane to Moscow, himself.

Dave Henry wanted our satellite atomic bomb sensor to tell the Pentagon what missile silos were still ok and which ones were hit. Then the Pentagon would reprogram the surviving missiles and, as Bill Goodsmirk would joke, "...shoot those *!^% !#@ Commies back."

Good thing we had nuclear submarines. Nobody could know exactly where they were. They were just somewhere deep, out there in the oceans. Not even the Pentagon knew. The submarines would surely retaliate.

His deep voice smiled as he talked to me. He was completely intrigued by what our satellite could do. I could feel his deep voice emoting, emoting how he loved this puzzle. He knew that I felt this puzzle was fun, too.

"The job may sound simple, but the satellite is rotating in space, somewhere out there in the dark, 22,500 miles away, and has to look at stars to find out which way is up." he explained, wincing and moving his long arms like a satellite in space.

He was trying to move his hands to show me what I had to figure out. "You have to figure which way is up and precisely where the Earth is."

"Ok." I answered. "Doesn't seem to hard to do."

This thing *was indeed* hard to do. I had to think upside down, rotating, pointed somewhere else. And on top of all that, he wanted me to have the computer keep track of dozens of things that looked like just tiny sparkles and blips of the surface of the earth.

Dozens of atomic bombs all at once.

All I could think of was that

These guys want to keep on fighting wars after the world blows up.

LAZAP

"You should help us do a LAZAP," Tommy Thompson told me. From the way he said it, it sounded exciting.

He introduced me to the topic by asking me, "How do you know if the satellite is telling the truth?"

"What do you mean?" I replied, wondering if there were spies intercepting the telemetry downlink.

In a brief flashing moment I thought of all sorts of paranoid hallucinations for ways that someone could change the satellite data before it would get to my software.

"How do you know how well the satellite would locate the atomic bomb?" he asked, gently setting me up so to help him on an almost over-night, overtime activity where we wouldn't get any overtime pay.

"You compare what the satellite said with where the bomb actually went off." I replied, thinking of the simplest possible explanation for a calibration procedure.

My calculations would use the satellite data to tell me where the bomb went off.

"What bomb?" Don Lazap interjected, after waiting for Tommy's line and looking right at me. Then after a well timed pause, letting me realize what he said, he laughed.

"Oh" I mumbled as I thought for a few seconds.

We had not seen any atomic bombs in the atmosphere for as long as I had been here on this job. We didn't expect the United States to shoot any. We didn't expect the Commies to test more than one or two in the atmosphere during the next many years. And we didn't want to see any.

He made me realize we didn't have any atomic bombs we might use to see if the satellite sensors were working correctly, or accurately, or even if they were working at all.

"Ok, so how do we do it?" I asked.

I knew he was leading me somewhere. But I didn't quite know where.

"We shoot a laser at it," Don Lazap instantly interjected.

"It fools the hardware into thinking a bomb went off." Tommy explained.

Excitement started to take over my emotions. We shoot a laser at it. Wow. I want to see this. I didn't know they did this. That's got to be fun.

We were going to shoot a powerful laser at the satellite. I could have suspected what "LAZAP" meant. But I just had to ask.

"What does LAZAP mean?" I asked Tommy and Don Lazap..

"It's a Laser Zapper. What else would it mean?" Don said, smiling, chuckling.

"Where is this laser?" I asked.

In a rush of thoughts, I wished he would say we get to go to some exotic location like the Nevada Test Site. I will get a big, expensive steak meal. Then we will go watch some pretty ladies dance around with no underwear again. And then go to work the next day.

Fantasizing, I realized "Maybe not." Maybe they do this here in New Mexico. I will get some kind of a nice trip to the White Sands Missile Range. South of here a few hundred miles. White sand dunes. Mountains to the east, with ponderosa trees. Whole forests of them. And Mysterious laser hardware.

"By the East Gate." he said, snapping me out of the fantasy.

"Really?" I remarked, disappointed.

"Can I watch?" I asked, hoping they would let me in on the fun.

"Sure, if you do some work while you're there." Don Lazap snapped back. Don sounded serious.

"I don't want you just hanging around getting in the way." he added.

He said it in a way that implied people must often come around, watch Lazap, do nothing, eat his popcorn and just get in the way.

I considered it an adventure. I presumed they thought it was work. But I could tell they really liked the idea of shooting a laser at satellites.

"We don't come back there until it is really dark," Tommy told me.

"Go home, have a good meal, get some rest. Then come back 10:30 pm or so, with a flashlight." he instructed.

"And bring a jacket. It gets cold," he added.

It was dark and the sky was clear above the semi-desert of Kirtland Air Force Base. In the crisp air I could see stars all across the sky. The city lights lit the sky a little, but not enough to matter. Without my headlights, I could not see enough to walk. It was pitch black.

They deliberately chose the blackest, clearest coldest night they could. It made for good satellite watching.

The LAZAP site was a square, inconspicuous, white metal-sided building about the size of 4 garages. During the day, anyone

could see it on the way out the East Gate of Kirtland Air Force Base. Except this was night.

The building was located about a mile north of the glide path that commercial airliners take when landing from the east to the landing strip about 2 miles to the west. That meant it was also on the ascent path when a commercial airplane would take off from the west.

The building had some sturdy braces on its sides, and what looked like some kind of railroad track thing attached to it. It was obviously some kind of mechanical contraption.

Once inside, I saw the telescope. It was an aluminum-bar-ribbed, reinforced aluminum tube almost 2 feet across and 12 feet long. Don Lazap had mounted it with a few strong supports that folded down somewhat so it would not poke through the roof.

Don Lazap used the telescope backwards. He shot the laser beam backwards, so to speak, into the eyepiece of the telescope out the front of the telescope and into the sky. This whole contraption was inside a metal building.

The room was full of all kinds of optical hardware, such as mirrors and clamps painted pitch black, and oscilloscopes, meters, wrenches, pipes, welders, telephones, chairs, paper, junk and electrical things everywhere. This place was real a mess.

A metal room, as big as an two person office, with no windows at all, was crammed into the building at the north corner. Inside the room was the laser and its power supply. The telescope was at the south corner of the building.

Outside, an old fashioned radar sat waiting to rotate. This radar was the kind that looked like a ten foot wide push broom held up in the air, wrapped in a smooth tarp and painted green, and connected by a fat cable spinal cord to a green metal military house trailer next to it.

"So, how does the telescope point to the satellite?" I asked, looking around at the building.

I didn't see any astronomy dome here anywhere.

"We move the roof back." Don Laser said.

"What?" I responded, surprised. They laughed. Nobody ever expected the roof to move back, so they always got a laugh out of that question. Everyone asked how they got the telescope inside that building to see stars outside the building.

The roof was on wheels. When it was time to LAZAP, they moved the roof back. The whole top of the building was open to the sky.

Now it was time to shoot the laser and they pulled back the roof.

The night was so cold. Tommy told me we had no choice but to pick a cold, dark, clear night, otherwise we could not see the satellite. While waiting around I thought of all kinds of reasons

why we were doing nothing and waiting in the dark. I thought maybe we would also have to wait till late at night for the satellite to get into the right position in the sky. Maybe we waited for the airplanes to quit coming by so often. I didn't know. It was too cold to ask why. The wind blew and chilled everything, and, I thought to myself, "it was freezing my eye balls."

The only place I could get warm was in my car.

I thought about that laser. The laser was so powerful it could blind 10,000 people all at once, if the beam were carefully split into 10,000 little beams and shined directly into their eyes.

I thought about the satellite. The satellite was out there in the sky somewhere. Tommy said "somewhat south and somewhat up." It was about 22,500 nautical miles away. I never did care much for knowing what star was what. North star. That was it. I wasn't sure where the geosynchronous belt was. It was just out there in the sky somewhere.

I could work the equations to point in the sky, but that was completely different. That was equations.

Then an airplane came by, landing from the east and approximately crossing our path. My thoughts raced.

What! Hey! This is NOT something the leaders of the laboratory want me to be talking about in public.

If that laser beam beams itself into the windshield of the airplane, the whole cockpit will light up 1000 times brighter than a flashbulb. The pilots could go blind instantly, just when they are landing.

The old fashioned Army Radar machine was turning its radar dome, scanning the sky. Some young guys were inside the green metal building, huddled around a glowing green picture tube radar screen. The tube showed that line scanning around just like I saw in the 1945 war movies. This radar was exactly like the movies. It was real. The two guys inside were carefully watching that radar screen.

Each one was holding a button connected by a long wire to the laser switch. If either let go of his button, the circuit is broken and the laser won't fire. That's the safety mechanism. Anybody could stop the laser by just letting go.

Outside the radar shack, 3 different people were all bundled up in winter Eskimo suits. Two had binoculars. One had some kind of spotter telescope on an expensive tripod. All three were holding a button connected to that long wire.

We were still waiting.

Before he hooked up the laser, Don let me crawl up the metal ladder and peek into the eyepiece. Sure enough, there was a spot of light thing he said was a satellite. It looked like a star. The only difference between it and the other dim stars is that it was standing still. All the other stars were slowly moving past it.

I saw with my own eyes what they meant by a geosynchronous satellite.

This meant it was time.

Don Laser started the countdown. At zero, I heard a faint t-BOOMPt, with a slight pop to it. I didn't see a thing. No big red flash.

"Hey, I didn't see a thing." I complained.

"You are supposed to open your eyes at "fire", not close them." Don said, laughing. The others chuckled at me, too. I was the neophyte with a Ph.D. It made them feel good that they knew more than a Ph.D.

Tommy told me that "The normal thing people do is to hold their eyes wide open during the countdown, and then, just at the last second, right on 'fire', they blink, ".

I see. All during the countdown I was straining to hold my eyes wide open, with the cold air freezing my eyeballs. Just when he said "fire," I blinked. It was a natural reaction. Apparently, one has to be taught how to deliberately watch a laser shot.

"Train yourself to close your eyes during the countdown, 3, 2, 1, and *open* them on "fire." " Tommy instructed me.

An excited technician heard my trying to see it and told me "it looks just like an arrow going right for the satellite. Just watch." He was really digging it.

I tried. The next countdown began.
"3, 2," I heard.

I deliberately blinked.

"1" the countdown continued, as I deliberately opened my eyes and stared.

"Fire." I heard over the loudspeaker.

I didn't see anything.

"Why don't I see anything?" I asked.

"You aren't looking at the right place." someone else said, friendly, and trying to help me see it. He pointed to some stars in the sky and said "it goes right there."

I didn't know stars, so I didn't understand "right there."

"How come I can't see it?" I blurted out to the three technicians who were laying in portable picnic chairs, facing the sky.

"Well, the laser beam flash is so short that if you aren't looking at it, you don't see it," one of them said.

"You have to know where to look, or you don't see anything," another one said.

The first one took out his flashlight and pointed it into the sky for me.

"It's right there," he said, holding the pointed white beam so I could see.

"3, 2, 1 fire"

And nothing happened.

"Airplane." someone said.

The red and green lights of the airplane stood out. No landing lights, just the red and green lights at the tips of the wings. One of the spotters let go of his button when he saw the airplane

That's what they said, and I saw it work. If anybody let go of the button, the laser would not fire. And it didn't.

The airplane was way out of the way, down by the Manzano mountains, 30 miles away. Way out of the way. There wasn't any way they could have hit it. And the spotter was doing his job.

"3, 2, 1, Fire" the voice on the loudspeaker calmly spoke, sounding bored.

"I saw it!" I yelled.

I saw a flash, out of the corner of my eye. The next three shots, I saw a flash somewhere. Until I got the hang of it all I saw was a flash, way to the left, or up, or somewhere, but not straight out.

It took a dozen more shots, I finally started to see the arrow. It sure did look like the beam left the laser and shot, travelled, like a beautiful arrow, straight into the dark sky, right at the satellite.

No one could see the satellite without the telescope. But the laser shot right at it, and we could all see it shooting, like an arrow.

"This can't be" I told Tommy.

We could not be seeing the laser beam going out like an arrow. It's all over way faster than our eye could possibly see, and I complained, puzzled.

"It can't take that long to get to the top of the atmosphere." I tried to explain.

"You can't see a beam moving at the speed of light." I asserted, emphatically, trying to explain more.

I knew that the air wasn't any more than 20 miles up, and 40 miles across. The laser beam would travel the entire 20 or 40 miles in less than a 1/5 of a millisecond. Eyes don't respond that fast at all. That's 75 times faster than the frame rate of a TV or movie.

"Doesn't matter. It looks like it" the technician with the flashlight asserted right back.

He was right. It looked like it every time.

This was fun.

And when it was all over, I realized that I didn't do a thing. I got away with just watching.

This was so exciting that I brought my young daughters the next time we did it. Jennifer was about 10 years old and Alyson was about 8.

After I looked into the telescope we let Jennifer and Alyson see. Don and I let them crawl up the 8 foot flimsy aluminum ladder, in the dark and freezing cold, next to bare high voltage wires, C-clamps and sharp metal angle irons, in the freezing cold, so they could look into a telescope.

Neither could see much of anything except black. The eyepiece is like the eyepiece of binoculars. Unless the eye is up against the eyepiece and looking straight into it, one sees nothing, darkness, black. But they acted like they saw stars. They were brave and cold.

SAFETY HAZARD.

I realized this was a safety hazard. I am sure this would be forbidden. One can not place children in such dangerous situations.

It was dangerous. Someone could get hurt. But we were being very careful. I thought that those greenie extremist safety cops would just have to come out here at night and catch us. I wasn't going to tell them.

Besides, it was NOT that dangerous because the hospital was just 2 miles down the street, and we had flashlights.

The satellite designers and operators needed this LAZAP so much and it worked so well that they gave Don Lazap money. Don built a professional telescope system, complete with all the safety attachments included. He placed a 3/4 million dollar, completely electronically controlled telescope from France in a pristine astronomy dome building built with new construction blocks. No more old broken down used trailers. I smelled fresh paint and read the brand new shining serial number plates. A big, 12 inch pipe brought the laser beam into the telescope from a perfectly comfortable laser building next door, as big as 3 offices. The entire laser and a whole 3 ton table of optics sat comfortably inside that new building.

A comfortable, well heated trailer control room sat next to the old, removable roof building, now used for storing parts. We sat by

consoles with TV screens showing what the telescope saw. We saw the stars on our TV screen.

A moment before LAZAP "fire," a mirror automatically turned and switched our TV camera out and guided the laser beam into the telescope.

The prettiest and biggest computer monitor in the whole trailer, complete with crisp, hi definition text, maps and bright colors, was a direct telemetry link to the Albuquerque Air Traffic Controller. The old, World War II radar dome still turned, the spotters still looked out for airplanes, but the Air Traffic Controller had a direct link to our laser.

Even though we had a TV camera to look through the telescope when the laser was not shooting through it, the telescope was fascinating. Don let me look directly into the telescope at Saturn one night, before we did the LAZAP. Saturn looked yellow. Smog yellow.

On another night we pointed at Jupiter's moons. Not much to see on the TV monitor, but spacey to do. We got to use a joystick to point the telescope around. This was so interesting that Danny Holloway brought some hot looking girlfriend out here to watch. She was interesting. I showed her whatever I could to keep her around. But it didn't work. She went off with Danny in the dark anyway.

My computer in the main building was connected directly to the control room. We computed calibration constants from the LAZAP signals the satellite picked up. Don Summers ran the computer codes. My job was to tell Don Summers what a good job we were doing collecting location data, recalibrating the software, and locating the laser flash using the satellite. I had figured all the algorithms. He got to make them work.

We did our job well. Our software calculated where the "bomb" the satellite saw apparently hit. The software would *nearly* always tell us that "a big atomic bomb apparently went off about 2000 feet east of Don Summers and my office."

"Nearly" was a significant description of what went on. We noticed that the software would give us a wrong answer depending on what season it was.

"The sun is wrinkling the satellite" Tommy Thompson told me. Every day the sun angle changed on the satellite. It wrinkled, just like a cookie sheet in an oven. The satellite would wrinkle and unwrinkled every day, as the sun moved in the sky. Different parts of the spy satellite would get hot and then cool off. That would very slightly twist the satellite optical telescopes. When that happened, the software would tell us "a big atomic bomb just went off somewhere else." Bad dog.

"The wrinkles change with the seasons" Tommy said. Sure enough, every season was different.

When Don Summers and I included the calibrations for each season, we got gold stars. Good dog.

"You get to work overtime till you get it right." said Dr. Larry Ellis, our new boss. He joked, and he didn't joke. We didn't get paid by the hour. We got paid, and the job must get done.

It was obvious. I knew it without proof. Everybody must be shooting lasers into the sky. The Bad Guys must be doing int. We can't be the only ones shooting lasers at satellites.

And I also knew: the target satellites were not blowing up, either.

I realized that I could do this kind of work till I retired.

Unhappy in the nice new offices

And behold, completely new offices appeared. Modern trailers with clean hallways, big enough for offices on each side of a hallway, with individual rooms. some offices had doors that locked. Each room even had a window. The entryways each had a clean, new aluminum metal step. Clean, new bathrooms. Computer terminals everywhere. Outside and away from the big huge bullpen building. Separate. Comfortable. My office even had *two* felt boards. That was status, and a window.

I kept my desk clean and I had a nice computer. This was great.

My new boss, Dr. Larry Ellis, smiled a big, wide smile and spoke with soothing tones of voice. I thought he could empathize with everyone he met. He got excited in a nice way about all kinds of things, technical or not. And Larry did NOT make people mad, like Dave Henry did. Dave never made me mad. But he sure aggravated some of the others. Everybody got along with Larry.

"I'm aggressive, but not ambitious." he once told me.

Sharp women with technical degrees were coming into the group fast and furious. For some reason, these females really seemed to be taking over. I thought it curious that they deserved what they were getting. This was NOT affirmative action. This was pure meritocracy. They were dominating by merit.

I should have been happy. But it was not turning out that way.

I got to work on a unique, multi-sensor laser and satellite project as the Project Leader. The good parts included working with Ray Prior, a marvelously productive hardware / firmware fellow, and Dr. Kathie Hiebert-Dodd, a highly productive mathematical software creator/implementer. The bad part was what the project philosophy was supposed to be about. I will let some boss tell of it. If they do, I will chime in with hisses.

I also got to be Project Leader of a new and different satellite system, as well as the original one. I got to stand around and delegate for the late night LAZAP's. I got to be head of a small team, with Dr. Ron Schmitt, a really good mathematician, as one of

the team members. I got to have Merry Peterson on my team, a mathematician who went to the same university I did, and almost at the same time.

One time, Merry was so full of mischief that she jumped on my lap to make our relationship look risqué to the Air Force, official visitors about to enter my office.

And I got to work with Jerry Van Slambrook, the guy who made networks really work.

Everyone seemed to get along with each other. Maybe I was dreaming, but I thought we all got along.

I should have been happy.

My office was in the Eastern set of trailers, with a wonderful window view of the mountains to the east. Debee Risvold is across from me, Marjorie at the end. They both did software,

My social life went up a notch. Debee and Paul Beck, a hardware guy, convinced me to take up clogging, after hours. That was really fun. Every Thursday evening I got to go dancing with Debee. Paul would not show up that often. Debee clogged very very well.

Of course, Terri my wife didn't mind at all, that I would go dancing alone with Debee every Thursday evening. Terri was very open minded.

Terri knew. It was much less exciting than all that. If you ever watched cloggers, you would see that nobody gets to touch anybody else. Not like real dancing.

I should have been happy.

And I was unhappy. Something was missing. I was still going nowhere. Clogging with Debee was more fun than work. It should not be that way. Work should be more fun.

I could work here till I retired. The spy satellite topic was not about to go away. We were making hardware and ground stations for a war that we all knew was just not going to happen. We would all lose our retirement if it did. The Russians would lose theirs, too. Everybody knew it.

And I could feel that I would never do anything great working with spy satellites.

I liked the mathematical coordinate transformation part of my job. I liked the people, and the smart, genetically superior females. My home was wonderful. I could be as secure as I wished.

But there was not one thing here that was great.

- **Spark Exploder**

- **A Spark Exploder, Space Dust Rocket**

Unhappy with the meaningless job, I kept looking for ways to escape. I kept looking for a way to make a powerful rocket to let us leave Earth, to travel the solar system. Any clue would do.

My day job on spy satellites paid the mortgage. Space travel had to be just a hobby, a fantasy, a daydream vision.

Then, two friends gave me puzzle pieces, clues, that ignited my space fantasy.

The first clue: Merri Petersen, computer geek space spy working for me on my project, told me she knew of people who said the water in space was on the near earth asteroids. I didn't know what "near earth asteroids" were, but I believed Merri.

One could get hydrogen from water. Then we could fuel the NERVA propellant tanks. All we needed would be some water in space. Merri told me it was there.

The second clue; Dr. Gere Harlan, a physicist, excitedly told me how fast the particles exploded off his spark exploder. He said they went "5 to 10 kilometers per second." That really caught my attention.

Gere was so excited about it that he got me excited about it. I thought the "5 to 10 kilometers per second" number was way better than what NERVA could do. This could be a clue, I thought.

Excited and ignorant, I saw how his electric spark exploder could be simple. He used an electric spark to blow up dust. There was plenty of dust in space, on anything you landed on, so all the dust could be "rocket fuel", propellant for a rocket. We could have nearly unlimited amounts of rocket fuel.

We could inhabit the solar system. We could go to any planet we wanted.

Gere was making and perfecting spark exploders to detonate high explosives. They called it a "slapper." His exploder would be more safe than a blasting cap.

{{ image: simple slapper exploder, with dust flying off like rocket exhaust }}

All I would need was an electric generator and some dust. All the puzzle pieces were there! I knew people wanted to make electric generators in space because President Regan was paying for a Star Wars program. The Star Wars guys were figuring how to put high

power electric generators in space. There was plenty of dust in space. I could probably land on any asteroid or on the moon and get all the dust I wanted.

{{ image of bag of dust from some space object }}

To make a propulsion system using Gere's spark exploder, all I needed to do was to put a pinch of space dust on top of an exploder like Gere said. Then I would have a simple rocket and a simple propulsion system way better than NERVA and we could take 1000's of people to Mars. It would be better because I could just "refuel" my dust bag anywhere along the way. Like unlimited gas stations in space.

We could start an Exodus, to leave Earth. We could inhabit space. Thousands of us at a time could travel happily to Mars, and beyond.

{{ image of bag of dust, electric generator, spark slapper exploder }}

All I needed was an electric generator that would supply 1,000,000 kilowatts of electricity to the spark exploder.

Woe is me. Nature was *not* on my side. Nobody knew how to make that kind of electric generator in space. The best they could figure, not do, was about 10,000 kilowatts, and it would weigh more than an entire NASA Space Shuttle. The best anyone actually did was about 40 kilowatts. That 40 was a lot less than the 1,000,000 I needed.

It would have been worse if I had stuck to it. I did not know that "... 5 to 10 ..." was no better at all than NERVA. I did not know my rocket science, but did not know it.

My wonderful idea was not going to work.

This was more childish than a high school senior project.

Space travel was screwed.

If I had done my homework, I would never have taken this path. The "5 to 10 kilometers per second" was not better at all. When you don't do your homework, you take wrong paths and don't know it.

That's exactly what I did.

- Comet Water from Dr. Marsha Neugebauer,
- and Don Summers' " ... clear profit"

Comet Water In Space

Every once in a while Nature *is* on your side. While we were working on our spy satellites, a lady named Dr. Marsha Neugebauer visited the National Laboratory from the Jet Propulsion Lab at Cal Tech. Funded by NASA, she would tell us about the comet Haley and about some kind of plasma related to comets. I went to hear her speak.

She would probably have clues. I knew of a great trick to use on such important people who present their work in public. I could trick them into volunteering clues and doing my homework for me.

When a speaker gives a talk, the speaker wants people to ask questions and give them attention. No matter how important they are, they will talk with you when they are done if you ask them a question during question/answer time. They will recognize you because you asked them a question.

You just need to elbow your way to the podium as fast as you can, and immediately after they are done talking. Use your whole body to get in the way of the other people trying to do the same thing. This is a trick I learned from the Aerospace military industrial complex. It really works.

So, I did just that. I asked her some question, I can't remember what it was. And then when she was done speaking, I rushed up to the podium.

Would she know of anyone who knew where there might be water in space? A hunch told me she might know. I told her I wanted water, real water, not just the kind of water that is locked up in a sidewalk.

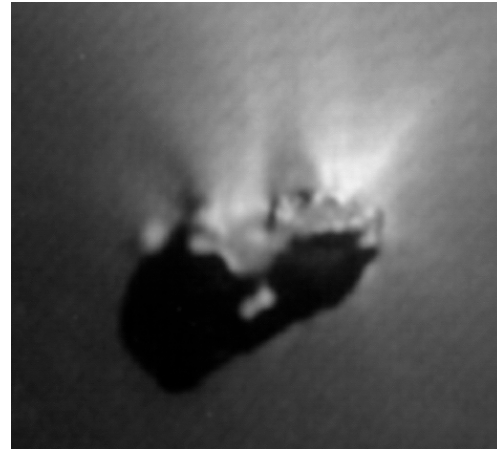
A sidewalk is a rock like a rock in space, like an asteroid. If you heat a chunk of your sidewalk in your oven, to as hot as the oven will go, it will crackle and spit, and some water boils off. Sometimes a rock in the middle of a campground fire pit will explode and hurt people, kill them even. That's how much water there can be.

"Not that kind of water" I demanded of Marsha Neugebauer.

I expected her to tell me there wasn't any.

Instead,
"Right here," she said
with an excited smile.

Immediately she pulled out a fresh, new picture only she and her friends had seen, of the Comet Halley. She pointed right to the white spot on the comet where the water was spewing off, making a clear vapor trail of fog in space.



\ comet_halley_bw.jpg

"Wow!" I emoted, totally surprised.

I became instantly serious about nuclear rockets again. I got all excited.

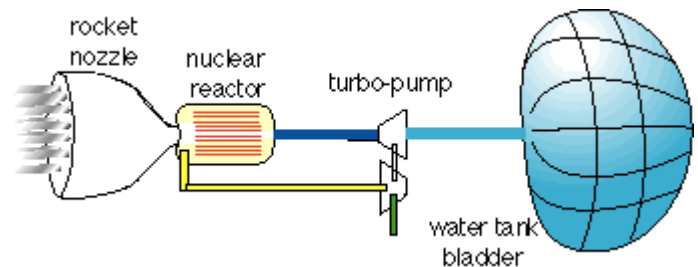
Since I could see with my own eyes there was at least some water in space, I calculated using water instead of hydrogen in the NERVA type rocket. That would make a steam rocket. I suspected it would not work very well.

You would think that putting water directly into a rocket would be simpler than having to first separate out the hydrogen and then freezing the hydrogen to *minus* 400 Fahrenheit.

I would use a rocket something like NERVA and use water steam instead of hydrogen gas as propellant. A rather simple calculation showed that the nuclear heated steam rocket would work about 400% times worse than NERVA.

At that time I had not yet learned to figure orbital transfers, so I did not know if the steam rocket was bad or extremely bad. I knew it was not good. I set it aside for a while.

However, the steam rocket was so simple I could not let go of it. I kept drawing it and looking for more accurate ways to evaluate it anyway.



Steam Rocket:

heat water using a small nuclear reactor. Guide the steam into a rocket nozzle.

What could be simpler? We would pump water into the nuclear reactor. The nuclear reactor would boil the water into steam at a temperature that

would make the steam pipes glow bright-orange hot. The hyper-hot steam would expand in a rocket nozzle directly attached to the reactor.

I kept at it because Dr. Marsha Neugebauer and my coworker named Merri Petersen both insisted that there was water in space, and Merri told me who was working on it.

All excited, I told Don Summers how wonderful it was, instead of focusing entirely on spy satellites. I was the Project Leader and Don was my mathematician.

Don Summers, who was always focusing on work, on spy satellites, told me to my face, poking me in the chest as he said it:

"The conquest of space is going nowhere until there is a clear profit."

Those were his exact words.

Unfortunately, he was so right that he tattooed this day in my memory.

- **Forbidden Question at Vail**

A Forbidden Question

Sometimes, you need to back off, relax and *ask Forbidden Questions* to make it all come together.

Relaxing for an Aspie can mean calculating rocket equations. I would rather do that than go fishing. Fish are slimy. The fish hook is dangerous and can hook your finger and make blood come out. Someone else's hook can snag your eye. They don't look when they wave that long pole with a hook on the end of the long string.

You can buy peeled fish in the store. You can't buy a rocket to take half the United States to Mars in the store.

On a ski trip to Vail one April 1987 I discovered a stunning way to use the energy and propellant of a nuclear rocket. It was completely puzzling, and it changed the direction of my career.

I was on vacation. This meant I could ask really crazy questions and figure their answers, regardless if the questions were stupid or crazy. I could ask Forbidden Questions and get away with it.

The Forbidden Question was: How hot should I run the nuclear rocket?

If you ask that question the rocket scientists will think you are stupid and treat you like a journalist or English teacher. If you are an Aerospace Engineer or Rocket Scientist and you ask that question in public, they will avoid you every chance they get because you would be a crank, quack, know-not. The answer is always "as hot as you can get away with." Don't Even Ask.

But, I was on vacation. It was my own vacation time. I was in the back seat of the car and Jennifer was driving. I could relax. And I could ask any damn question I wanted.

A very subtle difference between familiar rockets and this nuclear rocket was that the propellant was separate from the energy. The propellant is actually a coolant, like the radiator of a car. If your radiator clogs up and blocks the coolant flow because you didn't change the antifreeze like you were supposed to and it gunks up, then the engine heats up and can break. If you run the coolant too fast, because the little valve thingy in the radiator hose is broken and you don't know it, the engine never warms up and your car sputters and won't run smoothly.

I knew I could do this with the rocket. If I ran the propellant through the nuclear heater very fast, the temperature of the nuclear rocket exhaust would drop. I would use much more propellant than if I ran a small amount of propellant. What would happen if I did that?

It's a stupid question. The rocket performs worse. Ask a Rocket Scientist

But we were on vacation, and I was trying to launch everyone in the USA on a trip to Mars, 1000 people at a time. We were stopping at the nearest space gas station, loading up with water, or whatever, dust maybe, and then tour on to elsewhere. Mars was a low grade destination. But Mars was popular.

Since we only had to pay a lot of money to launch the space ship, without its propellant "fuel," just like you buy a car or truck, all we cared about was the cost of the launching the ship.

You never buy a car with a gas tank that holds all the fuel you will ever use in the car. That's stupid. But that's what a NASA rocket does.

That is why I asked the Forbidden Question.

Life is full of Forbidden Questions like this.

The propellant was cheap, dirt cheap, space rock cheap. It was on one of those near Earth Asteroids that Merri Peterson was talking about. Or, it was on a comet Dr. Marsha Neugebauer showed me.

I wanted to figure it out for myself. This was fun. The figuring was fun and simple.

So, in the back seat of the car, on the way to Vail Colorado from Albuquerque New Mexico, I asked:

What if you are not launching the propellant?

What if you are sauntering up to a space gas station, to a comet or near Earth Asteroid?

In that case, you only care how much it costs to fill up, and you

know that is cheap. All you launched was the space truck with an empty tank. You did not have to pay for all the fuel it would ever use, like a NASA rocket does.

On a hunch, I wondered what would happen if I only cared about us, which was us on the rocket ship, and not about the propellant, the "rocket fuel."

This really was different.

When I finally figured out how to write the rocket equation with the energy source on the ship and the propellant at the gas station, *separated*, it was too simple. It was so simple a junior in high school could figure it, almost. It was so simple that I decided to find what number the answer would actually be.

Hot rocket? Cold Rocket?

I expected "hot rocket" because this was rocket science.

But it could also turn out to be "cold rocket" "lowest". When you change the rules, you *could* get a completely different answer. You *often* get a completely different answer. This could have been like that laser phasor beam I had worked on long ago. Long ago, I got "middle" as the answer.

Nature is always a bitch. She is almost always not on your side. That's what we should expect when we do this kind of thing.

Sitting at the breakfast table at Terri's cousin's home, finally at Vail, Colorado, our host Michael Roessmann handed me a cup of coffee and then started mixing the pancake batter.

My face was pointed into the calculator and a small piece of paper with the equation. My simple pocket calculator iterated the solution to the transcendental equation to 2 decimal places. I was done before Michael served me a hot pancake.

Surprise!

Completely unexpected surprise.

Nature was on my side!

The answer was not only "middle" and *not hottest rocket*, but was even better.

It was a number that was about like what the steam rocket would deliver, bad as the steam rocket was.

If you only took high school science, you could do this.

The rocket equation was very simple:

$$d = V \ln((s + m) / s)$$

"d" is the "delta V" your rocket can achieve.
Bigger means better, and farther.

"V" is the specific velocity, the velocity of molecules of the propellant.
You will figure the best V. Bigger V is harder to do.

"s" is your ship.

You are in it. You bought it to ride in.

"m" is the propellant mass,

You buy it at some asteroid to fill up your tank.

"Ln" means "natural logarithm",

Use your handy, \$5 pocket calculator

The energy E is as much energy as you can get out of the nuclear reactor or atomic bomb. The energy all goes into the rocket exhaust:

$$E = 1/2 m V^2$$

That's it. All you need to do is find the V that gives you the biggest d.

Calculate.

You find out that V is about 2/3 times d.

!! Hey !!, Nature was on your side.

If the " 2/3 " had been 15 or some other large number, you would be screwed.

It would mean the best rocket would have to run really melting, vaporizing hot. Engineers would be right and would avoid you.

If the " 0.6 " had been 0.01 or some small number, you would be screwed.

It would mean you would have to buy the whole asteroid to gas up.

Anything greater than 1 means Nature is a Bitch.

But when it was just *under 1*, it meant you could run the reactor cooler, use a little more gas, and go a lot farther.

Nature was Mother, not a Bitch.

The absolutely unexpected and amazing thing was that the *best specific velocity* was about 2/3 of the velocity needed to get to wherever, like to Mars. To Mars, the particular answer was "steam rocket."

The steam rocket would therefore take a bigger payload to Mars than NERVA!

I was stunned.

I was so stunned during the day that instead of focusing on skiing, I fell and hurt my shoulder. It hurts when I raise my arm, to this day, 20 years later.

This was heresy. I was a heretic. But the equations kept insisting on the heresy. The equations kept saying that the best possible thing we should do to go from Earth to Mars was to use a crummy steam rocket, and definitely *not* use the super high performance NERVA rocket.

Subconscious Magic

Why did I ever ask that Forbidden Question?

Probably because my subconscious remembered something

crucial.

Your mind works deep and it works when you don't realize it. Some brain surgeons after WWII found out by accident that if they tickled the right brain nerve, one would have a complete replay of a point in time, complete with background sounds and with the intense emotions of the moment.

It seems that the brain may record every single perception in our lifetime. It doesn't recall them so easy, but it does record, apparently.

In this case, my subconscious noticed that this problem was just like that laser phasor beam problem, and then it remembered the answer is probably a "middle".

I did not know that I had subconsciously remembered the lesson of the laser phasor beam. The subconscious remembered that the energy source had been a laser, and in this case it was the nuclear heater. It remembered that the mass had been the target itself, and in this case the rocket propellant.

It remembered the objective: bash it as hard as possible. Bashing a target to bits and bashing a rocket from Earth to Mars would be the same thing.

It remembered the question: do we energize most, middle or least? The answer was "middle."

Therefore, Magically, the Answer had to be "middle."

To my scheming, devious, subconscious mind, the only suspense was "where is middle?".

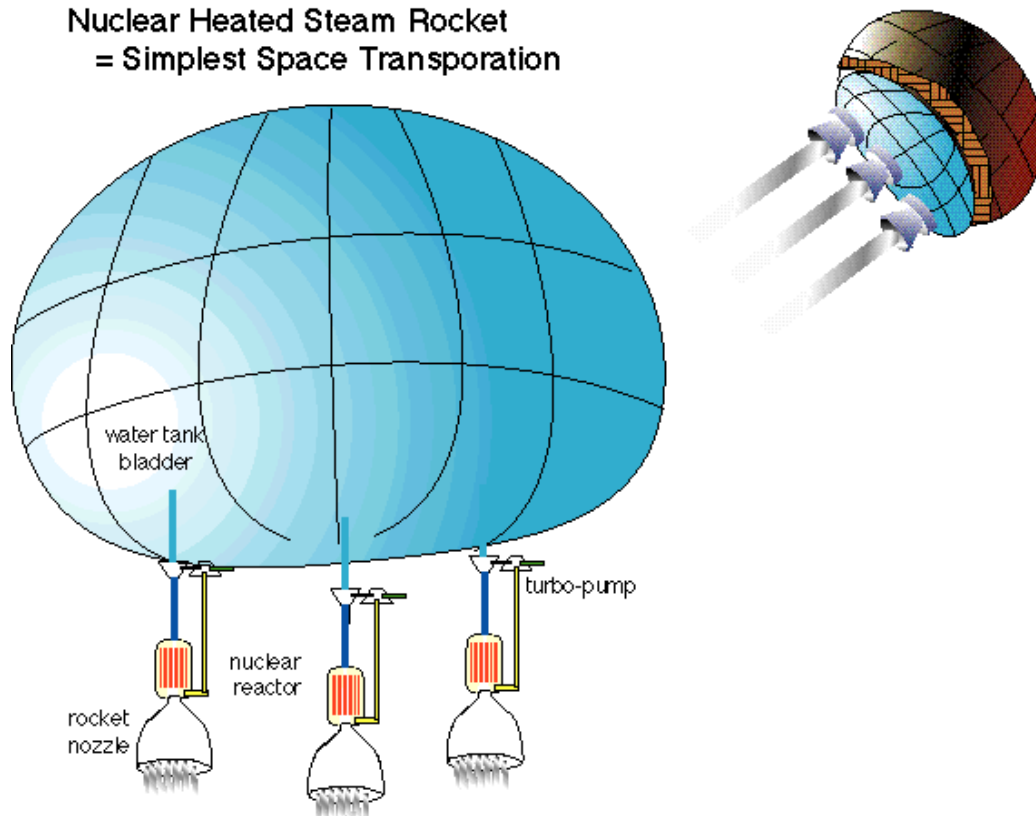
It was a coin toss whether Nature would be a Mother or a Bitch. For once she was Mother Nature on our side.

Magic.

We are all too busy to do our homework. If I had done my homework very carefully, very tediously, I would have discovered that those who designed electric ion rocket engines had discovered the exact same thing I did, but 30 years earlier.

The main scientist who did the work had died, so he did not talk about it much anymore. Therefore, I was not such a heretic after all, but no one knew it. Nobody did the homework. Not even NASA.

Nuclear Heated Steam Rocket = Simplest Space Transportation



A steam rocket uses water that is stored in a very large bladder. Nuclear reactors heat the water, boiling it into super hot steam. Rocket nozzles use the super hot steam to propel huge payloads. It makes the simplest complete system in space.

- **General Dynamics job**

A Job At A Space Ship Company

The last thing I did at Sandia Labs as a Project Leader for Spy Satellites was to ask my boss's boss, Gary Masters, how I could do this marvelous discovery for rocket engines and space transport in his space department.

"You can't do that and work here," he said. It was epochal.

Instead of keeping a nice, secure, profitable job as a space spy, I gave up my job at Sandia National Lab, the nuclear weaponization facility. I left.

A former colleague, Dr. Dave Freiwald, asked me to be the Program Manager for a Satellite to Submarine, Laser Communication system program. The job was an adventure, a job in San Diego with General Dynamics, a company who made rockets and space vehicles for the US Government. I had joined the "Laser Systems Laboratory" of General Dynamics Space Systems Division.

Inhabiting the solar system was still just a hobby. My hobby goal was to find water in space, and then to get General Dynamics to get a contract to go there and exploit it, use it, make it work.

And then huge number of us could leave the planet.

I believed it completely. And my Forbidden Question was proof. It drove me, like Religion.

At General Dynamics, a space ship company, I looked for anyone who would know where water would be in space. Still, almost no one knew the answer. This was not a popular astronomy to do. Almost no one did it. There is no glamour in finding rocks or ice cubes in the solar system.

The problem was to find water minerals or ice in space, and near enough to get to and accessible enough to be useful.

I talked about it to anyone and everyone. I knew that I had a key to the game: a calculation that showed that steam rocket propulsion would be able to send many more people to Mars than anything yet proposed.

We could inhabit the solar system using a steam rocket, and I could back it up with my equation. That's what I thought. I was sure of it. All Visionaries are. We almost never know how hard it will be.

A Visionary fellow named Dave Nickerson heard me.

- **Starship Submarine**
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Submarine Starship

The Submarine sailors of the United States Navy startled me. They were highly technical, highly intelligent, and they told me their submarines were like space ships.

It was middle of November of 1989. We were in Groton Connecticut, a the General Dynamics submarine factory. They called this place "Electric Boat." I was one of a few VIP's being personally escorted on a tour of the submarine factory. We were VIP's from Elsewhere, some other General Dynamics division. There were 120,000 people in General Dynamics.

It was as cold as one would expect on the east coast right next to the ocean with a wind blowing on a cold morning after a light frost. It was a clear day, but chilly. The sun was just rising over the buildings. I was really glad I wore my best, dark grey, cashmere overcoat.

This was my first time at a real, ship building, General Dynamics factory. Workers were lined up at the security gate to start their day making nuclear submarines.

Dr. Bob Geary was assigned to be one of our "Old Bulls," one of the Guardian Angels in charge of making GD LSL a rousing success. He had been a Vice President at General Dynamics, Quincy, before they closed it down.

"General Dynamics takes care of it's executives," he commented when we visited him, in a small, parking place office on the 12th floor of GD headquarters. He was waiting for something big to happen so he could take it over and run it. Somehow he didn't think we were going to fit his Vision, but he played along, most of the time sarcastically.

According to his sneers, we were wimps, effete, and not bold or brazen enough. He even said bad things in front of us about our boss, Freiwald, behind his back. I thought Geary was evil.

"Will the Program Manager for Satellite to Submarine Laser Communication from the Famous General Dynamics Laser System Laboratory, please step over here, ahead of everyone else trying to get into the submarine factory," Geary beckoned half

joking, with a tone of thinly veiled, aggressive sharp sarcasm I clearly sensed.

The VIPs from GDLSL were waiting in the wrong line to get through Security. We thought we were just like everybody else. Everybody else was coming to work and there was a long line.

However, we were The Suits. That's what the Blue Collar workers called us. They were Blue Collar, Union. Because we were Suits, we got to go around the line and get special treatment.

"Suits." We were "Suits." The union workers hated the Suits. I did not quite get, it at first. From what I could see, most of the high up, Vice Presidents of General Dynamics I had met thoroughly resembled cheating liars out to clean your clock, eat your lunch, and get yours, whatever yours is.

By the standards of the places I had spent nearly 20 years around, like AT&T, Sandia Labs, Los Alamos National Labs, these guys were evil. The Suits were always aggressively finding ways to screw the workers. I had never met any group like these managers in my life.

I thought perhaps the entire industrial world might be the same. Ford, General Motors, Chrysler, Caterpillar, International Harvester, Fruehauf, any big company with big competition and whose objective was to make money, they were all candidates for being evil.

In sharp contrast, the National Labs where Dave Freiwald and I came from were out to fulfill Visions. Here it was different. There seemed to be no vision.

After about an hour of introductions and feather fluffing, we began our day with a tour of a Big Boomer Submarine in the process of being built. The prospect of this excited us for days before we came here. None of us had been in a submarine. All of us came from science and engineering laboratories.

A young guy, younger than me, named Dave Nickerson had just started hanging around GDLSL, as an emissary from a Washington office. Dave Nickerson was the youngest of the Suits, younger than me. Some were ex U.S. Navy. There were many Washington offices. He liked GDLSL because lasers and satellites were flashy, more spectacular than a submarine. He had worked for the office of the president of the Electric Boat division here. He knew everyone and they knew him. He could walk through any door. He was befriending us, and we liked that.

"Please descend into this Starship Submarine, through this rather small, metal hole." Nickerson said to me, as we entered the Trident "boomer" submarine.

I noted that he used the phrase "Starship." Before we visited Electric Boat, Dave and I had talked about space.

The submarine was almost finished, but still under construction for the finishing touches. To get into the submarine I had to ignore the almost jagged, 3 inch around, 5 inch thick metal things, knob like things, round elbow things, big bolts and nuts and latches that work

the hatch. The nuts on the bolts were as big as golf balls. Everything on this steel boat was massive.

"Try not to slip and fall 10 feet as you descend." he half joked.

We had to go through the ritual of entering like U.S. Navy submariners do, through the small hole in the top. I guess this hole was a bit like that round, hatch door the astronauts go through from one module to another. But astronauts float thru. Nickerson was joking.

I almost slipped. I really could have fallen 10 feet on to hard metal things. If I had a bad back or an arm in a cast, I would probably have had to stay out. This was certainly a physical place.

The workers must have been getting into the submarine some other way, because there were hundreds of them, all over the inside of this monster submarine, working with all kinds of tools and paint and wrenches and heavy cables. There seemed to be 3 or 4 floors on the part we were allowed to walk through. The lights were bright enough to clearly see everything.

Everything was made of metal. Walls. floors, hand railings, no matter what. Along every hallway I saw pipes and tubes bolted to the wall, with valves or switches connected every which way.

In some places I saw levers and rods, real mechanical devices, and coil springs 5 times bigger than what you would see under an 18 wheeler. No matter where I looked up at the ceiling, no matter where I was in whatever part of the Starship Submarine, I always saw more and different kinds of pipes and cables and valves, switches and more pipes, pipes of all sizes, pipes attached to the walls, going everywhere. This was definitely NOT like an airplane.

I had my best Pentagon suit on. We were scheduled that afternoon to meet with the President of the General Dynamics Electric Boat Division. We were all prepared to show how smart we were. Freiwald had us prepare piles of viewgraph overhead transparencies, enough to keep the meeting going for 10 hours. We were not dressed for this steel boat tour.

We were traversing a passageway-to-be that connected what looked like all 3 floors. I could see up and down to the other levels. There were plenty of lights everywhere. Workers were everywhere. They were painting and had scaffolds and boards and sheets on the floor we had to walk on.

When we walked by the white paint job these guys were doing, and when I saw the white spots of dripped paint on the floor, one as big as my hand, fresh like it had been just dropped as we walked by, I realized I was a Stupid Suit.

These guys would "accidentally" drop white paint on my suit, and I would look like a Dumb Suit in the Big Meeting.

There were also oily things around here, unfinished, dirty things. I started to watch out for everything, not to bump into anything, and to watch out above my head.

As we wandered through the ship, I watched the expression on the faces of the workers as we passed. They did not like us. I could see it.

Dave Nickerson was ahead of us, telling us about something or other. He reminded me of the conversations we had had before we came here.

Dave was always trying to find new things that would change the world. Dave found a way to access some of the research money of a new, General Dynamics division called the "Space Defense Initiatives Office," the SDIO. Dave worked there and was one of their thinkers.

Dave Nickerson and I immediately recognized we had a common Vision: Space. Space travel. General Dynamics and Space. We had talked about it several times before we visited Electric Boat.

Chuck Vollmer was his boss and liked the ideas Dave came up with. Vollmer was an ex air force fighter pilot, was the bold and brazen guy in charge of the SDIO. He was their General Manager.

Vollmer was describing his days as a fighter pilot. Flying a jet through live bullets was more danger any of us had ever seen. Vollmer fit the "ex fighter pilot" image perfectly. Nothing could knock him down as he zoomed at near the speed of sound, engines roaring, through live fire near the ground.

"I was drawing fire, so we can target them." he told me and a few other, gawking neophytes at an evening party at Dave Freiwald's house.

We had visited Vollmer's division often. Nearly every time we went to the Pentagon, Crystal City or Washington DC, we stopped at the SDIO.

I met Dave Nickerson at the SDIO. Dave Nickerson was fascinated by my completely new, never heard of before, novel and simple concept of taking 1000 people to Mars, or somewhere else in the solar system. He told me that what he really liked was the enthusiasm and passion I had, and that I would back everything I said with real data.

I kept telling him about how a steam rocket could take hundreds, or even thousands, of people through the solar system and especially to Mars. I excitedly told him how General Dynamics could be the one to initiate an Exodus to space.

I realized it really was different for him to interact with a whole group of people who were driven by Vision, instead of greed and power like the rest of General Dynamics.

As we were walking around the unfinished sub, I thought about the lack of Vision at Electric Boat, about how Vollmer listened to Nickerson, and what Nickerson had told me about a submarine.

"Hey Dave, you really think this submarine we're in is like a space ship?" I blurted out.

It was a series of thoughts all in my head and must have hit him out of the blue. I realized my question was complete out context.

"A submarine is like a space ship to Mars, you know." he shot right back. He was thinking the same thing I was about the Starship Submarine.

It took a few seconds, and then the other Electric Boat people volunteered the same story as Nickerson. At first, it was crazy.

"The submarine *is* like a space ship," said someone walking with us who used to be an officer on a submarine. He emphasized "is" and deliberately repeated what Dave said.

I could not believe these crazy, whako statements these submariner people were asserting.

How could a submarine be like a space ship?

I thought for a moment:

Submarines travel in the water, with smelly fish everywhere and gooey seaweed, and pooping birds sitting on the antenna. All you have to do to launch this ship is to have some lady break a champagne bottle on the front of the boat and let the thing slide off the rollers and splash into the water.

A submarine is ****not**** like space ship.

Anybody knows that. Space is space. Dark, empty, and you have to take off in a rocket to get there.

I walked a few feet and stared at some kind of submarine part, as if the conversation was just idle talk.

And after only a moment, an ex-Navy submariner who had been there spoke up, as if he was trying to convince me about a Starship Submarine, like Nickerson was saying.

"We traveled underneath the ice cap. Several months. Completely disconnected from the whole world. With no way to come help or get us if we just vanished forever," he bragged.

"How long can you stay under?" I asked.

"Indefinitely," blurted another fellow, immediately. Then the fellow thought for a moment, looked at the ceiling a bit and continued "except that we would run out of food."

I realized it could almost be true.

"If we really had to, the food could last 9 months," continued the fellow, clearly trying to be precise when speaking to Suits wearing their full Suit.

Watching that fellow work so hard at speaking precisely, I realized that our "Suits," which included a conservative tie, a dark suit, a white shirt, and wing tip shoes, were a uniform, just like the uniform that Navy people were used to. Our suits were the uniform, and the more we looked like someone from the Pentagon, the higher rank we apparently had. I had deliberately dressed like the highest ranking "Suit" I could find in Vollmer's office. My suit mentor was a retired General.

"Why do you think there are 117 people on the submarine?" Dave asked me, setting me up for his main point, I could tell. I could see the others, submariners, perking up. They all knew the answer.

"I don't know. Soldiers I guess." I incorrectly answered.

"Skill sets" said Dave, in his typically succinct way of proclaiming a truth.

"Each person has a function. Dentist, doctor, machinist, cook." he said.

"Just like space." he said, succinctly, again.

The submariners smiled, and they were all looking at me to see my reaction.

The ex-Navy officer with obvious status among his peers expounded on the way the Navy picks submariners.

"The nuclear submarine can travel essentially disconnected from Earth for as long as we have food and medical supplies. Or until we go crazy. And we deliberately choose people for submarine duty carefully, a special type that doesn't go crazy."

He look around, and his peers laughed.

"We make everything else we need. We wash clothes, mend the clothes, and communicate by radio or satellite when we get a chance."

"We have at least one of every skill it takes to be independent. Some skills we have two or three of each." Dave asserted.

"Whatever it takes to have a complete, self contained society," the ex-officer said.

"What about an appendix operation?" I asked, always trying to probe the limits.

"We've done an appendix operation on a table. We are prepared for that." the ex-officer volunteered.

"Just like space." said Dave.

I could not believe it. They identified with astronauts.

From that point on, interacting with Electric Boat and the submariners became something directly related to space, not just a field trip tour.

The submarine seemed so spacious. It seemed like a visit to a small starship, something like a big spacecraft, like a tiny version of a small Starship Enterprise. As soon as we crawled into the entry hole, it was like entering a very advanced space station. It was clearly much bigger than any space station the astronauts were working in.

Gerry Dobson??whohuh?? at Sandia had told me a decade earlier that the submarines were completely cramped, highly claustrophobic things.

"No space between you and the ceiling. You have to squeeze when you pass someone in the hallway. Beds are one board wide." he asserted, claiming they were awful places.

It wasn't that way. It was a lot more like 100 big motor-homes, all packed and piled carefully together, connected together, with long hallways, and made of metal, heavy metal, and with all the furniture made of metal, and all with very expensive electronics.

The beds weren't as bad as they said. They were like wide shelves along a hallway, the submarine bedroom hallway. Two or three shelves of beds. Each with a little cloth curtain, like a hammock strap, so you don't roll out. The submarine didn't roll around continuously, like a boat on the surface. It travels deep, moving in practically still water.

It moved more like a spaceship than a rowboat. No one was sleeping there at the moment.

And I could see how I would hate it completely. I could not see how I could get myself into my favorite sleeping position, a fetal position. I didn't see any nice fluffy pillows, either.

We were slowly walking through the part of the submarine where the 10 foot wide, vertical long tubes hold the nuclear tipped missiles. Somebody was explaining something boring. I did not much notice the chair-sized space between the tubes until Dave pointed them out.

The space between missile launch tubes was like the space between neatly stacked water glasses in a cupboard.

Dave pointed to one of those spaces, one that had the chair and said

"Someone owns that space."

"What do you mean?" I replied, curious about the leading statement.

"Someone will sit there and read a book. And no one will touch his chair or sit in it or disturb what he has there. It is his space. Territory. That's how it works."

"17 laps per mile" volunteered someone who noticed how completely immersed I was in all these little nuances of their spaceship, the submarine.

"The submariners jog around this track for exercise. 17 times around is a mile." smiled one of our tour guide executives.

"You gotta get some exercise, or you get out of shape." he said.

"You could be out here many months at a time."

"And no jogger steps on the guy's foot sitting in the chair." joked Dave.

"I bet you are really glad to get out of the submarine and breath some fresh air after a few months in here." I asserted, trying to think of how I would feel if I were ordered to do this.

"Ohh, No. Not at all." disagreed a Navy person, submariner, just standing there, disagreeing with me completely.

"When you first open that hatch and poke your head out, you immediately smell the fish and decaying seaweed. It stinks out there." he said.

"Really?" puzzled, I answered.

"The air in the submarine is cleaned meticulously. We have to. We can't have bad air killing us, making us sick. That could sink the submarine." asserted a taller, quite clearly highly educated ex-submariner also working as a Suit for Electric Boat.

"Wow," I said out loud.

"Cramped up with 100 or so people for 6 months, and the air inside smells fresher than the air outside."

I was amazed.

They would not let us near the section where the nuclear reactor power supply was. That required a higher clearance than I had. If I had still been at Sandia, I could go anywhere I damn pleased on this ship. But, I left. So I couldn't. We only had Department of Defense Secret clearances. Wimpy clearances. Reserved for plain, military secrets. Couldn't even walk around a reactor.

They did let us tour a torpedo tube area. It smelled a little bit of oil and looked like it was blue collar machinist construction site. The room was all metal. The room was obviously the place where 10 or 20 foot long torpedoes would be loaded into the tubes.

A thin, mid 40's mechanic machinist with dark hair and dark, horn-rimmed glasses for the farsighted was fixing something metallic while sitting on a metal ledge of some kind. A 20 inch long, 1 inch thick, chrome plated, heavy duty, dirty steel wrench precariously sat on another metal ledge between him and me. As I passed I engaged him in some small talk, about how impressive this submarine was and how everything was so carefully put together. He seemed to refuse my attempt to connect.

I easily saw what would eventually be racks on which torpedoes would rest, waiting to be stuffed into those rather big torpedo holes. It looked like I could fit myself into one of those tubes, and with a

tiny bit elbow room. The room was at least as big as a good sized two car garage. I did not see where the torpedoes were stored. The ceiling was somewhat low, but plenty enough room for the taller ones to walk. Pipes and tubes and levers and hinges, all made of heavy metal, were connected to every wall and ceiling space, and in this room, to chest high steel racks as long as a truck.

As I walked back towards the door, talking about something with the guy behind me, I moved my foot out of the way of the wrench that could drop on my foot. It was out of Sicilian paranoid instinct. Paranoia that they are out to get you. It's one of my genetic defects.

And the wrench fell, just as my foot went by. Not a lot of noise, just that heavy thunk. I looked up, and the machinist had his head turned away from where the wrench was, and then he looked directly at me, through his dark plastic horn-rimmed glasses.

"Wow. I could have hurt my foot." I exclaimed, smiling, to him, glad that I instinctly moved it.

He stared at me, somewhat distinctly very unfriendly, clearly disinterested, and said in a plain, monotone "must have fallen." He kept on working, like all of us were not there.

I was wearing a suit. And I realized what had just happened:
You are judged by your company.

As we looked out an executive window of a room on the floor where the President of Electric Boat had his office, we saw the skeletons of submarines-to-be and the place where they dry-dock them.

A big submarine looked like a whale as it slowly moved inland up the middle of the big river. Almost completely submerged, black, just a little of its black skin uncovered from the water, it looked a lot like a whale. It moved so slowly, again like a whale.

"How big is that? Looks long to me," I asked.

"Longer than a football field. That's a boomer," Dave replied.

They call the big ones the "Boomers." Maybe they call them that because the nuclear warheads make a big boom when they explode.

"How much does one of these things weigh?" I asked.

"Oh, I don't know, 10,000 tons. You can look it up in Janes. I remember one of those small attack subs displaced 3000 tons. These are probably 10,000." Dave replied.

"Janes" is a big, 15 inch long, 3 inch thick book of color pictures and details of military airplanes, boats, submarines, battleships, and weapons. When I paged through a copy I thought that most

of the stuff in Janes would be secret. The details were amazing, down to the placement of bolts and rivets.

We were about to start our meeting. I realized that we were a group of Ph.D.'s and scientists, and our audience, all from Electric Boat, were not. To them, we were highly intellectual Scientists from the Laser System Laboratory.

One could tell by the mannerisms of the civilian managers that most were keenly aware that we were NOT their kind of suits.

Only the ex Navy people seemed to be intellectual. I sensed a kinship with them, as if they had the ethics of the National Labs, and had to work in the midst of evil one.

As we wandered away from the window with the view, a peg point branded itself in my mind-page of key data:
A Starship Submarine weighs 10,000 tons.

Our meetings went nowhere except to entertain and dazzle them with our engineering fantasies.

Nickerson, Jokell, money, and the propulsive capture discovery

Bootlegging Steam Rockets: The Start

It was my passion for my Vision that did it. I inspired someone else, and he tried to make the Vision come true.

Dave Nickerson had come from the Submarine factory. The submariners felt a kinship with space explorers, at least because both kinds leave our world in self contained life support units, go where no one else can go, and then explore, alone, for a long time. They both leave our world, alone.

Nickerson was promoted to work at the "SDIO", a "space defense initiatives office." The SDIO had money for space things, exploratory things. Nickerson got us some money for us to show how a steam rocket might win.

And then, we could lead the way to inhabit the solar system.

Unfortunately, the space cadet Program Manager guy who got the money screwed it up.

And, it was rough getting my boss to go along with it.

After the whole episode, the space cadet casually gave me a clue that would make the concept practical.

Getting the first real money ever to explore a steam rocket started in late autumn at in the Sorrento Valley, north San Diego. The trees were green and the air was cool but not chilly.

The SDIO loaned us a few people for a day, from Washington DC, to help us explore all sorts of outlandish excursions from our only real business here at the Laser Lab. Our real business was to make and sell satellite-to-submarine laser communication systems. We had no business doing the unrelated things my boss had on the entire agenda.

The whole day, we did everything one would expect of good bureaucrat engineers working for General Dynamics. We composed pretty viewgraphs and nice charts, and we referenced the names of important United States Navy Admirals in Washington DC.

Typical arrogant manager, our General Manager, Dave Freiwald, wanted our Lab to do all kinds of things for which we had no engineers or scientists to do the work or invent the work. He wanted to do things with not one single person who was an expert at what he wanted.

How does that work? With Big Corporation Money. Glad-handers, Pepsi Executives and other non-technical's infest big corporations and are oblivious to the harsh reality of engineering details and science principles.

With a typical, DOA dead-on-arrival move, Dave Freiwald brought his experts to the meeting: several marketing people, a couple of pentagon consultants, and some managers from other GD divisions that were not doing well, to "help".

"That's why he will succeed," I thought, sarcastically, "because he doesn't need the engineers or scientists to imagine new things."

Many managers think they can always hire the scientist or engineer when he needs them. It's true, but only the kind of true how a lawyer would say it. You *can* hire a scientist or engineer whenever you need them.

However, getting one who is expert at what you need and who can invent what you want is damn near impossible, damn near always. But you *can* hire one whose skills don't apply, any time.

During the meeting I could not help thinking in disgust, "You only need the managers and the marketing guys. Sell something you don't have, even if you have no idea if anyone can make it. Then go hire any old engineer to make it."

During this meeting we both had to think out of the box for General Manager Dave Freiwald. Neither of us had the technical skills Freiwald needed. Neither did Freiwald. Freiwald did not know what he was talking about.

Puzzled, I did wonder if maybe Freiwald really did now what he was doing. After all, he was the General Manager, and I was not.

All day long, none of us would tell Freiwald that his half baked ideas had already been considered, or not even considered because of obvious idiocy, or that they would not work. None of us could tell Freiwald anything. His ego was so big he would and often did explode at the any suggestion that he didn't know what he was talking about.

After the meeting it was clear no one here knew anything technical about what Freiwald wanted. His marketers told him so, told us so, and told us that our competitors did know their technical business.

Arrogant Freiwald ignored them.

That whole day gave me a bad, anxiety-derived stomach ache.

And no, Freiwald did *not* know what he was doing, and that kind of stupid management did keep us from winning any contracts.

An Epochal Memory

Every chance I got, every break, every free moment, I would talk with Dave Nickerson about how the calculations of the steam rocket showed we could completely change the way humans would go to space. I kept showing him how we could take a Starship Submarine to Mars.

"But we need a start," I kept repeating. I did not know Nickerson had any money. He just kept acting interested, so I kept talking at him with my Visions.

Then Nickerson made a move. He started telling me how he would go to Space Systems first, talk with their Managers, and then come to GD LSL second.

"You don't have money. Space Systems has money," he told me.

"The SDIO does have money for space," he asserted, "for concepts exactly like this."

"They do?" I answered, trying to get him to say it again. I hoped that making him repeat it would prod him to make it true, whether it was or not.

"After this meeting, lets talk," he confided.

The end of the day came slowly. I kept wanting to hurry the "...lets talk" part.

After the meeting and almost past suppertime, we were standing in the parking lot of GD LSL. The comfortable cool early evening air, clear blue sky, the blue-green eucalyptus trees with their leaves flowing gently in the slow breeze, the clean architecture of our lab combined to soothe our nerves.

This was an epochal event. It was excitement.

I was facing towards the SDIO, which was only a couple thousand miles due east of where we were standing. Nickerson worked at the SDIO. He was facing west and was facing me. I kept glancing towards GD Space Systems, just over the hill a few miles to the southeast. Dave kept referring to Space Systems.

"I can get you money to work out the concept," he asserted, smiling, and obviously tickled that he found an idea that could really work.

"The concept is to extract water from Deimos, moon of Mars, and then use it to power a steam rocket to take people between here and there," I asserted.

We kept talking about gong to Mars.

"We could take as many people there as used to come over on the steamboats, like the Irish and like may grandparents did," I added.

Dave Nickerson saw the entire concept and what it could mean for space travel. I was glad he could see it without spouting off fantasies, like most of those who dabbled in space concepts did.

"I will do it through Ed Coy," he said

Coy had been General Coy, now retired from the Air Force and working at SDIO. He would be the lead person.

Dave Nickerson did not figure out the engineering details much himself. I absolved him of guilt. Normally I would not absolve someone for not figuring the details. But Dave would get us money, and Dave depended on us to figure the details.

"So what if he doesn't compute anything. I don't know if he can compute, and I don't care. He takes the word of the scientists and he bets on people." I thought to myself on the way home, justifying everything Dave did.

Within a few weeks, Dave Nickerson actually did get the money. He really did convince Chuck Vollmer, the General Manager of the General Dynamics SDIO, to allocate \$50 K to do a breakthrough, joint space project with the new Laser Lab and Space Systems Division.

This was just like the National Labs, where we would ask for the money and it would happen.

This was the way the story was supposed to go.

=====

No road is really smooth.

Our General Manager, Dave Freiwald, just could not stand the diversion to space topics. He didn't invent it. The diversion I

brought was no more outlandish than his ideas. But he didn't invent it.

Freiwald wanted to be the boss of lasers that talk to submarines, and of things that he invented. He didn't invent what he called a crazy space water scheme. He treated this like I was doing a hobby on company time. He didn't like it at all. If he didn't invent it, he just didn't care.

"Freiwald invented everything in the world," Vollmer sarcastically volunteered one day, commenting on how Freiwald projected his self image.

Vollmer, Dave Nickerson's boss, put up with Freiwald and saw my steam rocket project as new visibility, so he funded me. Freiwald got the credit for another \$50 K of "breakthrough project" money.

We had to bootleg steam rockets.

To get the money, Dave Nickerson had to assign a Principal Investigator, a "PI". The PI had to be one that the Great General Dynamics preferred. Obviously, Nickerson had to pick someone to be the Principal Investigator who was already doing things for NASA. That left me out. To them, this would obviously be some type of a NASA project. Too bad for the inventor: I was at the wrong place, at the submarine communication place.

They guy he picked was a Ph.D. named Bruce Jokell, at the GD Space Systems Division.

Big Corporations will do that to you. They will take your idea and give it to the most deserving person they have. Obviously, the arrogant leaders know that the

deserving person could make something of your idea far better than you. The company says so. The chosen person is typically the more "experienced" one.

Typically, the "experienced" one is out of a job at the moment, working on company "overhead". This means they keep the person around as an employee, make him do odd jobs until they or he finds something for a day job.

The "experienced person" will get to tell everyone about your idea and they will actually get the credit, even though it was completely your idea. They will also get the money to do it and will get to tell you what to do and when to do it. You will be angry.

Does that sound like a good deal? Sure. Your idea gets implemented. It could be really good for the Big Corporation.

No.

It's like a fish should jump on your hook because it is good for the Life Form. Or like a deer with monster antlers should run up to the hunter, because hunters pay for keeping the predators away from the deer.

Sure.

That's what would have happened here.

Except that Jokell screwed it up and I would not give him the keys to get out.

Exofuel: exoatmospheric fuel

This should have been really exciting.

Three of us were in the big conference room at GD LSL, the laser lab, at the large, wood table in the center of the room. Each of us wore some version of a Pentagon suit. The lights were bright enough to read. The chairs were big enough for fat managers, big generals and the typically thin marketing guys, "Suits." The chairs were cheap, but very sturdy. The room was big enough for 60, and the three of us had the room to ourselves. That felt good. We felt important.

Dave Freiwald, our General Manager, was somewhere else and not making demands. People in the other rooms and labs of the facility were quietly working, making lasers for Satellite to Submarine Laser Communications. The weather outside was overcast and nice, as usual for the Sorento Valley, 25 minutes north of the San Diego airport.

Bruce Jokell, Ph.D., Rocket Science, the newly appointed Program Manager for my idea, was preparing for the first meeting with the players. The room was quiet. Bruce was sitting to my left at the conference table. Nickerson was to my right. We are talking about what we are going to do as a team. I was slightly surprised that Jokell had a copy of what I wrote about Deimos, moon of Mars, and space travel.

Jokell put his copy of my 2 page description on the table in front of him. I looked at his copy to see how it came out after Xeroxing. I saw and I liked my hand drawn, tiny cartoons of the moons of Mars and a nuclear rocket.

He didn't like the words at all. It was clear that to him, I was just a physicist, some guy from a laser lab, and he, Dr. Bruce Jokell Ph.D. was the rocket scientist connected directly to NASA.

Bruce was the Ph.D. Manager in charge of a real NASA Project. Someday it was supposed to have real NASA money and real people working for him. His every body movement was shouting at Dave Nickerson, the man with the money, "What does this Zuppero guy know? Why do we have to put up with him? Throw the laser guys out."

I could feel it, like heat.

Jokell just could not buy what I wrote about space travel. He was condescending and snotty about my coming up with anything having to do with space. It was obvious at our first meeting.

It was my fault. When I read what I wrote, what Jokell pointed out what I wrote, I saw that my writing did me in. I was minor leagues. My writing style clearly showed I was amateur at space topics. I didn't know anything about the rockets and missions of that time. To him, it was clear I obviously did not know anything.

"Of course," I thought, as if replying to his unspoken assessment, "he is pretty much correct. I only have one thing absolutely right. All the rest is made up."

The thing I had correct was the only thing that counted.

The arrogant Rocket Scientist was not smart enough to see it.

The only thing I had right was a key concept that could change everything. Physics is typically that way. One little thing here or there and everything changes completely. That's what I had.

And that is what I did not communicate clearly. Therefore, we were starting off on the wrong track.

I was too much of an Aspie.

Neurotypicals would have seen this, maybe.

It was true that I didn't know any details about what these guys were already doing. I didn't know much about manned or unmanned deep space planet probes. All I knew about were spy satellites and communications, ***and how to take 1000 people to Mars.***

Bruce Jokell was a rocket scientist. I was a physicist. I knew he would have to abide by the laws of physics, but he didn't know it yet. I could tell I would win the technical battle, but might loose the real battle.

Fretting, I did not like that my own writing did me in. I had made up all kinds of marketing stories about what the new rocket would mean for humans occupying space. I did not know when I wrote it that I did not need to do that. I was too immature.

Hey, you, 4th grader!

"Only the key"

Write only the key!

Say "I don't know that part yet" or say "that part is not relevant" when they press on you for details that don't count.

You can win fast if you do that. You can loose like I did if you don't.

But, Jokell and I were both in the dark. Two Ph.D.'s, both in the dark. I was ineffective. He was arrogant.

I could see his deficiencies. He acted the way an insecure person acts. He acted like a lower level person in the midst of a swirl of powerful Corporate Bulls. That's what he actually was.

I could not see my own deficiencies, but I did know I was too timid, with my tail between my legs, the way an underdog perceives himself.

And we went on, even though neither Bruce Jokell nor I believed in the other.

We quickly agreed that we needed a title for this project. A nice title was not that hard to figure. We were getting "fuel" from outside our atmosphere. The fuel was water. Bruce would split the water and compress it and liquefy it into liquid hydrogen and liquid oxygen. Those were real fuels. But that seemed harder to do than my way, just using the water directly. Either way, we were bringing something liquid back from space, and we would put it into our rocket fuel tanks.

So the title would have the word "fuel" in it.

It was coming from outside the Earth, "exo" the Earth.

During my spy satellite days I learned the phrase "exoatmospheric burst," for an atomic bomb detonated outside the atmosphere. Our fuel was "exoatmospheric."

So, it was obvious, the name must be short for "exoatmospheric fuel":

"EXOFUEL"

I really liked my acronym. "**Exofuel**" I repeated to myself, 15 or 50 times, and thought a big smile while I thought it. I liked the image of lower case letters better:

exofuel

As we sat there, we made the plans for who would do the rocket science and who would say what to do. Nickerson designated that Jokell controlled the money, which meant Jokell was boss. Jokell brought Chris Cassell to do the rocket science. I got to have a co-worker title. Neither Jokell nor I was completely happy. I was not happy that Jokell got to be the boss of something that I clearly invented, and something that was the key to space travel in the solar system. He was not happy that I was pushing steam rockets.

Any rocket scientist could see that steam rockets were worse than cryo-fuel rockets. It was obvious, to a Rocket Scientist.

And I was a Physicist, and Physicists make the Rules that Rocket Science had to live by. I found a new rule: a steam rocket could be monstrously better than a their cryo-fuel rockets for some missions. Going to Mars was one of those missions. That was the first reason Bruce was not happy. He didn't know about the new rule I found.

On the other hand, I screwed myself when I fueled his second reason to be unhappy. It was my inability to write or communicate clearly. He could clearly see that I clearly didn't know anything about manned exploration of Mars or about any other deep space missions. He could see I was only familiar with military satellites in orbit around Earth.

This experience, where Nickerson is forced to give the brilliant new idea to someone who doesn't know the first thing about it, was how I learned first hand what the Evil Power Grabbers of General Dynamics do. Nickerson had no choice.

The General Dynamics system demands that the managers steal Visions from their Little Visionaries. The Little Visionaries are the ones who actually dream dreams and feel the exhilaration for us as we soar above our dull lives.

Then The Evil Power Grabbers go for the kill. They give the plum of a vision to someone who obviously has more skills than this Little Visionary. Obviously to The Evil Power Grabbers, one of their comrades has more connections to NASA than I do, since I am only a Little Visionary. Jokell is the comrade. Their comrade published more things on space than I did. His NASA resume was better than mine. So he got it.

I had screwed everything up, except the important thing. The only thing I did NOT have screwed up is the one thing, the most important thing, the world changing thing: my payload was about 1000 times larger and my rocket far simpler than anything known to NASA.

I was wrong when I thought that the rocket scientists had never calculated my propulsion scheme. They did.

They did not have water in space. I asserted I did. That was the difference.

Without that, my scheme would not work.

Actually, I did not know *exactly* where to get the water in space. The only places I knew of to get water in space for sure were the comets, and I thought they were too far away. Maybe that is why the Rocket Scientists would not listen.

I started to go into depression. It was entirely my fault that they didn't see it. I was telling the story wrong. I knew I didn't know how to tell it right. I knew I didn't know how to fix my deficiency.

Reality also helped depress me. The word "probably" was the problem, as in "probably get the water by roasting the dust of Deimos." I did not know if the Deimos dust was as dry as a baked dust on a dry road, like the moon, or if it was a hydrated mineral, like regular table sugar, like what many asteroids were supposed to be. I just didn't know.

Depression set in, because if there were no water in space, everything I said would be useless. I began to despair, because Rocket Scientists were the experts, and I was only an outsider with nothing but fantasies.

Water on Deimos of Mars would be absolutely ideal for the occupation of Mars. Water in orbit around the Earth would be phantasmagorical, but that was a fantasy and I knew it.

I had calculated several different options and found out how Deimos of Mars was a perfect staging area, a stepping stone for Mars. The orbit was nearly perfect for optimal transfers.

Unexpectedly, Bruce Jokell also believed there was water on Deimos of Mars. His buddy had figured a way to extract the water.

Our **exofuel** program would figure a way to use the water it would extract from Deimos.

Bruce Jokell should have seen it.

Plodding Along

Our little **Exofuel** program went on, a few small steps at a time. The team would make contact only about once a month or so. A \$50,000 R&D program was typically that way. It only paid for a few months of work, and the work had to be spread out so it would not interfere with the day job.

Chris Cassell at space systems division kept doing the work.

Every time we met, the Principal Investigator of the **EXOFUEL** project made it more clear. He was so full of himself that he could not see the key physics. No matter what I would say, Jokell would screw up the direction of the research focus. He screwed it up from the start.

He missed a factor of 1000 increase in payload. I could not believe he that he could not figure, but he could not figure.

Somewhat despairing, I began to hear myself echoing the words "Now we know: **Rocket Scientists Can't Figure.**"

If he would figure, he would see that his knee-jerk approach would not work. But he insisted on his way. Bruce Jokell insisted that we make a space architecture that would extract water from the Deimos dust, separate it into hydrogen and oxygen gasses, then compress the gasses and freeze them to cryogenic temperatures into liquid hydrogen and oxygen fuels. This upset me every time I heard it.

So damn complicated.

That is not what we got the money for. We got the money to look at something really new and progressive, steam propulsion. We got the money to look at something that would permit us to simply skip over all the hard steps and all the steps that required heavy and expensive, inefficient machines in space, such as those electric water splitters. We specifically were not supposed to get the money to look at water splitters. It frustrated me every time I heard the details of how our team was looking at water splitters.

I tried to talk with Jokell about it.

"My buddy figured out how to roast the dust of Deimos with an electric heater. Then you get the water," Bruce Jokell explained to me, when I asked him where he got the data he claimed.

"When was this?" I asked.

Stupid idiot.

You don't need *any* electricity. You roast the dust of Deimos with a nuclear reactor itself. Electricity is hugely not efficient. What a dumb shiphead.

"A year ago." Bruce replied.

"What does he do?" I asked, wondering how the guy splits the water.

"Then you split the water into hydrogen and oxygen and," Bruce went on.

"blah blah blah blah blah." was all I could hear him say.

I had already calculated that water splitter part. I waited until I he was finished with the water splitter part to start listening again. But he kept on going.

"Blah Blah you can read about rocket science on how water on the Martian moon can be converted into rocket fuel and," he continued, as I heard more blah blah blah.

"NO!" was all I could think.

"NO!" was all I could emote.

"This is Terrible," I thought.

Talking to myself as I walked to my truck to go home from work, I said "I think he doesn't understand. I can deliver a few thousand tons of water back to Earth orbit, from Mars. That's enough to send a small Starship Submarine back to Mars, full of people."

On another day, later, sitting on a plane to the Pentagon, I took out my calculator and figured once more, just how much a few thousand tons of rocket fuel was good for.

"That's more rocket fuel than what a dozen space shuttles weigh." I commented softly, aloud, and under the whooshing roar of the airplane cabin.

"And he is piddling around with a few thousand *pounds*," I thought, referring to the 20 tons or so of rocket fuel the **Exofuel** program was coming up with.

He is doing *pounds* and I am doing *tons*.

What an idiot.

I would see Nickerson nearly every time I went to the Pentagon. We used Nickerson's helpers. We had helpers from General Dynamics who knew how to get us in and out of the Pentagon and to see important Admirals. The helpers worked in the same group as Nickerson.

"I can't do much about it," Dave Nickerson said, when I explained in many ways what was going wrong.

He really could not do much about it. At General Dynamics, the Program Manager had the last say. Jokell was the Program Manager of the little R&D project.

"Get what we can out of it," Nickerson told me

Nothing ever goes perfectly. We always had to settle for what we could out of whatever we were doing.

So we did it Bruce Jokell's way, and I just somewhat gave up on Jokell.

Resigned to loose this battle, I calmed myself down.

I wondered if maybe it was me that was wrong. If I were wrong, I would change my ways.

Space Cadet Society

If it's your vision, keep it. Don't let the other guys intimidate you. You are the best promoter. That's what I learned, and I was glad.

A few weeks after coming back from the Pentagon on space laser communication business, our space enthusiast group, the "L5 Society," featured Bruce Jokell as a speaker at the local library.

Terri went with me that evening to hear the guy, "The Famous Dr. Bruce Jokell, Program Manager for NASA trips to Mars," would present an early evening talk in an entire a corner of the Poway, California library, with 40 grade school kids sitting everywhere, even on the floor.

"He is a really dull speaker," Terri whispered to me, as she became restless at having to sit through something so boring after she had spent a hard, long day at work.

She somewhat surprised me when she whispered that to me. I expected her to say he was a good speaker. Her disparaging comment prompted me to watch the responses of his audience closely. Her comment meant that his method was NOT better.

I watched the kids unconsciously reveal their boredom. They acted something like they were in school and forced to listen to someone speak authoritatively on a topic they knew little about. That was strange, because Bruce knew his own business well.

He put up a viewgraph with words on it. I saw he borrowed it from his day job work. I had a hard time reading it, and I even knew exactly what that viewgraph was about. The printing was small. The page was full of small print. After trying hard to read fast, I could see that his viewgraph detailed some of the Mars mission objectives and constraints.

That was one reason he was a poor speaker. He showed something nearly unreadable. What was readable was words and more words, but nothing striking.

*No pictures.
Tiny words.*

Then he put up another viewgraph. It seemed to be like a flow chart with little boxes and little lines going every which way, punctuated by tiny, unreadable words.

"This is a mission architecture diagram," he went on. That didn't work either.

"I don't know what point he is trying to make," Terri told me.

I tried to figure his point, too. From what he said, he was in charge of figuring some kind of living and working arrangement for people going to Mars.

I put myself into the shoes of the pre-teenagers in his audience. About the only thing he said that got our attention was how cramped it was going to be.

"You have to realize that 10 people are going to spend 2 or 3 years in a room about the size of this part of the library we are in." he said, waving his arm to signify the part we could see.

Some of us looked around the room. It seemed pretty big to me. I could not see the other side of the floor we were on. This was a public library in a San Diego suburb where there was a lot of money. It had a big second floor.

"People will get on each other's nerves," he said, reminding us of how annoying people can be.

"Just imagine you have to be in this same room for a month, with the people sitting next to you," he asked the audience.

"People sitting next to me?" I wondered.

I get it: you probably don't like people sitting next to you.

We all got silent. We were thinking about that. A few of us looked at, stared at, someone else in the room for a moment.

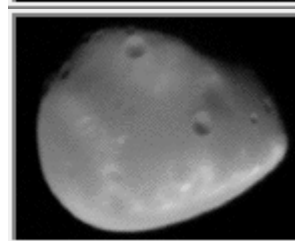
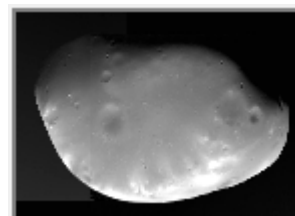
"People can really get on each other's nerves," he asserted.

He took us all into deep thought, I observed. That part of his presentation worked.

After a while, I wondered if he would mention what he and I were doing, with the **Exofuel** project.

He didn't mention my idea at all.

"Good." I thought, "He's not trying to claim it. It's mine."



\ Deimos

Nobody asked him a single question about what he talked about. That got my attention. It showed that his approach to

communicating was no better than mine. We were at least equals in that respect.

When it was all over, I introduced Bruce Jokell to Terri and told him he gave a nice talk. Then we left. The point I was trying to make was that I wanted to work as a team. I felt proud of myself for not telling him that no one could figure out what he was trying to say.

We could see it was dark outside and it must be 8 o'clock already. All kinds of street lights and cars and commotion greeted all of us as we stepped out of the library, and we were glad to get out of the meeting.

Alone, on the way to work the next morning, I fretted some more.

Talking out loud to myself, and not realizing that I was talking out loud, I fretted.

"Here he is, with my idea, and he gets the glory."

I retracted into deep thought, to see if I could find a solution to this problem.

I realized that the problem was that I was a new Program Manager in a new little division, a laser lab, doing Satellite to Submarine Laser Communication. The **Exofuel** topic was space, not submarines or satellites. There was a clear conflict here, and there is nothing Dave Nickerson could do about it. Dave could get the money, but he could not control all the political pieces.

Our monthly lunch meeting came up, and I went. I drove the 15 minutes to the cafeteria where we met.

"Hey, we are going to Mars. The United States is going to Mars." Jokell blurted out.

He was happy, somewhat smiling.

"How is that?" I asked.

I had not seen any big announcement on CNN that we were going Mars. I didn't see any big hoopla on TV, or in the newspapers.

"Didn't you see. Bush declared that we are going to Mars." Jokell affirmed.

"So? What's that mean?" I asked, cynically.

"The President said we are going to Mars, so we are." he affirmed again.

"Ok. You believe it. Not me," I thought.

"Are they funding you?" I asked, because the government was not handing out any money to anyone, it seemed.

"No. Not yet. But soon," Jokell replied.

Jokell had been appointed the Program Manager for a NASA funded study on going to Mars. General Dynamics won the contract, and it would begin when Congress allocated the money. Congress had not allocated any money yet. General Dynamics didn't get the real money yet, just like we at the Laser Lab. We didn't get any real money either. But General Dynamics won the contract. We at the Laser Lab did not win anything yet. When the money starts flowing, they will get their share.

"*Check's in the mail,*" I thought.

When we are all done calculating our **Exofuel** Program, Chris Cassell calculated that Jokell's architecture would haul a puny payload, just like I told Jokell. Of course the answer came out rotten. What did he expect? I kept telling him that it would, and the steam rocket way would make it come out marvelous.

He had insisted we split the water into hydrogen and oxygen. His way yielded about 20 tons of rocket fuel. What good would 20 tons of rocket fuel be? We could launch that much from Earth in one trip.

Therefore, the **exofuel** project didn't get any attention. It was more of the same old dumb science stuff, with no payoff to us taxpayers, and no way to take 1000 people to anywhere but broke.

I noticed that Chris Cassell could sure figure. He saw what I had figured and understood the results. He was being paid to do the work that Bruce told him to do and gave him a charge number for, and that was that. He was a junior person. I completely understood. He was smart, quick, and this guy was ok. He was my kind of rocket scientist.

If I were smarter, I could have fixed this situation. But I just didn't have the people and business skills.

After all, I do have Asperger's Autism.

I just didn't know how to interrupt and make the point to the key people. I didn't know how to get their names and call them or meet them on my own. I didn't realize that I could just call them.

If Cassell and I were to sit Bruce Jokell down and carefully lead him through the figuring, maybe Jokell would see..

We all knew why I would not help Bruce Jokell. This was MY vision. It could have been a Freudian omission on my part. If Jokell screws it up, then he does NOT get to steal it from me. So, I would let him screw it up. That way even though I loose this round, I can guarantee I will only give the Vision to Visionaries.

"Four letter words and a flipping finger signal to you, Bruce," I thought.

I could really begin despair at this point. I was not bright enough to point out the key facts clearly to anyone. I assumed they could

see the key pieces. I assumed wrong. They were not like me, willing to figure fast and change direction quickly. And since the rocket scientists were generally not bright enough, nor as bright as I assumed they could be, no one saw. It was my fault. My

personality was just too emotional, too off the wall, too un-professional.

A Gift from Bruce Rocket Scientist

Something good did come out of it.

The smell of bulk lunch meat and the clank of reworked silverware complimented the taste of those boiled peas and bland vinegar on the sterile salad. We were in a cafeteria at the General Dynamics Space Systems Division. The sky was grey, the temperature was mild, the cafeteria was half empty and most engineers were wearing their casual, non-hippie, non-beach-boy, not-a-Pentagon-suit K-Mart clothes. I saw many ties, many white shirts and a few sport coats. Bruce Jokell had a dark blue sport coat and tie, Chris Cassell had a tie, and I had my Pentagon suit on.

The three of us, Bruce Jokell, Christopher Cassell and I, were about to discuss our *exofuel* project and space travel over lunch.

We were eating while working so we would not have to charge our time against the exofuel charge number and make it run out of money. I was eating while working on manned space systems. I was bootlegging this kind of space topic, the manned variety. My boss the General Manager of the great and future glorious General Dynamics Laser Systems Laboratory, Dr. Dave Freiwald, scorned and scowled when I did this topic. It was what I invented, not what he invented. He could only focus on what he believed he initiated. I was supposed to be working unmanned, space laser to deep submarine communication space systems, which he found for General Dynamics. This exofuel was my space thing.

Somewhat like what first graders do, the three of us had been fantasizing together about the same space trip. We were off in a space ship carrying rocket fuel between Earth and Mars, trying to occupy the solar system. We were occupying Mars first. We wanted to be on the best kind of space ship we could find that would take us on our way back to Earth from Mars.

So, we were inventing it and then making it, make pretend, and then evaluating our work.

Our rocket had launched us away from Mars and sent us going backwards a little. It slowed us down so that we were going around the Sun a little slower than Mars was going around the Sun. We were going slower than Mars on purpose so that we would fall towards the Sun.

We started falling, faster and faster, somewhat towards the Sun and on a collision course with Earth. This was on purpose. We wanted to land on Earth, so our rocket scientist navigators were doing the right thing.

We were weightless, so all we felt after the rocket launched us away from Mars was nothing, weightlessness. This was going to be a long, 11 month trip.

All three of us knew that when we arrived at Earth we would be moving fast, way too fast to stop. We would need to do something to slow down. To stop at Earth, we had to do something powerful to slow us down.

Bruce asked me "Why are you using a heat shield? They're too heavy."

"Because you don't need any fuel." I replied.

We were both thinking the same thing. My version of the space ship has us stopping at earth by slamming into the atmosphere. The heat shield took the heat, and the atmosphere slowed us down. It was a tricky maneuver. We had to aim just exactly at the edge of the earth.

If we missed the edge of the earth altogether, we would fly right by Earth and be on our way back to Mars. But Mars would not be there when we got there. So we would be in an Earth-Mars orbit for decades, waiting each time for Mars to be there when we got to the Mars orbit. We better not miss the atmosphere.

If instead we aimed slightly into the earth instead of the edge, the air would push too hard on us. It would burn up our heat shield. The space ship would decelerate like a belly flop into a swimming pool from a 20 story building. Splat. Except that we would splat into a ball of fire. Spla-BAM.

But Bruce wasn't concerned about that. He trusted Rocket Science and the guidance mechanisms to do their job. He was worried about something else.

"So, how much would the heat shield weigh?" Bruce asked.

"I don't know. We would use the same kind of heat shield the astronauts used.

"The heat shield is too heavy and too big," he asserted.

"A heat shield?" I responded, sheepishly.

I could tell he had the heat shield data I was trying to find but couldn't. I didn't know where to look and he did. He was at the rocket science place and I was at the laser place. Nobody at our place knew where to find heat shield data. We didn't need heat shield for our laser satellites. Many people where he worked had the data on their shelves. I didn't calculate what it would take at all. I just thought it would work.

He caught me proposing to do something stupid, and I knew it.

Amateurs and know-nothings did what I had just done, all the time. I heard one Know-Nothing say "why don't you just move an asteroid and park it in orbit around Earth." Stupid. It is possible, but not doable. It is like someone saying "why don't you just build a concrete bridge across the Atlantic ocean and then we can just drive across." It is possible, but one can't do it.

My heat shield was almost the same kind of thing, and this time I was the proven Know-Nothing.

"We could maybe get them down to 15% of the ship mass, but they seem to be too big to launch in one piece. And then assembling them in space seems to be too tricky," he said, calmly, as if he had tried to solve this problem and couldn't and was wondering if anyone else had an answer.

Bruce Jokell was very friendly this time. His tone of voice was not condescending at all, even though he caught me being stupid. . Something must have gone right. He must have gotten laid.

I could not understand his mannerisms. I could read his voice like an open book. I could read his facial expressions and body movements, and everything was strongly indicating "completely friendly."

Then Bruce asked me "Why don't you try propulsive capture?"

That was rocket-science for "why don't you use a rocket to slow us down?"

"I could, I suppose. I'll have to go calculate that," I responded as I somewhat stared into the cafeteria, almost knowing that the answer could be ok.

His intuition was good. My intuition said "it could work."

During the time that I said "Yeah, I'll go calculate that," and then focused on eating some of the bland salad I recalled why it might work. I had used a steam rocket to get there and it worked just fine. It ought to work coming back. It took only a millisecond to realize that coming back to Earth was actually easier than leaving Mars. Earth is heavier than Mars, and that made the orbital maneuver work better.

"Maybe it will work," I blurted out after about 30 seconds of deep mental figuring.

I promptly stopped eating the rest of the cardboard meat and peas and the cold lettuce with that orange looking goo dressing.

"I have to get back to the Laser Lab," I said as looked at my watch, suggesting I was running out of time.

Bruce's body language was being even more friendly.

I got up and left.

I was anxious, but I had meetings at the Laser Lab, and they took all my emotional attention. As soon as I got home I started calculating, even before Terri got home.

Concept Space took over. this was like going into a dreaming-while-awake trance. I existed in another space, a space of pure logical calculations, and concepts.

The graduate student in my head watched as I walked into the spare bedroom to my desk. He said "This is easy to figure. The orbital mechanics and the nuclear rocket part are easy. I've done this kind of calculation on my cheapie pocket calculator from Radio Shack. This is really easy. Any kid in high school can do it."

I sat down and wrote the rocket equation for a ship coming back from Mars. I made the ship's rocket do a thrust as it came somewhat close to earth, to make us go into a highly elliptic orbit around Earth.

All I had to calculate was the total thrusting "delta-V" needed to make the rocket ship go into a captured orbit around Earth. If the number would turn out not too big, we would be able to do it. 5000 meters per second would be big, but doable. 1000 would be small. 3000 would be ok.

I had our rocket ship was coming in with 4000 meters per second above earth escape velocity.

To my surprise, the first step did not require much thrusting, about 800 meters / second.

Then I made the ship go into an orbit that touched the Geosynchronous orbit. That cost only 127 m/s.

This was easy. Any high school freshman could figure these rocket delta-V's from the equation.

Then the hard step: how much delta-V would it take to make the ship go into a Geosynchronous orbit? That turned out to be 1159 meters per second.

"Amazing!" I said aloud. The total was about 2,123 meters per second. That was not so much.

The next step was to calculate how much water the steam rocket would take.

"Amazing!" I said again. It only took a few key presses on a simple scientific calculator. The amount of water it would take would be about 2.2 times the mass of the space ship. Since I had assumed that water was plentiful, this was not so bad.

I could not believe it. This was so simple. Exceedingly simple.

All I had to do to make the whole thing work was to heat dirt or comets to fry or boil out the water. Everything else was just "run the steam rocket."

It really worked. Bruce gave me a key orbital maneuver concept.

Maybe the Rocket Scientist did know something after all.

When I did what Bruce said, I could use the nuclear reactor steam rocket for all the maneuvers.

"It worked like crazy. Everything worked," I told Terri when she got home.

She didn't know what I was talking about.

--

During the next few weeks I could not stop thinking about how well the steam rocket would work. Everything changed after this "discovery," because there was only one unknown: where to get the water.

Everything else pointed to ships as big as submarines.

I was sitting in a boring meeting at our big conference room about some engineering detail about some problem not related to lasers or space. I was a non-participant guest. Daydreaming overtook me.

Talking to myself, I had a conversation with someone from NASA who would fund my mission if I convinced him we could change the world and Occupy the Solar System. He had just objected to my using so much water for propellant.

"Yes, I know, we waste water by using a rocket. But I know we have plenty of water, unlimited amounts of water. You can go figure on a cheap calculator," I said to him, the imaginary NASA person.

Then I realized I had better figure it again. I had figured this many many times before, so I knew the answer. But I liked the answer. So I always liked to figure it again, because the answer always came out wonderful.

Sitting at the big conference table, I was one of about 15 people who had to listen, and one of the 14 who were not needed.

"How many Starship Submarine trips is that, between here and Mars?" I wondered, almost aloud, almost alerting the people in the meeting that I was doing something else besides listening to them.

I used my shirt-pocket scientific calculator to figure the amount of water we would get from my favorite moon of Mars, named Deimos. I assumed we would roast only 10% of the moon, leaving 90% of it intact. We would roast its dust. I assumed 10% of it was water, like some people said. That gave 1%, something I did without my calculator. I only needed to know one real number to do this: the mass of Deimos. I remembered it was about 2 trillion tons (2E12). The whole moon is only about 10 km across.

So I took 1% of 2 trillion tons. Since I was sitting in a meeting and supposed to be doing something else, all I wrote on my giant, yellow legal notepad they gave me when they started the meeting, was "20e9."

That was a cryptic way of writing 20 billion tons.

I let myself feel how good that answer was. It felt like "a hell of a lot."

"I wonder how many Starship Submarine trips that is?" I asked myself.

I had to figure again.

"Make it easy" I thought.

"Nickerson's Starship Submarine weighs 10,000 tons, give or take." I thought.

"It takes 10 tons of water for each ton of Starship Submarine to get from Earth to Mars and back, refueling at Deimos, Mars. That's 100,000 tons of water per trip. How many trips?" I asked myself.

"If we are going to Occupy the Solar System, we better get a very large number of trips," I said to the imaginary NASA official who was going to tell Congress how this changed everything.

"This is like an airport. Lots of trips per day, lots of people go for the trip." I repeated to him.

I didn't need my pocket calculator for that one, but it made the time go by easier to press some buttons.

"20 E 9 divided by 100e3 is," I said to myself, waiting to I punch the numbers into my calculator until someone said something that sounded like it could be calculated.

"200,000" read the calculator.

"**200,000 trips**" I said to myself. I smiled and nodded my head in approval. Maybe someone was watching me, and this looked like I was approving of what the speaker was doing because I calculated it.

"Wow!" I said, almost aloud.

If 1000 people at a time take the trip, that's 200 million people, or almost all the people in the United States of America.

Thanks Dr. Bruce Jokell, Famous Rocket Scientist from General Dynamics Space Systems Division, and Important Manager of a NASA trip to Mars Program, we could Occupy the Solar System.

Air Force Farce

"I know some guys up at Space Division who might fund us,"
Jokell told me about a month later.

That was exciting. All kinds of customers have money, a little money. Jokell had some friends in the United States Air Force who worked on new ideas. They were at Space Division, Los Angelis, California, about a 2 hour drive north of us. They had a little money. All we needed was some money from someone to prove that what we had was worth looking at.

Company politics always seem to work that way. No matter how much our marketing people would talk about some new idea, and no matter how much the engineers and scientists would claim it would change the world, not a single person would move to support it until someone else, outside, a customer, would pay real money, no matter how small.

That's the way it seemed to be, no matter what. If someone else paid money, no matter how small, the idea was worth pursuing. Otherwise, it was just words.

One more time I remembered what Dr. Al Lovelace told me about paying for Visions: "Bring Money"

"If you want a space mission, bring money." he told me, within one week of starting work at General Dynamics. He was the Big Boss, and he knew.

But to get money, one had to have marketing money. This was a government accounting detail.

Jokell talked Dave Nickerson into getting us some marketing money to go visit his friends at Space Division.

I had thought that we would just go, like I used to "just go" when I worked at Sandia National Labs. Until this trip, I didn't realize how the system worked. I thought that we only had to go up to Los Angelis, an hour or two ride. We would only be gone one afternoon. Why would anyone care, or even notice?

"No, this is business," Mike Moran told me. "We have to keep track of every hour we charge, or we can go to jail," he reminded me. Moran was our Comptroller (chief accountant).

I remembered that lesson. Moran, had once told me a story about time cards I could not forget.

"You can get a D in college for cheating and General Dynamics will hire you without even flinching, or asking why," he told me one day, as we were talking about how unethical General Dynamics seemed to be.

"I saw them do it," he asserted.

He saw them hire a guy with few skills who was also a known cheat. He was a warm body. General Dynamics had some government contracts that read "cost plus fee," so more people meant more fee.

I was shocked, but it was true.

Moran then told me about the work habits of General Dynamics engineers he knew:

"These engineers will try to get out of work every chance they get."

I told Moran our guys at our Laser Lab were not like that at all.

"All the engineers I know of would quit if you paid them and made them do nothing."

He was shocked, but it was true.

Moran was ethical.

"You can cheat 'em out of work, but don't cheat their timecard. That's their money," he said, sarcastically, about our employer.

So, to make sure we did not cheat the unethical ones, someone had to go get a few "Business Development" dollars to pay for us to go take a trip to the United States Air Force Space Division headquarters, just up the street a piece in Los Angelis.

We had to write a reason in the marketing money form, for the Comptroller.

"Our reason for going is: they are a prospective customer, and we will get to show them how much of a breakthrough this is for them."

I had worked with the U.S. Air Force while I was at Sandia. I knew first hand that the Space Division people were smart guys.

Jokell and I were trying to get along. Maybe we tried because we had to. I suspect Dave Nickerson, the guy with the money, had communicated to Jokell that he wanted me in the game, with my steam rockets.

Jokell had obtained a company car and we were driving on the long clean highway up to Los Angelis, a 1 or 2 hour ride, depending on traffic. We were both elated that we really were on our way to see the US Air Force Space Division, Los Angelis.

We were sitting in the car, not saying much, when Bruce broke the ice. He told me about how the girls he gets to date, now that he was divorced and in some group where he got to meet people, the "girls want to do it immediately." He did not use any explicit language.

"You mean they want to do it on the first date?" I asked him, using similar language,

"Right away. They don't want to wait." he said, not boasting, and with a tone that clearly suggested he would not mind waiting to find out more about them.

"Are they good looking?" I asked.

I had to ask. Jokell was a relatively handsome fellow, made good money in Aerospace, had a Ph.D., was a relatively straight arrow, no drugs, no dope, no violence, nothing bad. I would expect that ladies looking for someone like that would do whatever they could think of to get him.

"These are really good looking ladies," he asserted.

"This last lady I went out with was beautiful, smart, not off on metaphysics or psychic phenomena." he added.

I could not tell if he was bragging or making it up. Most males make things like that up. I envied him.

That did break the ice.

When we finally arrived at Space Division, Jokell delivered the presentation. He let me contribute 3 viewgraphs, describing the key discovery of the optimum in specific impulse. But he got to do the talking. He buried what he considered to be an obtuse point deep in a stack of overhead slides that would put anyone to sleep. And that is what we did. We put them to sleep.

All I saw was that he screwed it up again, by not pointing out the factor of 100 right away.

I thought there was a factor of 100 increase in payload. Our exofuel device would deliver thousands of tons. Bruce's way the way NASA and the Air Force would do it, would deliver tens of tons. That would make us a 100 times better than anything known.

That would be a breakthrough.

Where in our presentation did he show the breakthrough? Why should the guys at Space Division listen and do something?

Nothing we presented would do show it.

To his credit, Bruce actually did show my overhead of the rocket equation, the one that I figured when I went skiing at Vail, April 1987, and hurt my shoulder joint.

But he completely and entirely missed the fact that we are talking a huge, absolutely huge jump in payload. The Air Force would really want to know about a huge jump in payload.

They didn't get it from Bruce Jokell.

I can't fault him that badly. I never made my point either, or Jokell and everyone else would have gotten it.

I went to visit Bruce Jokell one last time before we had to deliver a final exofuel report. I was there on a Saturday, on my own time.

He was sitting at his desk in a rather open area in what a friend of mine called a "bull pen." The bull pen stretched longer than a

football field and almost as wide. This was on the 2nd floor of a General Dynamics building where they kept Jokell, and probably some of the Evil General Dynamics contractors. This was one of the Bull Pens they put engineers in if they only earned a "D" grade in college, or if they got caught cheating and needed a job.

"You can work as little as you can get away with in the bull pen. This is Cost Plus Fixed Fee contracting, and you are a Cost. You earn the Fee by sitting here." I heard Mike Moran say, in my mind.

Jokell's small desk and little Mac SE computer un-impressed me, as the sun blinded my eyes through his cheap metal window shade. He didn't have much of an office. I had an office with a locking door. He was in a bullpen..

I was trying to tell him we need to find water in space, water ice, or space won't work.

My words, "Space won't work." didn't register and didn't communicate quite right.

"Won't work" meant "all we will get to do is send 3 guys on a Field Trip to Mars, at our expense."

All I could think of was some Sports Event in Space.

"We are doing this *To Occupy The Solar System*, Nickerson and I", I thought.

"What do you want, a big chunk of ice with 'Tony take me' scratched on it?" he mocked at me.

Scorn. disgust.

"Well, Yeah." I replied.

"You dull son of a bitch," I thought.

I left mad. His scorn made me mad. Jokell and I never did get along like buddies.

My kind didn't care about an adventure to Mars. We wanted to occupy it. And if we could not occupy because Nature denied us the resources, then that's that. We would go away.

I was thinking: if I don't get a big iceberg, space won't work and I won't care.

An iceberg was the only way we could leave the planet 1000 at a time.

Exofuel never went anywhere. Bruce gave me a copy of our thick final report to prove it.

- **Dr. Jim Powell, birth of the Steam Rocket**

Birth of a Steam rocket

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Actually slinking and actually sneaking, I was making it happen.

It was a typically cloudy morning in Washington, DC. The Hyatt Regency, a somewhat expensive, business class hotel in Crystal City only 1/2 mile from the National Airport, provided me a courier bus to take me the 1/4 mile to the Metro Station, or to the airport when I needed it to. Sometimes you don't walk because it's too slow.

Crystal City was not a city. It was just a lot of brand new, high rise buildings in one mile strip near the Pentagon, including expensive hotels with shiny reflecting windows, and with all the main buildings connected by underground tunnels. Bureaucrats live here. They hand out money.

I dodged the light rain and drizzle when leaving the courier bus from my hotel at the south end of Crystal city and hurried into the tunnel to the Metro.

The Metro was always clean and safe. Sleek modern trains arrived often in the clean, safe, elegant stations, stations where the concrete walls were patterned with a modern architecture. The Metro was always perfectly clean. It fit the image of all the professional people who took it work, and fit the image of what a subway in the capitol of the United States should be. I was taking the Metro from Crystal City, in Virginia, to the Pentagon.

A courteous but clearly authoritative, approximately 55 year old, probably black, thin and clean-shaven Metro policeman politely informed me "there is no eating in this area."

I was eating from a bag of roasted sunflower seeds while waiting for the train.

"Oh, I'm sorry," I said, a bit startled as he brought me back to the reality of the clean tunnel of the Metro station. I was completely focused on trying to recognize every person at the Metro station. I was sneaking to the Pentagon and did NOT want to meet anyone I knew. Everything disappeared except the faces of the people at the station.

Immediately I put the food away. He knew I was lost in thought. I could tell he had seen my type many times. My type came from elsewhere, didn't know the rules and was typically lost and focused somewhere else, deep in thought.

I looked around and didn't see a single piece of paper or trash. The concrete pattern on the walls was clean, plain and pleasant. I sat on a perfectly clean bench. There were only two or three people wandering around me at this time. I missed rush hour. So far, ok.

I was sneaking, because I was not here on the business my boss sent me to do. That was yesterday. Yesterday we dodged the rain and took a cab. Yesterday, Retired Navy Captain Del Ritchhart was my guide and took us inside the Pentagon on General Dynamics Laser Systems Lab business. Del and I wandered around talking to Admirals and Captains about how wonderful an orbiting satellite would be, whose only mission is to point a laser towards earth. We explained how our laser would paint the ocean with blue laser light beams, digitally coded with secret messages for the submarines deep below. Everyone knew Del.

Today, Slinking and sneaking, I was also on my way to the same Pentagon, using the same Metro stop, and going in the same security gate. Only this time I was alone, completely on my own. I was on here for my own project, which my boss hated. He would probably get very mad if he caught me.

I was only supposed to be in the Pentagon to see Navy people about Laser Lab business, not to see the Air Force, Star Wars guys about manned space travel.

I made sure I didn't get off at "Pentagon City" stop. That was just a big mall. The correct stop was "Pentagon." This was stop for the basement entrance to the Pentagon. The Metro stopped here and only here, not to some place on the surface to a parking lot.

I went up the long, long escalator to the Pentagon from the Metro. The escalator seemed like a few hundred feet long and nearly straight up. One could get dizzy looking up the long tunnel. I looked at everyone who was coming the other way, to make sure I didn't know them.

I sat down by the old wood benches next to the bank of security guards to wait for my contact. The Pentagon security gate had a big waiting area with about 20 old fashioned wood-style benches.

I looked around and began to feel I was in a place just like the old movies about the Pentagon. Except that this was in color, not black and white. The old movies of the Pentagon were black and white. I started to daydream and imagine was really at the old Pentagon, during the 1950's.

It was always better to be early here. Del Ritchhart taught me that. Sometimes our escorts would get here early, maybe an extra 12 or 7 minutes ahead of time. That would mean we could get another 12 or whatever minutes with the people we were trying to influence or learn from. Everybody's schedule here seemed to be measured in minutes.

Every tens of seconds seemed like 3 minutes as I sat here, waiting, scanning everyone's faces to be sure I would not be recognized. There sure seemed to be a lot of non-military people coming here today, going to the Pentagon.

There were a lot of people going in and out of the security gates, too.

Clearly ethnic Americans, some with clearly Italian features, a disproportionately large number of American with African descent.

At least 3 fat ladies waddling around with apparently no schedule driving them, clearly badged for Pentagon security and passing through the security gates like they were Admirals.

Hot looking professional ladies in business suits moving with clear intent.

Lost souls in business suits from the engineering or science staff of some contractor far from California, looking around and gawking at everything and who have obviously never been here before and led by their perfectly groomed marketing goat.

Crowds of high school visitors on tour and dutifully following their barking military escort in Army green-brown uniform, holding his closely shaved head perfectly rigid with respect to his shoulders and his shoulders perfectly rigid with respect to the rest of him, and who was making sure they got the spirit of the regimentation of the Pentagon.

Colonels and officers absolutely perfectly groomed, with an equally perfectly groomed aid or two attending them. Three or four perfectly dressed males in dark blue suits with stripes exactly 1/2 to 3/4 inch apart and with the conservative tie and white shirt, walking with a clearly marked Admiral and giving him their "Elevator Speeches."

I was still sitting, waiting for Powell, entranced by the people going in and out the security gates.

As I sat there waiting for my contact inside the Pentagon to come out and get me, I fretted that every person who walked in or out might be someone I just met, and tell Del Ritchhart that they saw me. Del would tell my boss. And I would be in deep trouble.

I tried to look at everyone before they could see me, to make sure I could hide my face if I recognized them.

The security gate looked the same today as it did yesterday. So I fretted, because it reminded me that it was only yesterday when Del Richhart escorted me, and everyone knew him. When Del Richhart was a Captain in the U.S. Navy he had been their Official Navy Liaison to the "Hill." Everyone knew him.

Any contact between the elected officials on capitol hill and the Navy went through him, or else. Or else trouble for the Navy guy. No matter where we went, even when we would just be walking

somewhere in the Pentagon, someone would run up to him and shake his hand and smile and make such a fuss.

That is why we hired Del. He knew everyone and could get us to see anyone. It went the other way, too. If he said "I don't feel comfortable with that" then that was a message that we better not go tell somebody what we planned to tell them. We would sometimes exaggerate.

The contractors made it a point to use people like Del Ritchhart to make contacts in the Pentagon. The good part was that if a retired Navy Admiral or Captain called up one of his active-duty buddies for an appointment, the buddy would almost always grant the meeting. That was exceptionally valuable for the contractor.

The bad part was that these retired fellows were the most ethical fellows I ever met. They were like fine-mesh filters. They would only let us through if what we were proposing to talk about was good for the Navy or the government. The retired fellows kept their reputations clean.

Dell was the same and kept us honest. During the last year, he went with us every time we went to the Pentagon. He sure introduced us to a lot of people. We met so many people that I had good reason to be afraid someone would recognize me and ask "What are you doing here today?"

Lucky for me, no one saw me.

Looking at my watch, I realized that I had only been sitting here about 3 minutes. It seemed like half an hour.

My mind started to wander back to rocket science. Technical daydreaming like this almost always reduced my anxiety and helped me prepare and get into the mood of impending meetings.

No matter how I calculated it, the simple steam rocket worked like crazy. Just get some water and fly. So simple. "And it works," I said, almost aloud.

The payloads are big, as big as a Starship Submarine. The propulsion is simple, just like a U.S. Navy nuclear submarine's nuclear reactor water heater, almost. The missions would be stunning, a 100 people at a time, in a Starship Submarine, going to Mars. A whole fleet of them.

I heard the noise of the Pentagon and saw the people again. I was back in my chair, back from technical rehearsing.

"Where is Jim Powell?" I thought. I had never met him.

"What does he look like?" I thought.

"I only know his voice," I thought, having only talked to him on the phone.

"What we need is someone who can design a steam rocket that everyone will believe," said a voice in my head, trying to sort through my strategic intent for the meeting.

Locke Bogart led me to Jim Powell. Locke was one of my colleagues at GD LSL. Dave Freiwald brought him in. The engineers at GD LSL thought Locke was nuts, evil, crazy, and a wild man. They didn't like him at all. Locke did come from a whole other universe, an alternate reality. They were right.

But not evil. Locke was everything they said except evil. Locke was good, ethical, and smart, definitely smart. He could see concepts at the speed of lightning.

Locke came from the part of the defense department that was supposed to come up with new ideas. He was trained not to see barriers, and not to follow arbitrary rules made up by arbitrary kings and despots in arbitrary bureaucratic structures. He did not fit at GD LSL. But Freiwald brought Locke to the lab the same as he brought me in. None of us fit with General Dynamics because none of us were evil, power mad and greedy enough.

Locke took one look at the steam rocket and figured all the relevant technical details in about 10 milliseconds. He listened to the arguments for water of hydration and ice in space, and in another 10 milliseconds, he knew we needed to find a way to get a simple space mission to find it. He believed the water was out there just from other data he his acquaintances had told him about. In a flash he had figured it to the conclusion. As we used to say in college, "Done. Simple." Like a physicist of the finest kind, like a Creating Visionary from the Wild part of the Defense Department. I liked that part of Locke.

Jim Powell told me over the phone he was arranging for us to talk with "Crazy Roger," Colonel Roger Lenard, a U.S. Air Force fighter pilot who was now in charge of a secret nuclear rocket program.

Dr. Jim Powell was also a Creator Visionary from the wild part of the Department of Energy, at Brookhaven National Laboratory, New York. Powell and Locke knew each other. They worked together. Both knew reactors and how to figure them.

Jim and I and Hans Ludewig had talked over the phone, and Jim came up with a design for a nuclear rocket engine that would work on steam. He faxed me a copy and I faxed Dave Nickerson a copy. We all saw the design sketch.

Another 3 minutes had gone by. It was already 5 minutes before I was supposed to be here.

Hans Ludewig and Jim Powell appeared at the security area. "Tall fellow," I thought.

Bearded, very pleasant voice, not fat, not heavy set. Long coat, like they wear in New York. Of course, Powell must be from New York. No suit.

Hans was thin, about my height, very German looking.

I never knew where I was going in the Pentagon. I was always lost. Someone else was always the guide. It was an old building. It seemed to keep feeling like an old building no matter how often I wandered through parts that were being renovated. The passages were perfectly marked, with coordinates any engineer or soldier could follow. The floor number and the indicator for the number of the inner ring were painted as a number-letter mark, clearly stamped at every turn and every opportunity where one could go the wrong way. But I never know how to navigate this place anyway. Powell knew.

Powell lead us downstairs, to a basement. I thought he was kidding when he said "we have a hole in the basement of the Pentagon."

This really was a basement area. It looked like it. It was jammed with offices and important rooms with conference tables and a projection screen for viewgraphs, just like the rest of the building. The Star Wars basement place looked old. The placards and the framed posters were modern. shiny and new, very professionally done, perfect. The letters and words that were placed on the wall to designate the name and function of the important rooms were also new. But this place was still felt old, like it was built back during WWII. At least it didn't smell old.

No matter where I went in this Pentagon there would be a security desk area with no windows anywhere, and three people in charge. There would always be at least one well dressed and very attractive lady, one very plain but interesting and attractive lady, and one grossly overweight lady who would waddle slowly at her own pace and who did not care who was in a hurry or not. I was just a face to that one. The three of them were busy processing my security clearance.

This was definitely a standard waiting room for security. But it was dark down here. Not very many lights. There was plenty enough light to read by because they kept lamps by the chairs, and that was it. This furniture looked like it was the very best you could find in the Thrift Store. I noticed how beat up and scratched it was.

It only took them a few minutes to show me I passed the security screening. My clearance was ok. Someone inconspicuously pressed a hidden button behind the counter as we approached so we could open the metal door into the more secure area.

Powell led us to a small room inside another, truly unimpressive and old waiting area, with another, uncomfortable, thin couch and hard chairs. Then Crazy Roger came in. His shortness and thinness surprised me.

Powell introduced me. I had heard of Crazy Roger but never met him till now. He was short, cocky, animated. Jim and Roger talked for a minute or two about something else. And then Powell talked to Roger and told him that this rocket engine would change the world, and all we needed was \$5 K to document it.

"Sure." said Roger, "Tack it on to the something or other." he instructed. Jim was already doing a reactor design of some kind for some space propulsion topic. I did not know any of its details at all. But I clearly understood "Tack it on..." That was how many great ideas got funded. I vouched for the fact that the nuclear heated steam rocket will definitely change the balance of power in space. No doubt about that. "Whoever gets one first, wins," I said.

"We got the money," I thought, over and over. I was elated.

Jim was pretty smart. He told me in physics language how he had tested some nuclear reactor fuel beads that were supposed to go inside a gas cooled reactor. For some reason, he actually had tested these beads in red hot steam.

"You tested them at 1200 C?" I asked.

That temperature would make the pipes glow red hot.

"Yes, of course," he assured me.

This was odd. The gas in the gas cooled reactor that I thought he was working on was helium. Helium is one of the most inert gasses known. The reactor beads were designed to work in helium. Why would they test the beads in steam? Chemically reacting, red hot, highly corrosive steam?

The weird part of this is that the reactor fuel beads were not designed to work in water at all. Instead, Jim tested them in steam. I don't know why he did that.

I was sure glad, because this was precisely what we needed. It was real. We needed something real. A real test.

"The steam immediately oxidized the pellets and coated them with an oxide, insulating. They didn't leak for a few days. That means they'll work." Jim said.

I knew exactly how well that orange-hot temperature, 1200 K, would work in a steam rocket. It would work just barely fine.

Since Powell's fuel pellets survived, and since he knew the physics behind this fortunate Coincidence Of Nature, it meant we had found the key piece needed to design the nuclear heated steam rocket.

As we walked out, the philosophical graduate student in my head emoted a mini-fantasy.

"If you are an obvious Visionary, other Visionaries give you wonderful Visions as gifts, for free," the philosophical graduate student asserted, as we passed people in the Pentagon hallway who might have known me, but I didn't care.

"He gave me his "particle bed reactor" vision, and I gave him the steam rocket vision." the student continued.

I realized that during this uneventful meeting, Jim Powell and Hans Ludewig invented a nuclear heated steam rocket to take 1000 people through the solar system.

Powell and Ludewig had other things to do, so we all went our own way. Someone led me out of the secure area, back to the Metro entrance area.

As I wandered around the news stand about 100 feet from the Metro door area, marveling at the different news papers these Pentagon people read and the 100 varieties of donuts they eat, I had only myself to talk to.

I was fantasizing:

"This invention is just like the invention of the steam powered ocean liner. We must have a steam engine first. I could not take 3000 Italians and Irishmen, fighting with each other all the way from Europe to America, and marrying each other's sisters when they got there, on a boat powered by sails. We needed a real engine, a powerful engine for the ship.

Sailboats are nice, but they only take a few dozen people across an ocean, and the trip takes too long. Columbus proved it. When we invented the steam engine and powered ships with it, everything changed. The engine made the difference between a few thousand pilgrims and a real mass migration. The same thing happens with space."

I wandered down the long, long escalator to the Metro station. Perfectly clean. Not a speck of dirt. Not a single piece of discarded paper or food wrapper. Discarded newspapers went in the garbage can, which was also in perfect condition. Nobody seemed to be talking.

I started talking to myself about Powell:

Powell understood instantly. Powell is no rocket scientist. He is a Ph.D. physicist. That's sure better than a rocket scientist. And he's a Visionary. He saw immediately what the engine would mean to humans occupying the solar system. I didn't have to explain. He knew. He even told me what it would mean.

People in suits were walking around the Metro station, waiting for a train. No matter what time of day I rode there were people like me in suits wandering around here.

I really liked this Metro. So quiet. So clean.

I was hyped and pumped up. All sorts of conversations were running through my head.

They say there are 10 girls for every 1 man in Washington DC. I don't believe it. I see many ladies here who are pretty and trim. I can count.

Only about 1 out of 3 ladies is NOT reading a book. I wonder why?

*About 1 lady out of 2 is with somebody. Must be that there are
2 ladies for each male.*

The Metro was such a nice ride. I had to check and recheck to make sure I caught the right one. I almost never went anywhere in Washington on my own. Del always told me which Metro to get.

I still had to catch the plane back to San Diego today. The Metro took me to Crystal City. From Crystal City I went to my hotel room. I have to watch for my stop because it came up fast, and I was running out of time.

My stop came up fast, like it was supposed to. I always got confused here. I always got off the Metro train at Crystal City perfectly ok. But the stop is completely underground and there are several ways to leave the Metro Area. They are all underground. They all lead to underground tunnels with newsstands, shops and places to eat. No road signs.

If I didn't dally too long I would have 5 extra minutes to browse the shops.

I wondered "Now which way do I go?"

I only had myself to talk to. So I did, almost talking aloud:
I count 5 racks of dirty magazines at this newsstand.

I guess men away from home get lonesome.

I can buy a Penthouse.

There sure are a lot of others on this rack.

Hey, this is explicit. I'm buying a few of these. Hard to choose.

Across the aisle I see Italian food. Too bloating.

Two shops down. I see Chinese. I like Chinese food.

Crystal City underground was a Mall, all underground.

I was still hyped about the Pentagon meeting and now started talking, repeating myself, to myself, over and over.

There is plenty of water in space, but there is no hydrogen.

Water is di-hydrogen monoxide.

Separating out the "monoxide" is really hard to do.

Jim Powell understood in a millisecond.

Jim knew instantly, and so did Dave Nickerson and Lock Bogart.

We can now send 100 or a 1000 people to Mars on a Starship Submarine.

Every time I walked down the shining tile brick walkway the same memory came back. The movie "Dune" had people living deep underground in beautiful rooms, deep underground in tunnels.

Every time I walked this way I pretended I was in "Dune," modern day style.

The brick hallway had steps that changed levels and changed direction. I would always pretend these hallways were the tunnels of an asteroid, and I was moving through the tunnels.

I wanted to know: How would it feel moving through the tunnels inside an asteroid, in zero gravity?

An asteroid has in nearly zero gravity.

I had figured several years earlier that we would have to live deep inside the asteroid, in tunnels. We would need to have shops and working offices just like here in Crystal City, all in tunnels. We would live in volumes, just like the offices above.

In space, we would live in volumes, not on surfaces like on Earth.

How would it feel to almost float around the asteroid tunnels in zero gravity?

I pretended more:

These newsstands and food shops on both sides of me are what in this asteroid tunnel.

*I need to give me just a little kick in the right direction, and I move,
almost without needing to push.*

These daydreams about living in tunnels in asteroids were really naive. Jokell would have laughed at them.

The Hyatt Regency Hotel was new, clean, shining, majestic, with a huge volume in the great room when we enter. It's shining escalators going up at least 3 levels, up only half way to the ceiling. The see-through elevator goes up and down at least 5 levels and disappears into the ceiling.

Hurrying to my room I talked to myself loud enough that someone might have heard me.

This is spacey.

Marble walls.

Huge.

I want a house like this.

One really good perk working for General Dynamics was that they put us up in the best hotels. I could take an Admiral here for a meeting and he would feel completely comfortable.

The Somewhat Evil and the Somewhat Arrogant

Jerry Husler was a tall, blond, smiling fellow who looked a little like a football player. He had a deep voice and a friendly handshake. Jerry was our Director of Marketing. He and I had been talking to some fellows at the Defense Research Projects Agency in the Washington DC area about a secret communication system. They were on some higher floor of a 15 floor hi rise.

We had just finished telling these prospective customers something that would probably not work. It stretched our ability to deliver and would probably break the laws of engineering and physics. But Jerry knew how to make really professional looking handouts. So, even if the thing would not work, he made it look like it would work because he printed it on glossy, color handouts. This was the best of General Dynamics ethics.

We were looking out in the late afternoon light at the building next to the one we were in, with its rows and rows of windows .

"That building is about the size of the ice I would use for a space ship," I told Jerry. I explained the concept and how I would take as many people as were in that building to Mars, and how I could use water ice as rocket fuel in a nuclear heated steam rocket to get them there.

"It will work," I told Jerry. I kept telling anyone I met and everyone I worked with how it would work. My excitement about it would not stay quiet.

I couldn't stop talking about the steam rocket and how it would change everything.

"All we need to find is water in space, and everything will change," I asserted.

I owned the discovery, a real discovery, and I knew it. I could prove it. I could back up every statement I made.

"We could go to space wholesale." I concluded.

"Freiwald won't like your doing that space thing," Jerry asserted.

I would agree that Freiwald would definitely would not like my having stayed over an extra half day to talk to the Pentagon guys on my own space topic.

"Freiwald will hand you your balls on a platter if he ever finds out," Jerry volunteered.

"He doesn't have the power to do it." I responded, without even waiting to think about what I had just said. Freiwald had the power to fire me. But he didn't have the power to change the laws of Physics.

Freiwald really didn't have "the power," because The Force was not with him.

I was completely confident, and even bold.

"I have something that will make the Laser Lab look silly." I told Jerry, smiling.

"I have something that will change the way humans go to space. Freiwald doesn't have anything like that."

I let Jerry know I was completely confident and had something real.

Jerry dealt in bullshit. Real things stopped him cold.

I didn't realize it immediately, but Jerry was testing me.

As we were waiting for the elevator and looking out the window of the 20 year old building, I realized Jerry was betraying my trust. He was telling Freiwald what I was doing, whenever he would find out.

When I told Jerry "he doesn't have the power" I was signaling inadvertently but forcefully that if Freiwald tries, I will succeed on top of him.

I inadvertently signaled to Jerry I was the one who had The Power. I had the power to hand them their own prized parts on a rusty platter.

Locke Bogart had taken a risk by introducing me to Jim Powell on GD LSL company time. Locke knew we had to risk our jobs to make real Visions come true.

Locke and I and nearly every Program Manager or executive who worked for or with Dave Freiwald learned to dislike the guy Freiwald. It was a shame, because Freiwald really tried. He tried hard. He was imaginative and thorough. He looked for loopholes for us to get extra perks.

I had liked Freiwald for many years before I worked for him, because he tried so persistently. But he just plain drove people mad. He drove customers mad. He drove his employees, his colleagues and his equals mad. He drove his bosses mad enough for them to move him out of their sight.

Locke Bogart only made some people mad only some of the time. But Locke would figure and Locke had Visions. Locke helped me bootleg steam rockets because Locke was a Visionary, too.

Now all we needed is water in space.

- **Jim Arnold and the Near Earth Asteroid crowd**

Jim Arnold at UCSD

It really matters where you physically are.

What would you do if you really wanted to know something, and don't know where to start?

You would go where it's happening.

You have to be where it's happening. If you want to be a movie star, you can't be in Kansas or South Dakota. You have to move near Hollywood. It's the same with anything else. If you want to learn about space things, you have to move to the Aerospace Belt. That would be Southern California, along the coast. And that's where I had moved to.

Yes, it's nearly always hard to move to where it's happening. In my case, I had given up a good job with the government. I gave up a secure job and a great pension and a wonderful vacation package, 5 weeks a year. But I had been in Albuquerque, not Southern California in the Aerospace Belt. Nobody in Albuquerque knew where the water was in space.

If only I could find water in space, we would have something we could use to start exploring and living there. Humans could start leaving Earth. Where was the water? I was now in the right place, so someone here should know.

My day job in the Aerospace Belt was to get a space program going to make and launch satellites with lasers on them, to beam communication data to submarines lurking deep beneath the ocean. That day job let me meet all kinds of people who would know who knows.

My hobby job was to find the key for humans to leave Earth. I needed to find water in space.

You need to ask "who would know who knows?"

Then you get lots of answers.

If you ask "*who knows* where the water is in space?", then almost no one knows. You may as well be in Kansas, or South Dakota.

But if you ask "*who would know who knows* where there would be water in space?" then you get many answers. All kinds of people give you leads, and many of them are very good.

And that's exactly what happened.

I was in the right place, in San Diego working for a rocket maker and near to UC San Diego (UCSD). One of the things UCSD did was to have lunch meetings where people would talk about space. Different people from different places would come and talk about what they knew and did.

The campus of the University of California at San Diego had big eucalyptus trees, clean, well dressed and well fed students, nice cars

in the parking lots and very plain but clean architecture. It also had old metal walls enclosing the labs and offices. UCSD had painted some walls a dull, dirty yellow.

I had to break away from work to go listen to the speakers UCSD invited. The California Space Institute, associated with UCSD, brought visitors to the campus to speak about space topics. I was able to get on their mailing list because I was a Program Manager of something related to space and satellites from General Dynamics. General Dynamics had money and very good connections, so they liked us to be there.

At one such meeting I listened as an astronomer talk about how his calculation showed the rings of Saturn looked suspiciously like the aftermath of a whole moon exploding, about 10 million years ago.

And after that meeting, I got to meet Sally Ride. Famous Astronaut Sally Ride was their new President. I wanted to meet Dr. Sally Ride. I think she was the first female astronaut. I figured maybe she could help tell the world about the steam rocket that could let us inhabit the solar system. "People would listen to her," I thought.

I thought she would be really interested in space. But to my surprise she was burned out about space. She was leaving space.

Sally Ride told me she was going to change her focus and do lasers. We laughed about it because I told her I wanted to leave lasers to do space. We talked about lasers a bit. I told her I had learned that the atmosphere of Mars could have an inverted population of carbon monoxide molecules. One can sometimes make lasers with gasses that have "inverted populations."

That could mean that the atmospheres of planets might be used to create an extremely high power, high energy laser in space, if we so arranged. We might be able to use the atmosphere of whole planets to amplify communication signals, for communication.

Or maybe, even more exciting and evil, we would use the lasers as extremely powerful weapons. We would fry errant enemies with lasers powered by the atmospheres of entire planets. The energized atmosphere of a whole planet would be controlled by super smart, very powerful Masters. We would stimulate the atmosphere to emit planet sized beams of energy, and focus them from outer space on to the surface of victim planets. It would be more powerful than any weapon anywhere.

Fantasy. But quite possible.

{{ **images:** Mars, with it's "inverted population" atmosphere, pulsing, glowing, just bursting with energy, and then us: stimulating it to emit, and then: BAM! a planet sized power beam shoots out, doing Star Wars type damage (!) }}

Now that would be a phasor beam project, for sure.

But that was lasers with an evil Star Wars twist, and I wanted water in space, completely different.

"Ah, you want to talk to Jim Arnold. He studies asteroids and meteorites." she said.

Jim Arnold was standing around right there among us, not saying much.

"Is there any water of hydration on an asteroid?" I asked.

When you ask a question, you need to use the right vocabulary. "Water of hydration" was the right vocabulary.

That question in plain language meant "would any of the asteroids out there give off water steam if we heated them?" If you cook cookies till they roast and turn black, water comes off. That is almost "water of hydration". If you cook Epsom Salts, water comes off. That is real water of hydration.

"Well, in some, yes there is." replied Jim Arnold.

Then I told Jim Arnold about the steam rocket and how it would push a big payload, bigger than anything we had yet invented. But it needed water. Huge amounts of water.

"You know there is a whole group of people interested in that. You ought to talk to them." he told me.

He asked me to follow him to his office. A small office in the Chemistry Department. In a building with dull painted metal walls and metal doors. In a dull building. On an upper floor with dirty leaves blown there from the wet ocean wind. He could almost see the ocean from his office. And then Jim Arnold gave me John Lewis's phone number.

"Talk to him. Tell him I said to call." he said, giving me the entre I needed.

When he walked out of his office to get something, I stood there focusing closely at the index card he let me hold. The card had John Lewis's number on it, the number Arnold gave me. There were more numbers on the card, and I copied one down to make sure I had at least two ways to get hold of this fellow. I kept phone data like Arnold did, but mine was on computer, not like his on those old index cards..

In those days, people used 3 x 5 inch, stiff paper sheets called "index cards" to store their phone numbers. If they lost the card, they lost everything. Nowadays, we use computers. If the disc drive burns out, we loose everything.

Arnold didn't tell me that he was one of the first people who analyzed the idea that there could be a whole lake of ice at the poles of our own moon. He never said a word that he was interested in finding water, too. He did not brag that he predicted ice on the forever dark poles of the moon. He never volunteered that he

worked with the former head of JPL, the Jet Propulsion Lab, the NASA funded lab of California Institute of Technology.

He didn't say a thing about moon ice, even several years later when he would review my a paper on mining the local comets for ice. He just would not brag.

He started me on the right path. I thank him forever.

I went there, to a meeting at UCSD asking who would know who would know, and someone knew.

- **Mayor of the Moon, Buzz Aldrin, and Space Solar Power catastrophe**

Famous Astronaut Buzz Aldrin and Dan Greenwood, Mayor of the Moon

Echoes of what Don Summers had told me, verbatim, just before I had left a secure job rattled in my head:

"The conquest of space is going nowhere until there is a clear profit."

If getting all the electricity humans would ever need from space is not a clear profit, then what is?

The California Space Institute had mailed me a notice about a Solar Power Satellite meeting. That would be an interesting meeting. Getting electricity from a satellite should be "a clear profit." That's what I was looking for. They also claimed the world famous Carl Sagan and the famous astronaut Buzz Aldrin would be there.

This could be a very important meeting. We could change the world, entirely. No more oil wars. No more nuclear reactor problems. Free electricity from the sun, from space, for everyone.

We could save the world.

I showed up. A happy mathematician business man who said he wanted to be "Mayor of the Moon." hosted the meeting. His name was Dan Greenwood. Dan looked about 49 years old, taller, thinner, pleasant, wore a brown suit and was always smiling.

The famous Carl Sagan was supposed to show up, so I made it a point to be there. Some local San Diego rocket scientists and space scientists sponsored the meeting. Their program would set up solar power satellites and beam electricity down to Earth. Dan Greenwood's group would put solar power electric generators on the Moon instead of on satellites. Then they would beam microwave electricity back to Earth, and we would all be saved.

Someone had named this meeting "Lunar Power 1."

The first time I met him Dan Greenwood said

"Hey, lets generate electricity on the moon, using solar power, and beam it to earth with microwave beams. And it will only cost a Trillion dollars to start. What a grand idea."

Duh? He seemed to be a bit simple. These guys seemed like clowns. Were these guys for real?

It was early evening of a very pleasant, mildly sunny day in La Jolla, California. A gentle breeze blew from the Pacific Ocean, and green succulent plants were almost visibly growing and were already as tall as trees. Flowers were in full bloom. The La Jolla building had red tile floors, and the triple-wide, open doors leading to a garden-like walk that went directly to the beach.

- Mayor of the Moon, Buzz Aldrin, and Space Solar Power catastrophe
Rocket science and the Navy picked a great part of the world. I was glad to be here.

The sun was still shining, and it was shining directly into my eyes. I was on the second floor, facing towards the west facing window, watching the sun setting lower and closer to the ocean. A rather pretty scene, I thought, as I looked straight out the window over the deep blue Pacific ocean at sunset.

I had to pay something atrocious for the meal, but it didn't matter. Carl Sagan and Buzz Aldrin were supposed to be there.

This was a perfect scene for a save-the-world project.

I didn't know exactly what the Astronaut Buzz Aldrin had done, but I sure knew about Carl Sagan. My wife Terri gave me one of his books for Christmas because it was about infinity and space. He was famous. He was on "Nova" and talked about "billions and billions of stars." People would listen to Carl Sagan.

I thought about how I would tell Carl Sagan about the steam rocket and how to populate the solar system.

I kept looking for Carl Sagan. No Carl Sagan. Dr. Bruce Jokell Showed up instead.

What a downer. Why would Bruce Jokell show up? I was still not comfortable with Jokell, because he was still wrong on using electricity for his rocket fuel, and I was an Aspie. Bruce and I stayed away from each other this meeting.

Dan Greenwood noticed that I would listen. Aspies will hyper focus on things. The reason I never got caught being an Aspie was that I focused on people. Most Aspies are like Spock and don't care about humanoids. I focused on Greenwood.

Dan repeated to me at least a few different times that he wanted to be "Mayor of the Moon." From his mannerisms and the way he talked about how he would achieve that goal, I concluded he was not playing Hardball Politics like General Dynamics. He was playing back-woods softball.

My General Dynamics training sprang into action when I noticed a scary poster towards the south end of the meeting room.

"Never show anything that scares the customer away." I recalled Jerry Husler telling us, teaching us to be marketing types. Jerry Husler was one of those marketers you hear about. He would make things up, have them drawn up into very pretty brochures, and sell them. Then the engineers would have to find a way to

make the crazy things work that Jerry had shown in his beautiful brochures.

Recall that Husler was our chief marketer and taught us a lot.

"Never show anything that scares the customer away," his voice repeated.

I saw "\$1 Trillion" in big letters, as the cost of the program. I'm a customer, and that was about to scare me away.

"One Trillion dollars!," I said aloud, exclaiming to no one as I read the poster aloud.

I looked around. Nobody was listening to me, fortunately.

"Dumb. Real Dumb," I thought.

I had learned *not* to say "a Billion dollars," for our laser satellite. These guys were saying "Trillion.", a 1000 time more than a billion. At the Laser Lab we had done everything we could think of to drop the starting price of our satellite to well under \$500 Million. That \$500 million was down from the \$2.9 billion we first proposed. Our \$2.9 Billion scared the Navy people away. That was way too much. That was more than the price of a submarine. The entire Defense Budget was only \$250 Billion.

Jerry's words echoed again: "Never show anything that scares the customer away,"

These "Lunar Power 1" guys were imagining that their program would cost 4 times more than the entire Defense Budget of the United States. And that was just to start the program.

That was Stupid. That will chase away any and all serious supporters.

I had decided to go to this meeting because I wanted to see a "clear profit" in space, and to meet Carl Sagan. Carl didn't show and the "clear profit" was a clear disaster..

This other fellow, Buzz Aldrin, was the one who actually showed up. I couldn't exactly place him, but I knew that his name sounded like he was one of the important astronauts. I had forgotten which one. I never could follow the names of sports figures.

I knew that Neil Armstrong was the first to set foot on the moon, and Sally Ride was a lady astronaut, whom I met here at UCSD (University of California, San Diego), and Harrison Schmidt was a Ph.D. geologist who went to the moon and tried being a Senator.

And I remembered exactly where we were and what we were doing when the astronauts landed on the moon. But I didn't remember their names at all.

I had to think hard to remember Buzz's role.

I didn't meet them personally when they landed on the moon, so I didn't know them.

I could not recognize them either, because the astronauts had bubbles for faces. I couldn't relate their space suit bubble to a person anyway. What they did was easy to remember, but not their names.

NASA focused on athletic adventures. I didn't follow sports or any other athletic adventure, space or not.

I was surprised that he was just a plain looking fellow no taller than me, with a light brown suit. He was so friendly that I easily started talking to him right away. I focused on Buzz because he knew what he was talking about, was excited and passionate about it, and people would listen to him.

We immediately started talking about going to Mars. Neither of us even realized that we didn't ease in to the topic at all.

I told Buzz Aldrin about how I would power a space ship using steam, and how we would use a nuclear reactor to boil the water from the tank and turn it into red hot steam. I told him of the orbital maneuvers I would use to get to Mars and back. He understood everything instantly and instinctively.

Buzz told me how he would make his Mars space ship by having two astronaut capsules held together by a long, thousand foot cord, and that he would spin them. The spinning would create his gravity.

We all knew that without gravity, our bodies would loose bone calcium and we would have severe osteoporosis by the time we landed on Mars.

Buzz thoroughly earned his Ph.D. in Astronautics from MIT, judging from the things he said and the way he said them. I quickly figured out that he could and did figure. He understood exactly what I was talking about no matter what detail I mentioned.

About 10 of us sat down at one of several of the long tables in the room. I could tell from the kind of white tablecloth and table settings that this would be a rubber chicken supper. My objective was to sit by the people who counted.

Dave Criswell's 3 foot by 4 foot, white poster boards with the Trillion Dollar price tag were visible from every table in the room. I was facing west, towards the view of the ocean and sitting across from some oceanographer types and a very nice looking smart lady. Her name was Betty Walton.

When you go to meetings like these, they always serve some kind of thing they call "food" but feels like rubber. Typically it is hard boiled, rubber chicken, or hard steak.

You are not here to eat. You are here to elbow your way to the front of the line to talk with the key people. You can eat later. You are too fat anyway. That's what Jerry Husler barked at me during a marketing lesson.

Criswell, the speaker started describing how they would make electricity on the moon. This is why they brought us here. He told us that the solar power collectors would probably be located at the moon's poles because the sun shines there most of the time.

I was hoping he was going to explain "a clear profit."

Criswell told us how the solar power photovoltaic cells would energize electric power systems. The power systems would feed an array of microwave power converter devices on the surface of the moon. These devices would be like very efficient, microwave oven devices, except that they would beam their energy towards Earth.

It was grand. Dan Greenwood was smiling at the grandeur of it all.

I had picked up from Dan's language that Dan almost certainly had not calculated the details at all. I wondered how much detail was in Criswell's calculations.

I calculated the diffraction limit quickly, and estimated the smallest possible size of the transmitter antennae.

"They better be a hundred kilometers across," I thought.

The transmitters that were beaming the energy to Earth had to be "a hundred kilometers" across or the beam would spread out. I presumed they had calculated that already.

If you are any kind of Engineer, you would calculate statements like this in your head *while they talked*.

If you can't calculate like this, get out of the way. You are probably some political science major. You are not qualified to comment on global warming, electric cars, economics, space travel, medical procedures, or anything. Maybe you can comment on a good restaurant, but not on anything that matters.

"The power converters will feed microwave electricity to a 100 mile long antenna," Criswell said, as if on queue, "could be on the equator, or could be near the north or south pole of the moon."

Criswell had at least done his homework on the microwave antennae.

Criswell pulled out a picture of his lunar solar electric power scheme for earth. He had the moon, the Earth, and something strange, something that appeared to be a mirror in orbit around Earth. The mirror would reflect a microwave beam from the moon to the surface of the Earth.

{{ Image: the moon, the Earth, a reflector in orbit around earth, and a beam going from moon to reflector and from reflector to a spot on Earth }}

"That's nice," I thought, "he has to track something moving 10,000 miles per hour. His antenna is on the moon and its doesn't move. He has to change the direction of the beam entirely electronically, by phase control. That's going to be tricky."

Any engineer would tell you that this would be a bit tricky, at the power level Criswell was talking about. This was at the 10,000 Megawatt level, enough to power half of Los Angelis.

His voice and the words he used signaled that he did not do real things. Only calculation things.

"He has two things in space," I thought, "one on the moon and one in orbit close to Earth. Both are tough. Two miracles."

He would need 2 miracles to make any profit at all.

The good looking smart lady across from me involuntarily winced a facial expression when she heard microwaves would be focused on some spot on Earth. I could see she did not want to get cooked by a microwave beam some crazed geeks set up and whose beam accidentally wandered off target.

Criswell kept talking.

"Rectenna's on the ground collect the microwave radiation and convert it into DC power, anywhere on Earth, day and night," he asserted.

I heard him, but didn't quite believe it. His antennae would collect feeble microwave radiation and little rectifier diodes would convert the energy into DC electric power. I could buy what he said if it were a radio receiver. But as an electric power station?

Maybe we will have satellite radios someday, but not a satellite power plug. If the microwaves are strong enough to power something, they are powerful enough to fry you.

"How dangerous would that be?" I wondered.

"The microwave radiation that hits the earth is do diffuse that you could jog under the beam and be perfectly safe," Criswell asserted, again as if on queue.

It only took a millisecond or so for me to complete the emotion. I thought: "Hey, that's pretty good. What a nice coincidence. They figured it out and a microwave energy beam enough to power Los Angelis won't fry you when you jog under it. Neat. Did they calculate that right?"

"How big are these rectenna fields?" I wondered.

"These are not very big antenna farms, less than 5 miles across," Criswell asserted.

"Five miles across" is rather big. It's 16,000 acres, 25 square miles, more than the area covered by a San Francisco tourist map.

"This system will generate enough electricity to let everyone in the world use as much electricity as American's do today. All 50 Billion people," he asserted.

"Pretty simple," I thought. It all sounded pretty good. No nuclear reactors. Enough electricity for everyone.

"Fifty Billion People?" screamed a voice in my head.

"Where does he get that. That is 10 times as many people as we have on Earth right now."

I started to figure what it meant to have the population Criswell was using as his customer base.

Then, Dave Criswell proceeded to completely kill his project. Criswell chased everybody away with just one chart.

Not only did he point to that \$1 Trillion placard, he started to explain it and draw attention to it.

He made the chart so Big, so impossible to hide, 3 foot by 4 ft, so no one could miss it. He talked about it, casually defending how just to start the program it would cost a \$1 Trillion.

"Hey," I thought, imagining how to tell him, "that's ten to the twelfth dollars, as much as the entire USA National budget, \$ 1 000 Billion, \$1 000 000 000 000."

"That's almost as much as the United States collects in taxes," I mumbled, loud enough for the smart lady to hear me. She heard, but she was still wondering if the microwave beam would cook her.

His chart showed how it would cost way too much to make electricity this way.

For some reason, David Criswell insisted this would be cheaper and better than making electricity on Earth any other way.

"Why can't we use nuclear power?" I asked him, loud enough and blatantly interrupting enough that everyone could hear me.

"Because you need too many of them," he replied, instantly, as if he had calculated and really knew the answer..

I agreed. He was talking 10 kilowatts per person and 50 billion people. That would be 500,000 Gigawatts. A typical nuclear reactor power plant would generate about 1 Gigawatt. In my head I calculated that we would need 500,000 nuclear power stations.

"Yeah, you're right," I said.
way to make electricity that environmentalist extremists would let you do."

"You get everything you need from the moon," Dan Greenwood told me, smiling.

A friend of his agreed.

"You have an unlimited amount of silicon on the moon, in the sand," this fellow said.

Bull. This is stupid.

"This guy doesn't know anything," I thought.

Silicon and silicon dioxide, which is sand, are as different as sodium and sodium chloride, which is salt. Raw silicon doesn't just come pouring out of the sand. Raw sodium doesn't just come pouring out of salt.

Then I figured something that made the whole thing look silly. Criswell said that each power station would generate something like 10 Gigawatts. That is like 10 nuclear power stations would generate, but never mind. At 10 Gigawatts peer lunar solar power mirror station, that would mean about 50,000 antennae in orbit around earth. Each one is 10 or 100 km across. This is getting really nuts.

But, every time I had ever said "no, you can't do that," someone did it and made me wrong. So I shut up and tried to listen.

This guy was nuts. Instead of 500,000 nuclear power stations, he would need 50,000 of his solar power satellite mirrors. That's a huge number of monster things in space, and on the moon.

He must be a physicist. Completely impractical.

"Besides," he continued, obviously having been asked this question multiple times, "there is no other Questions kept popping into my head. Practical questions.

"Why can't I just generate electricity in the Sahara Desert or Arizona, and then beam it around the Earth, like you do?" I asked.

If his mirrors would work all the way from the moon, then sure as hell they would work from close by, like from Arizona.

These guys are crazy.

I just could not buy it. Anything we would do on Earth had to be easier than doing anything on the moon. The moon is dry. No water. No air. But the Arizona is sunny 12 hours a day and way easier to work on that any place anywhere in space, no matter what.

Blatant and outrageous. Space projects are way too expensive, and he could prove it.

I wanted these guys to win, because I wanted us to be a space faring nation, a space-faring species.

He had to make it cost less, or Congress would ignore him.

I told Criswell to find a way to make the initial start cost less, way less.

"You can't get anyone to buy it if it costs too much." I told him.

"You're going to kill your program before it starts" I asserted, bluntly.

"It's all because of that chart. The Trillion dollars is way too much to start." I asserted again.

Criswell resisted, adamantly.

"Well, go ahead. Resist." I emoted.

"You wonder why nobody cares about this?" I thought, loud enough for Criswell to "hear."

"Well, Dave, we don't need solar power electric generator on the moon now anyway. If we need electricity to save our lives, we can use nuclear electric generators, and they will cost a lot less."

I realized that talking with Buzz Aldrin was the only good part of the meeting.

Ice Exploding on to Earth

Trying to meet anyone of value here, I came across a very mild mannered astronomer who got his Ph.D. by doing calculations on the atmosphere of stars. I wondered why that would be worth doing. We are not going to be next to a star for a million years.

Dr. Ted Fay was about my size, thin, apparently vegetarian. His day job was working for an aerospace company named McDonnell Douglas in Los Angeles.

"Where can I find water ice near Earth?" I asked.

Any chance I got I asked that question.

"The comets. I think a piece of ice hit Tunguska, Siberia" he replied.

Startled, I didn't believe him. How can ice exist in space and not evaporate away, from the heat of the sunlight?

"You mean there are pieces of comet floating around near Earth?" I asked.

"I think it could be." he said, not very assertively.

I did not believe. I thought that Ted Fay could see how much I wanted it to be true, and he was just patronizing me, telling me whatever made me feel good.

He said ice existed on small comets or comet pieces.

I wondered about his words: "comet pieces" and "small comets?" What small comets?

What was especially captivating was that he said "crashing into Earth."

That would definitely qualify as "close". I wanted water in space, close enough to use. Crashing into Earth was bulls eye close.

As we were getting in a car, leaving the meeting, he promised me:

"We will find you your ice."

I did not believe him. But he said it in such a strange, subtle, ominous way that I thought there really might be ice out there in the space near earth.

I had come to the meeting to meet Carl Sagan. I had come here for a clear profit. Instead, I meet some astronaut, and the clear profit is a clear loss. The meeting was useless, as I had expected. The people throwing the party wanted to do something that would cost so much no one in their right mind would ever support it.

It was clear that we would not need solar power from the Moon to save the world. We could save the world with nuclear power. We could use Arizona instead of the moon for the collectors.

Alternatively, the overpopulating civilizations of the world could kill each other off and save us the trouble.

I did not like this meeting.

Many years later I would realize:

It didn't matter that Carl Sagan was a no-show. Buzz Aldrin showed, instead. And Ted Fay showed up, who knew where the water was.

- **Vomit in the Space Ship, and space is bad for us**
 - **Vomit in the Space Ship**

Supper with the oldest Russian astronaut

Just about everyone in those days had thought that people could live in space just like living on earth. Artists drew pictures of happy families with their happy kids and happy dogs with their tongues hanging out, all gently floating in a big space greenhouse as big as 20 football stadiums. Everything was green and neat, and everyone had a smile. Acres and acres of neat rows of crops were growing in the background, orchards with fruit on them, even. There was plenty of room and everyone was healthy and beautiful.

So, I was sure surprised when I found out that the zero gravity of space was bad for you. The local space society arranged for me to find out. That was *not* what I was supposed to learn.

This was the 26th of September, 1990. I heard some older lady say with an idealistic, naïve vocal intonation how this was "a beautiful San Diego evening."

This was *not* San Diego. We were in Escondido, 40 miles north of the San Diego airport and inland one range of hills, along the I 15 freeway.

"The World Future Society" blared the poster-banner marking the building of the meeting.

As I tried to find a parking space I could not help but notice how The World Future Society sure drew a crowd, of old people.

I saw old men wearing out-of-date suits and nice clothes, and driving older big cars that were in reasonable shape, with not too many dents and the paint still somewhat ok. The older women's faces showed excessive makeup and didn't hide the wrinkles. Some wore clothes that even I could recognize to be no longer in fashion.

"Only in California," I remembered thinking when I first heard the name "World Future Society." Now when I actually saw the people, it was even more clear. I shook my head slightly from side to side and emoted a feeling that expressed "What a name for a social group. They really think they are part of the force that is changing the Future of the World."

"These guys are probably second or third tier has-beens," I mused, "Ex Wanna-be's."

I wore my Pentagon suit. I wore my entire Pentagon uniform. I deliberately walked like I was someone who worked with the Pentagon and lobbied Congress. That was because I did.

It was a game. I could feel how the people here could tell immediately when they saw me that I was different from those old has-been's wandering around.

The L5 Society made this connection for me. They are now called "The National Space Society." I liked the part where they had enough clout to make some kind of valuable connection. This demonstrated the ability of L5 to connect. It made me feel good that I joined the L5 Society. The L5 Society gave me a choice seat.

The San Diego L5 Society had acquired some interesting "positioning" tickets to the supper meeting of the World Future Society. The positioning tickets were a reward for some work the L5 society did for the World Future Society, and the reward was a few seats with designated positions of the chairs at a table, relative to where the invited speaker sat.

Hey you, 4th Grader, do this:

Make sure you get a choice seat like this, any chance you can.

The "L5 Society" was hard core space cadets. It was originally started by some people who wanted to make a space base at "L5." L5 is the name of a place in space, place number 5, and there are only 5 such places around a heavy celestial object. It's a convenient place to put a space habitat in orbit around Earth.

I walked around the banquet hall for a few minutes, somewhat lost and gawking at the old, wrinkled has-beens. The room holding about 300 people was filling up. Then one of the L5 Society ladies found me and escorted me right to the special table. There were only six of us at the Russian Cosmonaut's table.

The waiters were preparing to serve some form of rubber chicken with fluffy, tasteless sponge desert coated with sugar glaze. The back wall of the stage was covered almost entirely by the silver-white projector screen. The podium was empty and waiting for the speaker to step up to it. The stage platform, up 3 feet off the floor, stuck out from the wall about 10 feet, and the steps up to it were only 5 feet from our table, to my left. My seat faced the audience. We had a prime spot.

The featured evening speaker, Cosmonaut Georgi Grechko, and some kind of aide / translator / guide person sat down at our table. Grechko faced me. The aide needed an extra chair. They forgot the Featured Evening Speaker would come with a Translator Aide Person. The aid spoke Russian. Grechko handed one of the stage attendants his box of slides, said something in Russian to him, and the aide said something English to him.

The first thing I noticed was that they called him "Cosmonaut," not "astronaut." The next thing I noticed was that he was just not very interested at all in either his audience or anyone at his table. It was like we did not exist.

We did not exist. He was trying to ask the aide, who spoke Russian, how to work the new video camera he just bought. He was asking in mixed English and Russian. He was clearly very captivated by the new toy. He was fondling it and fiddling with it. Then I noticed his English was not that good at all. No one with a ticket at this table spoke Russian.

The Cosmonaut finally noticed that we were sitting there at his table, staring at him. He caught on quickly. He looked at us and started to brag and name-drop.

I had been in this kind of situation many times. General Dynamics would set up a table and carefully place the important fellow, such as a United States Navy Admiral, with his one or two aides, and two or three of us who needed to talk with the Admiral, each in our appropriate places. My job was to talk to the important fellow. Get to know him. Engage him. Get him to invite me to his office early next week.

Someone who name-drops was also a familiar situation. The really big difference between this guy and meeting with a United States Navy Admiral was the name dropping. A US Admiral doesn't name-drop. The Admiral really does talk to the President.

I wondered "What do you say to an astronaut who can hardly speak English?"

He was trying to tell us about how he had just spent the day with Bert Rutan and with the super-high tech airplane Rutan had made. The airplane was like the one that flew around the world. We all knew about that airplane. That airplane made world history when it flew around the world. Most of us knew Rutan's name. He was the famous airplane inventor who made it all happen.

Grechko seemed at ease, and even as he bragged he did not seem that interested in us.

He passed around a 35 mm slide of something I found too hard to read and did not recognize. But one of the L5 Society people with me recognized it and acted all so-impressed.

I always asked questions. My question to him came rushing out of my mouth, driven by an instinct. I could feel what kind of person he was and what his mood seemed to be at the moment.

"What's it like inside a space ship?" I asked.

With no hesitation whatsoever, he looked at me and said
"Stink like barn."

His Russian accent came through clearly. But his human emotion of the humor of it all came through loud.

It took a moment for us to catch it. This guy was telling it like it is, with intonations of basic human body odors. Not prim. Not proper. Just plain bluntly human. Russian. Basic.

After a moment, I burst out laughing.

His instant answer and the smirk on his face added to the joke: I was not the first one in the world to ask him that question, either. But I didn't care. He looked at me and connected.

"I am oldest, grandpa, cosmonaut.
Am not that old.
Not in best shape,
but good enough,"

he said with a laugh, boasting a bit.

He seemed to change the subject, but he was now aware of me, and turned to me when he started talking, and then turned to the others to finish the sentence.

"Why does it stink?" I asked, looking directly into his eyes, and smirking a bit. He could tell I knew what to ask next. He was begging me to ask.

I could tell from the way he said first few words to us, and from what he said, that he was playful, not arrogant, and that he was certainly in charge, but not pompous.

He looked at me first again, and then talked to all of us at the table.

With a thick Russian accent he started:

"Young, astronaut,"

speaking in one word punctuations

"go, on, ship."

He continued, pausing just a moment, and then with his hands starting from his stomach and moving up and out, away from his face,

"and throw up."

He moved his hands away from his mouth one more time and looked at us, trying to communicate that slimy, smelly, awful stomach stuff comes blowing out their mouth, into a ship with no gravity, so it floats.

Graphic images of vomit floating weightless in blobs in a space ship startled us.

"Sch-tomahk sikh"

he said, with Russian accent. He meant "stomach sick".

The expressions on our faces instantly rewarded him. Our reactions were clearly why he liked to tell this story.

"I try to tell them."

he started to explain,

"They think,
what does old grandpa know?"

he said, referring to the young astronauts.

"But I know what to do,"
he said, speaking faster.

He moved his chair out, away from the table. Then he sat squarely
in the chair.

"I sit on chair and grip tight,"
he said, as he reached down to the chair seat and pulled himself
tightly into the chair, like his arms were tight straps clamping him
to it.

He tensed up and held on for a few seconds, clearly
straining. He was not acting and was actually showing us
what he actually did, in space, in the astronaut chair.

"I hold on tight for 10 minutes.
I don't throw up.
They do,"
he concluded, and then he laughed.

"Old guy know more than young punk."
he asserted, bragging and laughing a well rehearsed punch line.

"They have to be humble.
They throw up,
stink up ship."

"Can, not, open, door."
he added, waving his arms like trying to open a locked door in a
small car. He was trying to make us feel like we were locked in a
small car with obese, grossly vomiting adults, and he succeeded.

He wanted to make sure we understood that the ship smelled bad
and that vomit without ventilation was one of the reasons.

"Ship stink like barn."
he said again, turning to me, and concluding a short story I gave
him a chance to tell.

We finished eating the rubber bulk food.

Then the commentator spent a few minutes introducing him.
Grechko proceeded to narrate a picture story to the crowd, showing
Russian spacecraft of all kinds.

"I see your satellite."

he said as he held an imaginary sphere the size of a large
grapefruit.

"Was so tiny"
he said, with a puzzled look, and then the look became
deliberately puzzled.

"Tiny Payload."

"You, put, up, kilogram."
"We, put up, ton."

His humor was subtle but pointy.

He was referring to the fact that the Russian space vehicles
launched a 1000 times more mass than ours.

One of the major points of his speech was that Russia launched
far bigger payloads than the Americans, and he wanted us to
remember that.

He was right of course.

"Stink Like Barn" I won't forget.

All the spaceships smell like a barn. Every astronaut and space
ship visitor I ever met verified that. Every astronaut I ever talked
to assured me the ship "stink like barn."

I learned that space was bad for you. When we are weightless,
our bones loose calcium and our immune system does not work.
Our bones become brittle.

I learned that even the Russian space ships are too small. They
are like jails, dungeons, cruel and unusual punishment. Poop
floats, too, by the way.

The meeting was great fun.

The message was depressing. We are the wrong species for
space.

This was the first of a long series of disappointing facts about
space that hammered me.

- **Getting Fired because of "... no clear profit", Col. Simon Pete Worden and the White House**

• **Getting Fired From A Space Job**

A Message from The White House

"The conquest of space is going nowhere until there is a clear profit."

Don Summers had poked me in the chest with his index finger while he said it.

He was sure right.

Sure enough, we were being fired. Our conquest of space, with our wonderful satellite to submarine laser communication system, was not needed anymore. The Cold War was over. Nobody wanted to send secret messages to secret nuclear powered attack submarines, not even with a super marvelous laser in space. No one wanted to send secret target data to secret "Boomer" submarines with a belly full of rockets, each tipped with a handful of nuclear bombs. The Cold War was over.

The Clear Profit was gone. And so were we.

But my timing was superb. When Professor Jim Arnold gave me the phone number of the Professor who wrote the book on near earth asteroids, I had called the number. Professor John Lewis answered and assured me that there were many near earth asteroids, many that were easy to get to with a rocket, and many whose dried-clay-like dirt would spit water steam when heated up.

Better yet, Prof. John Lewis liked my idea of a steam rocket. He liked it so much, he gave me the phone number of one of his ex-students. The ex-student, Colonel Simon "Pete" Worden, was now in the White House. I left a phone message for Pete Worden in the White House.

6 October 1990.

Everyone in our lab that morning had that blank stare of the doomed. Everyone mumbled idle talk, like the condemned. Everyone slowly assembled into the conference room. Everybody knew. The big oak table that would normally seat 6 or 8 very important managers on each side, facing each other, was moved way off to the side. The room no longer looked like the Big Important VIP Conference Room. It now looked like a room with 100 chairs crammed into a room that should hold 30, at most, and with the extra chairs squeezed along all 4 walls.

I wandered outside for a moment, before going in with the rest of us. The overcast sky was quiet and grey even though it was 9 AM. No wind, no rain, no sun, plenty of parking. I looked longingly at

the place I got to go to every day. I knew it would change today. The entry to our building was a very pleasant, reddish brick stone, with artificial stone facades, smooth black rock panels for style, perfect, new anti-reflection glass doors, surrounded by green bushes, clean architecture, clean, new asphalt for parking, every tree and every bush neatly trimmed. The conference room door was 10 feet past the receptionist, through the electronically opened security door.

The pretty, 22 year old receptionist answering the phone and greeting visitors at the entrance of our facility was a temporary, sitting there only for this last week. As I wandered back, she told me how many there were in her family, where she was from, and some family history. I flirt a lot. I am an Aspie who focuses on people. Her story and her face were interesting. Her person was strong and confident.

Dr. Reg Lowe was our Vice President from the St. Louis headquarters of General Dynamics. He had announced this special meeting that we "all need to attend." Every one of us, every employee, was about to walk into the conference room to hear what Reg had to say.

We all knew why the Vice President from Headquarters commanded us to be here for this meeting, even though it was supposed to be a Big Secret. The Berlin Wall had fallen. The End of the Cold War was raging wild in southern California. There was no need for "Satellite to submarine laser communications" (SLC), and SLC is what we were all trying to do there, like it or not. The Navy had delayed funding our SLC program indefinitely and had no intention of spending the \$3 Billion everyone knew it would take for a prototype system.

No Clear Profit.

Only a female technician permitted herself to cry. She was crying all the way in. She knew but was not supposed to know. I knew what Reg Lowe was going to do the night before because my boss, The Great Freiwald the General Manager, called and told me.

"We have nothing to fear," my Freiwald told me, because "General Dynamics takes care of its managers. We will all have a job somewhere in GD." he asserted, reassuringly.

Just as I was on my way into the meeting room, the pretty receptionist casually handed me a message. I was a bit startled

when I saw who it was from. She didn't seem impressed at who it was from, and she was just taking messages. It was from "White House".

Colonel S. Pete Worden from the White House called me back. John Lewis told me to call Worden at the White House and leave a message. So a day before, I did. Amazing. The White House answered. Superb timing.

I walked into the jam packed conference room and sat in the back against the wall next to Bill Baker, the Department Manager head of the Mechanical Engineering Department.

Then Reg Lowe fired us all, the entire laboratory. Reg told everyone how we would get paid till January, how our benefits would be paid until then as well. To help us, GD was hiring a very well known, very effective outplacement service to help us all get jobs. Reg went and on and on and on.

I could not hear a thing during the whole meeting. I was smiling from ear to ear. I kept holding the message in my hand, on my lap, so I could glance at it, during the whole meeting, to make sure it was real.

All the message said was:
From: Pete Worden
Address: White House

As soon as Reg Lowe was done firing us all, I called the White House. Someone got Pete Worden. Almost as soon as I said hello I told him how to use a steam rocket to take huge payloads to Mars.

Hey 4th Graders, This Is Easy:

Moral of the Story: *Contacts count.*

You can meet anyone you need to meet.
Even if you are an autistic Aspie,
you can meet anyone you need to meet.

The only thing you must have is
passion,
passion for what you believe in.

- **Ice In Space from Village of the Damned, and Periodic Comets**

A Swarm Of Local Comets

When your daydream hobby job can change the world, and only you know it,
you will probably have some hard times.

Get ready for them.
The hard times are not that bad.

Village of the Damned

It was sometime in the winter of 1990. I was out of a job and looking for one, and always wearing a suit. Every morning I would put one of my Pentagon suits. I would choose a pair of my black wingtip tie shoes and put on a clean, pressed white shirt and a power tie. I would grab my briefcase and drive to my office about 25 miles from the lush green hills and opulent Rancho Bernardo, CA, and park in a clean, multilevel cement parking structure. Did I say "*my office*"?

It *looked like* we were employed.

Every day I would walk into a brand new, 4 story building with a blue-green glass outside wall. I would take the elevator to the 4th floor, open the heavy, 8 foot high, 3 inch thick, beautifully polished and stained hardwood doors with expensive, 1 foot dimension big brass door handles. My feet would almost sink into the thick new

carpet. Through those luxurious doors I entered the Offices for Fired Executives.

I would greet at least one well dressed young secretary, notice and appreciate her nice hooters, and then, I and at least a dozen other fired executives would disappear into the building, somewhere deeper, to the "offices". I would select a little cubby hole that would be *my office* for the day. I would scan the empty "offices" to find one with a window. Each office had a telephone. Some had a nice chair, and a few had a window with a nice view.

Then I would spend the day along with other depressed, fired Executives from all over San Diego, where every day we would feel the shame and total humiliation of being fired. We would look for a job from the *Village of the Damned*.

Every day I walked in shame. Being fired for any reason was Intense Shame and intense embarrassment.

Those of us from General Dynamics knew that when the new year started, our severance paychecks would stop.

All that we could be sure of was a telephone. Just a telephone. Everything else was a gift. The secretaries would professionally answer that phone and take faxes for us.

We were so lucky because we received this Special Executive Severance Benefit. We were the 5 managers of the General Dynamics Laser Lab. I was the only one who actually went to this office every day. I didn't know what the others did. Each of us was offered a nice, comfortable, free office, and we could count on free phones with free long distance calling, and a female voice to answer them for as long as it would take to get another job.

We even got special counseling services. Twice a week a different Ph.D. industrial psychologist would talk to us. One set of psychologists told us about the cycles of emotions of the Unemployed Executive. Another group would help train us on finding high paying work.

I would sometimes day dream out the window. I could not help it. After making a phone call, I needed time to think, to rejuvenate, to rest. Then, make another phone call.

Getting an office and phones at the Village of the Damned was a big perk reserved only for being a fired executive of General Dynamics. The rest of the guys only got some tutoring on how to go find their own jobs from their base at home.

Then General Dynamics fired the guy who fired us. Dr. Reg Lowe, Vice President of General Dynamics in St. Louis, himself got dumped. He didn't expect that. Neither did most of the people in all of General Dynamics all over the United States.

The head of General Dynamics Space Systems Division, the great and honorable Big Boss, Dr. Alan Lovelace may as well have gotten fired. He was sent off to a small building somewhere in Outer San Diego, 5 miles east of any impressive buildings, in charge of 35 people. That was his punishment and humiliation for letting the Cold War end.

The Evil of 50 years of unethical behavior of General Dynamics finally caught up with it.

From a few windows in the Village of the Damned I could see rolling waves of real offices in the rich suburbs of San Diego. Offices of people with jobs.

Hunting Ice, Hunting for Work

Every so often, at least a once a week, I needed to escape, to go somewhere with some intellectual diversity. The University of California at San Diego was only 5 or so miles away. I went there because their library had a section on astronomy and space resources. I needed to find ice in space so I could melt it, to get water to fill the steam rocket fuel tank. I was bound and determined to get a job saving the world and starting the Exodus to Space, to Inhabit the Solar System.

If I could not find any ice, I would not get a job, I thought. I had to find ice. I knew it was out there, somehow.

At this point, during the autumn and early winter of 1990, the only place one could find ice with 100% certainty and on something with low enough gravity to be useful, was on little moons far away, deep in the solar system, out by Saturn.

Bullheaded, I would only settle for a space water station what would let my little steam rocket haul 10,000 tons.

The only places in space that would let one little steam rocket launch and blast off with a 10,000 ton payload, and 20 times that much water for propellant in the water tank balloon, would be a place with almost no gravity. The only places like that were little asteroids and tiny moons, like the moons of Mars. Those were the only ones I knew of with low enough gravity.

If you were a real, imaginative rocket scientist, you would see a flaw here, and would trump me, figure out the key to getting huge amount of water, and beat me. But no one did. Lucky for me.

Even though my rocket scenario was not the best, I had a plan. I rehearsed it over and over. I doodled little pictures of the plan while I searched for more people to call. I wanted to make sure I knew what story to tell.

It was like a daydream.

I would take a rocket to some valuable rock- or moon-place in space. I would heat the dirt or permafrost until the water steam would come out. I would condense the water vapor. I would collect 200,000 tons of water. Then I would put the water into a tank, the rocket fuel tank balloon bladder.

I know how to calculate how a small tank could hold a lot of water. A tank weighing as little as the payload of the Shuttle could hold 25,000 tons of water, or more. That would be a huge amount. The Shuttle payload is 25 tons.

I would load the payload on top of the rocket. Then I would turn on the steam rocket engine.

The nuclear reactor, no bigger than big pickup truck, would boil the water into steam. The steam would be so hot the pipes would glow orange. I would connect the rocket nozzle directly to the nuclear reactor. Just like the nuclear reactor and rocket nozzle I wrapped my arms around at Jackass Flats, Nevada, 20 years earlier. The steam would come out the back of the rocket and push the rocket.

The rocket would roar silently in space.

The steam rocket would have enough power to launch 25,000 tons tons, not kilograms, off places with low gravity, like a small water moon of Saturn.

The rocket would decelerate the space ship and the ship would begin to fall towards the Sun.

My computers would very carefully calculate how long to decelerate and in what direction. We would aim it so we would almost hit earth.

A million miles from Earth we would turn on the rocket and slightly change course so we would not crash into Earth, but just skim it.

Finally, just as we got somewhat close to Earth, closer than the TV satellite stations at GEO, we would turn on the rockets to full thrust. We would try to slow down enough to become captured in an orbit around Earth itself.

Then we would have delivered the payload, 10,000 tons of water.

I did calculate it all. We would bring rocket fuel to an orbit around Earth.

And then we could fuel the Exodus and Inhabit the Solar System.

"Inhabit the Solar System"

What a daydream. I daydreamed this every single day at the Village of the Damned.

And I needed was real data. Saturn had two little moons that were almost pure ice and were so tiny they had almost no gravity. I could see them in my mind-eye. I had seen actual pictures of the little Saturn moons named Iapetus and Hyperion.

They were awfully far away. They were at Saturn. But they were absolutely 100% sure sources of water. I could not find anyone who would assure me of water in space any closer than these moons of Saturn.

I was fretting. The water had to be on places with almost no gravity, or my little engine would not push hard enough to push us off. We needed water to be closer than this. I needed water somewhere near Earth. I was fretting over it.

I fretted and fussed, but the reality forced me to continue. I knew I had it. The math proved it.

I need water in space to run the steam rockets that will let mankind open the Final Frontier. I am sticking with steam rockets and space. I have something no one else has.

The trees in the University of California at San Diego parking lot were always green. Once in a while a little fog or rain would mist my face as I walked the path to the library. Most of the time pretty young college ladies would pass by. They would not notice me at all. They would not even glance. I thought it was because I had my Pentagon suit on and I was already getting old and ugly and had bad breath. That was all true.

I was just wandering around in the library. The part of the library I needed was well lit. Almost no students gathered here, and almost

none were grabbing all the chairs. No computer terminals were here, to help me search. Dark, heavy wood tables were big enough to put 4 chairs around them, and for me to take an entire table for myself and to spread out. A coin operated Xerox machine was conveniently right there, by the books. This was the astronomy corner.

I was looking at each and every book on the shelf related to astronomy. Stars and galaxies didn't catch my eye. There were a rows and rows of them.

Ice in Space

And then I stumbled over it. "***Long-term Evolution of Short-period Comets***"

It was a binder, not a book. It's title had the words "comets" in it, so I dragged it out.

Strange title, too. I didn't know that "Short period" comets existed. The binder had a lot of comet orbit data, with pictures of the orbits. Some orbits looked like those symmetric patterns we used to see on the oscilloscope screens in old sci-fi movies. I saw rosettes and loops and curly squiggles.

Comets are water in space. That much I knew.

I did not expect what I saw before me. These fellows were describing a whole formation of comets between Mars and Jupiter. The authors were some Italian astronomers, "Carusi, A.; L. Kresak, E. Perozzzi, and G.B. Valsecchi" All of my ancestors are Italian. I didn't know Italians had done any science since the Leonardo Da Vinci and Galileo.

Why don't we see all these comets, right now?

Apparently, most astronomers must have known about these comets but forgot about them. Or, maybe they didn't tell me because they thought everyone knew. Maybe only Ted Fay knew and maybe that was the reason for his cryptic message to me: "We will get you your water."

Just for the heck of it, I calculated the delta-V a steam rocket would need to develop to make a trip from one of those comets back to Earth. I didn't have the exact equation with me, but I knew how make a good estimate.

The binder had listed most of the periodic comets. They had even listed the orbital elements in a form that I could calculate the delta-V with my hand calculator.

Nature is usually a bitch. Most of us don't really expect anything to work out. Things almost never work out. But the calculation was rather simple. So, I picked one whose orbital data looked like it might be good, and worked out the delta V.

Surprise!

One of them turned out to have a reasonable value of delta-V.

Something worked out.

So I kept looking. Even if there were only one, I only need one to win. This 2 inch thick binder was full of pages, and they only used about 2 or 3 pages for each comet. So, there just had to be another that would be as good, or maybe better.

I started to figure the delta-V for each one that looked right. I figured it with a hand calculator, right there in the library, because I could not afford the time nor the money to copy the whole thing. It cost 5 cents per copy. I was out of a job and "broke." I had to be selective. There were about 150 comets. When I had figured about 5 or 10 of them I realized that many of them were ok.

"OK" meant the mission delta V was low enough that the steam rocket could bring payloads back to Earth. I started making a list and copying the best ones.

Totally Stunning!

All the comets had weird orbits. Carusi and his colleagues had calculated the orbits for times extending thousands of years. When they did that, they saw abrupt changes in the orbit anytime the comet came close to any planet. Some orbits were simply unstable. Many had Lissajou patterns for orbits, which meant they were stable, but their orbits around the sun would be shaped like roses or flowers, symmetric but not circles or ellipses like everything else.

I went home with a few that looked reasonable.

This meant that I found the water. Ted Fay was right. He knew there was water there. He told me the first time I met him, at the Lunar Solar Power meeting, "we will find you your water." I didn't believe him. But he was right. He knew.

All the way home my mind repeated like an echo:

I need to redo the calculation.

There is always a mistake somewhere.

Makes it worse.

Every time.

Don't get too excited.

There was no mistake. And as expected, the delta_V's were not quite as wonderful as I had hoped.

A few weeks later I convinced Ted Fay and his wife to meet me at UCSB and we talked about it.

Ted was right. We did find the water. I found at least a few comets that were close enough to be water stations for my steam rocket.

I could not believe it.

- Elevator Speech

Stalking Customers and the Elevator Speech

Stalker at the Meeting

It was now early January 1991 in Poway, California, just 45 minutes from the San Diego airport. It was now official. All the Managers were fired, officially unemployed. Our paychecks officially ended December 1990. They cut off our money flow.

Fired or not, I was sticking to my Vision. I knew we could Inhabit the Solar System because I found where I could get the water. I saw the orbital data in the document at the UCSD library. Ted Fay knew all along his colleagues had found the water.

We had the key thing, the thing we needed most of all, abundant water in space.

However, I needed a job, a day job. Cutting the money flow was like someone numbed my arm with Novocain and then cut my wrist. During the first minute, nothing changed.

Strangely, nothing seemed to change when my paycheck died. The large, 1 inch brown olives we picked 4 months ago from the neighbor's tree were still curing in brine in the one gallon jars on the old wood desk in the garage. The eucalyptus trees in our yard, trimmed by the tree-trimmer guys so they would not be a fire hazard, still smelled the same when I crumbled a dark blue-green leaf and put it to my nose. The grass was still green. The two trees with the soft, peeling white bark were still growing. The 500 foot

hill a few streets away was still charred from the scary fire that dropped ashes in my driveway and on my shake-shingle wood roof, and turned the sun blood orange-red. But they cut off my pay.

The weather was the same, mild and partly cloudy. The computer and printer were the same. Terri still drove 45 minutes to work, every morning.

No wonder people go broke. Everything around you seems to be the same after you have no salary.

Absolutely determined to find someone somewhere to employ me to take 1000 people to Mars, I kept repeating to myself that I had something no rocket scientist had: a steam rocket. And, I had a heretic's rocket equation to prove that it would increase the payload by at least 100's of times. Multiple times I checked the equation and its assumptions, and verified it was an absolutely correct equation.

Most significant, I had also signed up for a NASA meeting on Mars and asteroids. Contacts count. Professor John Lewis would be at that meeting. He knew everyone.

The meeting was in Tucson, Arizona. Jennifer was going to go back to college in Las Cruces, New Mexico after the Christmas break. She could

drive me and drop me off in Tucson, Arizona, where the Space meeting was. That would save a couple hundred dollars of airplane ticket. I was going with her because it was on the way to the space meeting.

People in the space business went to these meetings, and I needed to find and meet them. General Dynamics taught me well on how to find and stalk the important people. For this I was skilled.

The Elevator Speech

If you want to change the world, you need to get your "Elevator Speech" perfect.

General Dynamics taught me the "Elevator Speech."

While Jen was driving us through the desert from San Diego to Tucson, the Elevator Speech, a lesson Dr. Frank Chesus taught me, replayed in my head. Chesus was the best of the Old Bulls of General Dynamics, I thought. He was definitely Ethical. He was once the Big Boss in Charge. He and I got along very well. I clearly heard him emphasize:

"You only have enough time to ride the elevator with him from the top floor to the bottom floor."

He looked right at me when he told me.

"You have to tell him such an interesting small talk story that he invites you to a real meeting, or tells you to call him on the phone."

For days before any meeting, we would practice our elevator speech. We would try it on people.

Stalking The Important Ones

General Dynamics held formal short courses for us the Executives on how to "stalk" people.

An Elevator Speech started with stalking the important person one needed to meet, such as a General or someone from Congress or the White House. The important person was someone who could strongly influence the awarding of a huge contract. A fleet of fighter aircraft or a new class of submarine could mean a contract for \$30 Billion. For example, that would only cost the taxpayers \$3 Billion a year, for 10 years, for a bunch of fast, 15,000 horsepower airborne race cars, called "fighter jets,".

First, go find out which important people are going to be there. Next, make it a point to learn the names of any important person who might even show up unexpected. Write the names down immediately. Then, look for one of those key persons. The person would most likely be an invited or keynote speaker.

A key point: physically move and position yourself so that the guy has to walk by you when he leaves the podium or gets up from the table.

Gerry Husler's imposing, commanding voice replayed in my mind. Husler was our Director of Business Development. He told me exactly how to do this. He was ordering me to do it.

"You better damn well make sure you are in his path even if you miss the free lunch. Get directly in his path. You can eat later. You're too fat anyway. Your job is to meet him, not to listen to him talk. You can talk to his aides. Refine your point based on what the guy says. Elbow your way in there so you are the one who gets to walk with him to the elevator. Got that?"

And then he smiled and laughed a bit. Husler was big enough to elbow his way around. I was smaller and had to resort to Kung Fu methods, fast walking and missing the meals.

Husler wanted me to elbow my way ahead of the more timid guys from other companies, our competitors. In this game, the successful ones push and shove to be first, to be the one the important fellow, the target, has to

pass when he finishes. When he passes, we start walking with him and tell him a very short story, the elevator speech.

Chesus's voice mentored me again:

"You have something he wants. You know it. You have to tell him. There's something positively intriguing about what we're doing. He needs it."

Then Chesus instructed me to be absolutely sure I had done my homework and knew exactly what thing that General really needed and really wanted.

Husler commanded:

"If you don't know exactly what that thing is, get out of the way. You'll be shoved out of the way by someone who does."

Husler didn't laugh when he said that. He was serious as hell. He knew we scientists from the Department of Energy were typically timid, too timid for him.

"You don't just run up to the guy and blab. Find out what he needs," he commanded.

Husler paused and smiled a little and commanded again, "Captivate him with a little story."

Husler told stories a lot. They were mostly bullshit because Gerry would typically lie about what we could do or what we already did. But he told a good story.

The General Dynamics marketing guys taught us how to work a meeting where we probably did not know anyone at all. When I had that job, we were looking for a new market for a laser and we would show up at a technical meeting related to it. We would make sure we attend the general startup meeting.

Starting out with a blank page was not that hard:

- 1.) Pick the most carefully dressed random person who people are swarming around,
- 2.) Just walk up and ask them "Who would know the person here that knows the most about xxx whatever?"

That would get us a name.

We would also look at the speaker's roster and write down the names of anyone who looked like they might be important or influential. We would only know their status or position by the list of attendees. We would go find them and ask the same thing:

"Who is the one that everyone respects?"

Then we would go look for technical leaders, because the technical leader would know who has the money. The technical leader got there by knowing in great detail what the money-persons want. This technical guy would only work on important things, things that pay money.

Then the Stalking began. I heard the voice of an Frank Chesus telling me how to do it, without Gerry Husler's bulldog mannerisms.

Pick a guy on the list. Move a chair and park right by the door where everyone has to go thru to get in and out. If he's in there, he has to pass right by you. Ask anyone around you if they know what this guy looks like. You tell them "I only know the person's name and I am supposed to meet him."

Frank taught me like an old sage teaching a young warrior. I was a warrior to him. He liked me because I understood his ham radio language. He loved that stuff. He loved the technical work. He had risen to be the General Manager of a General Dynamics Division. And he always favored the people who knew something, and were not those marketing bullshitters.

The oversize pants of his conservative suit had impressed my wife who told me he was old, boring, poorly dressed and arrogant. But I didn't think so. I liked him and followed every move he described. He was sharp and he would teach me every chance he got.

"You spend a lot of time finding out a whole list people who might lead you to the kind of person you need. You don't know who you need. That's why you are there, to find them. You keep all the names at your fingertips. Most of the people on your list you never heard of before. If the person is important, lots of people know what they look like. If they are not important, you don't care and cross them off the list."

Frank Chesus was direct, but it was like learning how to fight to win. Husler would bark loud to make sure we got the message:

"You better damn well know precisely what you want. If you don't, then don't play the game."

The desert of eastern California and western Arizona in the winter passed by my window as Jenny drove the old brown Honda packed to the bursting point with college stuff.

I started to fret and worry: "How am I going to pay for Jenny's college when my mortgage is \$2,200 per month and I don't have a job?"

Jenny bought a 6 week old little Siamese kitty, and we paid the \$100 for it. I fretted some more, thinking "Doesn't she understand? We are broke."

We weren't completely broke, but with no income, spending a dollar was like spending \$20. I had learned that fact the hard way. If I would save 5% of my income, which is really hard and nearly impossible, I would be saving \$1 out of every \$20. To get \$1 saved, I must make \$20.

So, when I have no income, if I spend \$1, it is like spending \$20.

Fretting. Sweating. Uncomfortable. I had no income. And there was no one on the horizon who was hiring. Everyone in the USA was laying off technical people. Just like now, only then it was just technical people.

The little black kitty pooped a little black thing the size of an olive pit. Driving in the heat of the Arizona desert made the kitty black thing fill the whole car with smell.

It took my mind off of things.

- **The January NASA Meeting: comet**

A NASA meeting on space and asteroids.

This meeting would be the start of a deluge, a hurricane of new places in the space near Earth we could use to inhabit the solar system.

Prof. John Lewis, the professor who wrote the book on near Earth asteroids, was in charge of the meeting. He told me about it and invited me.

Long before we approached Tucson, Arizona, this January 1991, wisps of the sweet smell of sage, the faint smell of a cactus flower, the smell of dry saltbush pollen and the flowers of a yucca, all stimulated memory flashbacks, like hallucinations. The familiar smell was the same entrancing smell we got when we first moved to the cold high desert in Albuquerque, during 1970 when Jennifer was born.

As we approached the city, the outsides of the clean, white-brown stucco buildings surprised me with the sharp contrast of the blues and reds the architects used on the walls. The city almost looked like a surreal painting. The city was so bright and clean, even as we began to see it from 30 miles away. The sun seemed brighter than San Diego, and the sky was deep blue, not like San Diego at all.

She dropped me off and went on to college in Las Cruces. I was alone, and without a car, without the expense account to pay for anything, without a business card stating how very important I was. I was here, with nothing. On my own.

Knee-jerk training from General Dynamics took over. My only purpose at this meeting was to play the game:

"Find contacts who will give me a big contract,"
otherwise known as a Job.

Instantly upon checking in to the Motel, I put on my Pentagon Uniform, a dark blue suit with thin stripes 1/2 inch apart, a white shirt, appointed with a simple green-red-banded Pentagon tie, and my black wing-tip shoes. I went to the meeting before doing anything.

It was a huge conference room, as science meetings go. It seemed big enough to hold a convention of aerospace contractors trying to win a space launch contract. According to the roster, it was only a bunch of space scientists and engineers trying to get small, one or two person contracts. Proof that this meeting was feeble, small and unimportant was the fact that there were no booths with vendors, and there were no Pentagon brass wandering around.

The conference room must have held 1000 chairs. The conference seemed to be packed. There seemed to be people everywhere, and the room was full most of the time.

Professor John Lewis was the chairperson introducing speakers and sitting right up front. Professor John Lewis wrote the book on asteroidal resources. He was famous.

Lewis, John S. and Ruth A. Lewis, "Space Resources, Breaking the Bonds of Earth," ISBN 0-231-06498-5, Columbia Univ. Press, New York 1987

This NASA meeting I signed up for had lots of the right kind of people for me to stalk, because Professor John Lewis told me who would be there and insisted I present my scheme at this meeting.

John Lewis was the fellow who gave me the phone number of Colonel Pete Worden, in the White House, and told me to use his name to get a return phone call. And I did get the return phone call. John Lewis was definitely one of the right guys to stalk. He was very quick and very smart, recognized by everyone to be so, and offered something more valuable than money: connections. He got me to speak with the White House.

Professor John Lewis was easy to approach, but the Professor was definitely not "easy." It was clear. Don't cross him even just lightly. He would eat you for lunch fast if you didn't know anything or if you wasted his time. He would tell you, fast. And he would not be kind about it.

Dr. Geoffrey Landis from NASA Lewis Research Center in Cleveland was my coauthor. He understood the steam rocket performance equations immediately. It was a simple knee jerk calculation for him the first time I showed it to him. He had a Ph.D. in some kind of rocket science.

Landis liked the idea of publishing the first paper on steam rockets with me. We showed how to get to Deimos, one of the two moons of Mars, from Earth orbit. Ours was a big space ship, about 30 times more massive than the Shuttle.

Jeff Landis is a Visionary, and he published science fiction stories to prove it. When I heard he wrote stories that people actually read, I gave him my Visions, too.

Jim Powell told me once, "If you find a Visionary, give him your Visions. You both win."

conference hall. The hall was full from about the third front row to about the middle before it began to thin out.

E My strategic position was just behind John Lewis, directly up front and close enough to ask him a question or two anytime I wanted. No one else was pestering him. "Good," I thought, "I have no competition."

h Who would be the next few people to meet? Usually, the first session has the heavyweights who give overviews or startling discoveries. These would be the guys. Sitting next to John Lewis with no one else for three rows might make me look special and that might soften the abruptness of my walking up to them and starting a conversation.

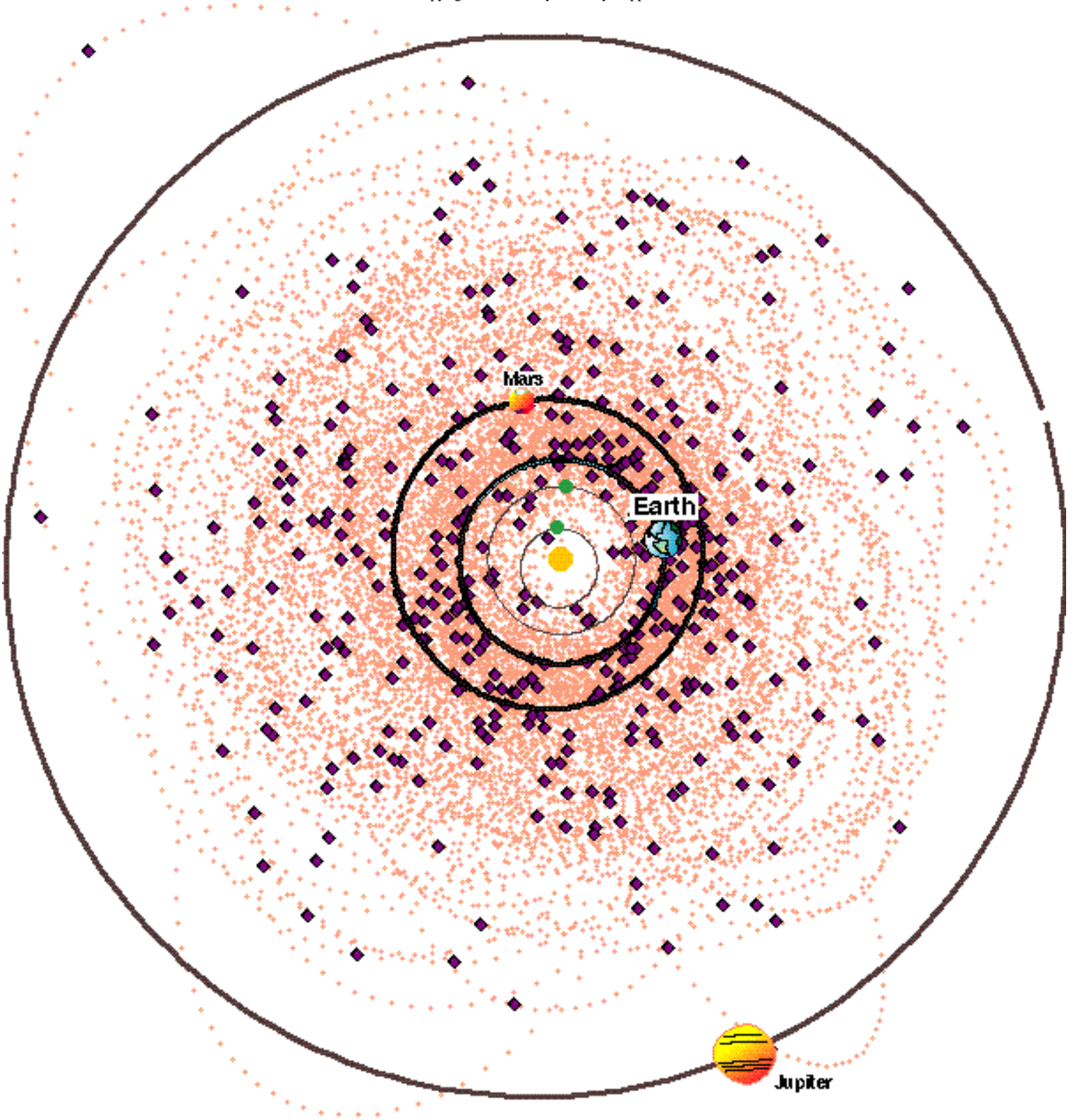
A Dr. Tom Gehrels took the podium and explained the near earth asteroid story. I had never heard this story, about asteroids swarming near earth. With a stunningly clear presentation and with a distinct north European accent, he told the entire audience that regular astronomers called the asteroids "vermin," little bugs crawling across the photographic plate. To others they were bugs. To him and a whole group of people who worked here in Arizona, these were interesting, and perhaps even dangerous to civilization.

g *So close they can and do crash into Earth and cause a disaster.*

l He spoke so slowly, carefully and clearly that anyone could understand, even a physicist like me. Gehrels would be an important person to meet, I thought. He dressed rather casually for a meeting, like one would expect astronomers to dress.

The best part was his invitation to take anyone at this conference for a tour of the astronomical observatory at the top of the mountain in the middle of the night. Stunning! I was definitely going to see those telescopes.

The lights of the conference hall dimmed. The movie screen behind the speakers' podium was big enough to show a movie. The overhead projector for our viewgraphs was a good one with good optics, so our viewgraphs could be clearly seen in the back of the



A swarm of asteroids swarming around Earth's orbit.

- **I** He was referring to the dust-covered small things, roaming the inner solar system, like Deimos, one of the tiny moons of Mars, and those periodic comets this mostly side of Jupiter that I learned about only a few months earlier. He wanted to talk about the closer comets, the ones that mostly this side of Jupiter, the dark and close ones that are not as hard to access as other comets. We both saw we had a common interest.

D"Why?" I asked.

e I thought that because the sun is constantly beating down on them, the ice ought to evaporate. That ought to happen anywhere this side of Jupiter. I **m**idn't understand.

O "The dust on the outside is a Knudsen diffuser," he said, as if that was all **S**he needed to say.

I I never hear about a "Knudsen diffuser" and I never learned about it either,

e "I forgot what it was, it was so long ago," I lied, hoping he would give me the one-line physics of it.

' "The mean free path is greater than the pore size." he replied, with a one-line physics explanation. His statement proved we could communicate fast.

I still didn't know what that all meant. However, I did know what a pore size was, and I did know what "mean free path" meant, so I thought someday I could figure out what that implied.

"What does that do for you?" I asked.

I asked him to tell me anyway, even though I could certainly figure it someday, because it was quicker to ask than to figure it out.

"It's the perfect evaporative cooler." he replied. Aha!

Whoever lives in Arizona or Albuquerque New Mexico like we did, they know what that means. When the water evaporates off the sopping wet air filter, it cools the air. One can see these evaporative coolers all over the rooftops of Albuquerque.

"The 4 inches of that fine black dust on the outside of a comet is the cooler. That 2000 feet of dust covering Deimos is a cooler." he said, emphasizing that the "Knudsen diffuser" was working.

"It's a Knudsen diffuser. Makes the ice have a billion year lifetime on Deimos." he asserted.

He made it clear with very few words. The slowly evaporating ice inside would cool itself very efficiently and stay frozen solid for astronomical times.

"Oh, marvelous," I said, not knowing what else to say after he told me there was ice everywhere out there.

"That means the comets will be icy inside, you wait and see."

"You know that layer is not very thick around those comets," he volunteered.

"How deep?" I asked. If it's deeper than the length of a simple space robot scoop, it's too deep.

"I don't know. But the calculations show between 4 inches and a meter" he replied, using both English and metric units at the same time.

Then Professor Frazer Fanale told the audience that 2000 feet under Deimos dust we would find ice. My heart began to pound. The only thing I needed to start an Exodus to Mars would be any kind of water on Deimos. Hydrated minerals would be ok. And Professor Frazer Fanale said "ice." Stunning.

Ice on the most accessible, most useful moon of Mars

However, the ice would be 2000 feet down, under the surface. That's too far down. But Frazer then told the audience that the gravity was so small that "two of us could shovel the dust ourselves." His arms waved. His body motions showed strong emotions, and I caught on.

While at the Laser Lab I calculated what happens when humans would dig deep into an asteroid. The calculation showed that a typical frail human could literally throw 1 ton rocks right up the mining shaft. The gravity on a small asteroid or moon like Deimos is so small that a 1 ton rock weighs about 30 pounds. Frazer Fanale was a mandatory guy to meet.

I stalked Frazer and maneuvered to sit next to him at lunch. He almost looked like an Italian. Maybe he was, but he was from Hawaii. He looked Hawaiian too. He had a brown suit, and looked slightly overweight.

His comments excited me so much I focused everything on asking Frazer Fanale about the ice. People were talking in the halls about the ice on low gravity places closer than the moons of Saturn, as if everyone knew about it. That was more than interesting. Frazier topped it by telling the crowd that ice would be right there on Deimos. I would tell the crowd how Deimos would be the best location from which to get off and on Mars from Earth. The combination of things was better than my wildest dream.

I wanted to go find Bruce Jokell and tell him "see, an ice cube with Tony Take Me written on it." I thought Jokell was there, somewhere. I saw his name on a roster, and somebody said they saw him. But I never bothered to find him. He didn't count. I was too busy.

At lunch, while eating rubber chicken and a vacuum-cleaner-dust type of gravy, Frazier told me why the comets had so much raw ice in them.

"The ice doesn't evaporate very fast on these things," he said.

"It's covered with a sooty fine powder, like a black scab."

This could be a Coincidence of Nature in our favor. Water ice for propulsion. And unlimited hydrocarbons, like space oil shale.

We were done with the technical talk, so we could now eat and be humans again.

"So, how do you like being a professor In Hawaii?" I asked, thinking only of the young girls he surely got to watch coming to class or walking around. I imagined cute college girls with the little skimpy shorts, or maybe bare breasted, because of the heat, the humidity and they are in Hawaii.

He then told me something depressing about his personal life that was completely the opposite, and he ended it with " I'm having a rough time. "

I didn't know what to say.

Fanale had claimed that Deimos had ice on it. There was just no way to tell for sure. We needed a space mission to find out.

"Just speculation," I thought. But exciting.

However:
ice in orbits near Earth doesn't evaporate away. It hides.

Frazer Fanale was just the start.

- **poison planet Mars**

- -----

Mars, the Poison Planet

The sun was shining out side and the weather was warm and pleasant, early January 1991. But most of us spent the afternoon in the large conference room. All the afternoon presentations were given in this one room, unlike most technical meetings, where many presentations go on simultaneously in many rooms.

The entire afternoon session after the lunch with Frazer was about Mars. Different speakers kept talking about the Carbon Monoxide on Mars.

"They mean carbon *dioxide*, don't they?" I thought.

Carbon Monoxide? The Poison? I was not sure I heard it correctly. Did I miss something?

Mars air is carbon dioxide, nitrogen and argon, with no oxygen. So, something must be different. They are clearly talking about carbon *monoxide*..

Every speaker insisted that there was carbon *monoxide* the poison in the air of Mars. Monoxide, not dioxide. Deadly gas.

At the same time, they were showing that there was about as much oxygen in the super thin Mars air as there was carbon monoxide. There is about as much free oxygen as there is carbon monoxide.

This is scary.

Mars air is deadly poison.

People kept talking about how they had to keep the carbon monoxide from mixing with our air, the air we will breathe when we are on Mars, even if we make our own air. The technical presenters were describing details, too.

I finally pictured what would happen. I imagined what I would tell my audience when describing life on Mars:

I would start the little story with the unexpected warning:

If you pick up a bucket of Mars dirt and look at it in your room, you have to watch out for the carbon monoxide.

Then I would place them in a typical Mars situation, just like these technical presenters described:

Just imagine.

I am on Mars with a
sharp, mature female astronaut
sitting in a very spacious, cozy
Mars office tent space capsule,
4 feet on a side,
Hah.

Every presenter described tiny, tiny accommodations. All I could think of was "solitary confinement," when they described it.

Then I would describe a simple activity:

With a bucket of Mars dirt we just spent the afternoon collecting.

We're poking around in it,

My hands would show how we are plucking a rock out of the bucket, looking at it, turning it over, pondering it for a second, then tossing it aside and getting another out of the bucket.

And then I deliver the punch line:

And we start to get
a bad headache.

I get dizzy.

Both of us doze off,
our brains dull,

and we droop against the Mars tent wall,

where we die from carbon monoxide oozing out of the dirt.

The next speaker got up and detailed again how the air on Mars has a bit of carbon monoxide in it, "enough to poison and kill the astronauts," he said, "unless we carefully isolate our environment from the Mars environment."

The speaker then proceeded to show how he was dealing with it when collecting water for the Mars astronauts. The younger, 25 year old researcher fellow showed how he would generate about a 1000 kilograms of water every year, and would not have any CO in it.

I was not paying that much attention, because I was looking around the room for important people. So, when the guy was finished, I went up to him and asked him.

"How much water did you say you collected in a year?" I asked.

"About 1000 kg." he replied.

"A ton?" I responded immediately, because he confirmed what I thought I heard.

"Well, yeah," he said.

"That is not a lot of water. That's, uh, 250 gallons." I said, quickly computing the equivalent of 1 ton of water.

"That approximately one year's drinking water for 1 person." he said.

"They are nuts. They must not take a bath for a year," I thought.

That session was the last time I ever heard about the carbon monoxide risk again.

It seems this topic is just not popular, and maybe it is just not the right thing to say when we are planning to send astronauts to Mars.

Maybe this turned into a NASA cover-up, a conspiracy to cover up that:

Mars is a poison planet.

I don't think I am going to Mars.

Comet Dust And The Asteroid People

The long hallway was bright from the winter Arizona sun.

The Arizona sun brightly shined into the rows of windows of the long hallway to the main lobby. People were wandering from the conference room door, wandering towards the room with the poster presentations, and wandering to the lobby. There were not a lot of places for people to disappear. I was trying to make contacts, and everyone was right here, somewhere.

I kept asking everyone

"Who would know the most about the comets?"

"You need to talk to Gene Shoemaker." said nearly every person I asked.

"Where is he?" I asked. "Would you point him out?"

"He's around here somewhere." everybody said. But I never found him. All I managed to get were lots of names and phone numbers of people who would put me in contact with him.

One of them was Professor Larry Lebovsky. Larry gave a technical presentation about his research on the comet dust. He had all kinds of data showing that the comets contain water ice. Some more. Some less.

As I sat and talked with him he described exactly what the comets were made of. The comets are made of a very fine dust. The dust is some kind of hydrocarbon mix.

Like oil shale?" I asked.

Someone in the poster room, the fellow whose day job was with Boze, the loudspeaker maker, but whose night job was trying to get a job related to a Mars mission, that fellow said "kerogen. It's kerogen. Oil Shale."

That fellow had said it authoritatively, but his day job was making loudspeakers. Lebovsky's day job was analyzing comets. So this was a key question.

" yes, like oil shale," Lebovsky affirmed.

He didn't make much of it. I thought it was somewhat weird that he just affirmed that the sky is full of oil shale, as much as we would ever want.

"And they definitely stay frozen," he affirmed.

"Did you hear Fanale, and how he said the ice would be on Deimos for a billion years?" I asked.

Yep. It's probably like Frazer Fanale says, at least over thousand of year time periods." he replied.

Some technical papers by Professor George Wetherill suggested the comets might stay frozen for 500,000 years.

"Maybe not because maybe they evaporate over that long a time. But they are definitely around as ice in space for more than many thousands of years."

Everything else Lebovsky said was not in common language, though, so only someone majoring in astronomy could decipher what he said.

I asked Larry where else I might read about this. Almost insulted, and very defensively, Lebovsky replied "I published 90% of the papers on the subject."

People did mention his name a lot, but only when talking about the subject he published 90% of.

He must be an expert in a very narrow field, I thought.

I was very glad I met him, because he asserted and confirmed with maximum authority just what I needed and wanted to know:

Comets are oil shale and water ice.

A thin, tall astronomy professor who talked, dressed and acted very important presented a paper showing definitively that a particular meteor shower was actually a shower of comet pebbles and dust.

This was news to me, even though it was common knowledge to the experts.

He told a little story about comets and meteor showers. It went something like this:

The comet pebbles and rocks that are mixed with the fine space oil shale dust and water ice come loose when the water evaporates and the dust flies off the comet. We see that stuff as a comet tail.

But the dust and rocks and pebbles do not have enough velocity to change orbit very much. So, the debris just migrates into a tube covering the entire orbit of the comet.

Earth flies through the tube, almost always when the comet is not there. All we see is a meteor shower.

When he was done with his story, he proceeded to derive the orbital mechanics of how one of the popular meteor showers was associated with a particular periodic comet. Apparently everyone knew about this but me.

This was intriguing, but I needed to find important people.

The halls were full of just the kind of people I needed to see. I made sure I talked to as many as I could possibly corner. I got as many of their cards as I could. Their cards would guarantee me that I had their telephone numbers, so I could call them. The cards would have the correct spelling of their names, in case they tried to hide.

Almost none of these attendees volunteered an email. Email had not yet caught on.

People mentioned the name "Ben Clark of Martin Marietta." People mentioned his name a lot, so I tracked him down. Then I talked to him about steam rockets. Clark was congenial. I should have been able to see in his eyes he didn't believe the steam rocket could beat any regular rocket he knew about. But I was focusing on meeting everyone important, regardless of whether they believed me.

Besides, I was out of a job and looking for one. I needed to meet anyone who might know of jobs. So I made sure to get his card.

Clark Chapman was placing himself in various strategic locations, where people had to pass by, and he was handing out an announcement of a meeting the coming July at San Jan Capistrano, on asteroids.

I signed up for his meeting. It didn't matter what it was about, it seemed to have the right attendees. And it was located just up the highway from where I lived. That was why I signed up.

As far as I was concerned, these were the comet people, and I was in the right place.

A Trip To Kitt Peak Observatory

A boy who was being sex changed into a girl sat next to me on a very long drive to the telescope farm at the top of the hill at Kitt Peak, Arizona. I did not want to talk to her, him.

He, she, did not know anything or anyone and it was very clear. In addition, I did not want to flirt with a boy, especially a not so cute boy in very uncomplimentary girls clothes. I suspected and I did not know for sure whether or not she was really still part he. I just sensed it.

I was not discourteous to her / him earlier that day, and accidentally was somewhat seen trying to peek down her / his blouse to see if there was something female there. She was dressed in a 1930's, farm-type cotton dress, sorta with no class at all, like it was a boy putting on a dress from the attic, and with what looked like no bra. She acted somewhat like a boy. I had a strange aversion NOT to flirt with her, which is opposite to my personality. I usually can't help myself around females. I always flirt with pretty females. I can't help talking to smart females every chance I get. I flirt all the time, too much, says Terri. But not with this lady. Something not quite right. She must be a boy, I imagined. So I tried to check.

I was definitely uncomfortable, because he / she wanted to talk. The real problem was that I wanted to sit next to someone who knew something. I knew from his / her presentation earlier that day that he / she didn't know anyone, and didn't know about comets. This was sure a long bus ride up the hill, in the dark no less.

I did not find any smart, sharp, friendly females to flirt with, or I would have made sure to sit with them.

As we reached the top of the hill at Kitt Peak, all I could see was the flat roof, dorm-like homes the astronomers and their wives lived in. The astronomers who lived there pointed out their homes. One of them bragged about how they could walk a minute to get to

work, and not have any traffic, and their wives would not complain when they stayed out all night.

Then we walked into a dome, in the dark. It was so dark I could not see the impressive majesty of the other domes.

This was a telescope dome farm. The clear black sky was a star-speckled ceiling stretching any direction along the horizon to any direction to the horizon. Stars were everywhere. It was as clear here as it was during that pitch black night during the mid 1980's back in the foothills of a desert near Albuquerque. Terri and I and our young girls watched the stars from a stock-tank / hot tub with Bruce and Chris and their girls, and it was the only other time I ever saw stars that clearly and brightly in the night sky. That is why I was not surprised at the number of stars. I was glad it was a such a stunningly clear night, so we could see.

Dr. Tom Gehrels was so glad that we picked a time for the meeting when the moon was somewhere else. He told us to be thankful because this view was stunning.

We got to crawl up the ladder out the top of one of the domes. The dome had a metal ladder going straight up to the roof. It looked pretty dangerous to me. It looked like the only reason for that ladder and the hatch was to get to look straight up into the sky. Anyone who wanted got a turn climbing straight up, 20 or 30 feet it seemed.

I crawled up because it was my only chance to do it.

The night was rather cool, and the look out the top was definitely scary. I was still afraid of heights. This was almost like being on the top of a 1000 foot high radio antenna. When I got to the top, all I did was poke my head out enough to look straight up. My

arms were too short and my hands were too tightly clamped around the ladder rungs.

I was looking straight up. But I didn't know stars. I could not tell anybody where in the sky to look for Mars, even though I headed a group at Sandia that would point telescopes from spy satellites. I did not need to see them because it was all equations to me.

Dr. Wolfgang Seboldt of Germany was totally puzzled and astounded when I asked him where Orion was.

"You can't see it?" he asked. "No. Where is it?"

It was directly straight up. It is the only thing I could see. I was looking right at it.

Inside the dark dome, we saw the thick telescope mounts, and the huge, 3 foot across metal elbow things that hold the telescope drives. But I did not see the chair and the eyepiece where the observer sits, like the Far Side cartoon shows. There was no place for a seat.

All I saw was a computer. Tom Geherles was so proud of his computer imager. Geherls had worked hard to get that star-watching, CCD video imaging device. The concept of a digital camera did not exist yet.

Nobody looked thru the telescope. A computer did. David Rabinowitz and Mark Elowitz demonstrated how the CCD array saw and tracked the stars. No photographic plates needed. We saw for our selves how the computer looked at the star pictures and picked out the moving things, so it could track them.

When the operators find a moving spot, they track it for as many days as they can. If the orbit they get for it is not in the asteroid or comet catalog, they get to name it. Rabinowitz and Elowitz were finding all kinds of new, near earth asteroids, at least one a month.

They were excited about their CCD imaging device because it made the search so much faster. In the old days, the astronomer would take a picture of some small part of the sky, and then a week or a month later take another picture of the same place. Then, they would try to see what is different about it. Literally. It was not so easy.

The whole process of finding near earth objects was very similar to looking at a picture of gravel on a road, and then a picture of gravel on the same road and the same spot 1 second later. The objective would be to find the little bug or ant that moved only a little bit among all the stones and dirt. They used to do that with their eyes. Their computer and CCD imager changed all that.

Now we could find new near earth objects several times a month, instead of years.

To these fellows, they are new asteroids.

"I don't know why they like these near earth asteroids so much. They are just rocks in space," I said to a fellow named Dave Kuck, who happened to walk with me through some of the tour.

On the way down the hill in the bus, I made sure I sat with someone who knew something. Dave Kuck was a mining consultant and wanted to get into space mining .

This was a twist. He had stalked me. He knew I had the ideal way to bring all that stuff he would mine back to Earth. He needed what I had. On the ride back I learned one reason why the moon is worthless, direct from a commercial mining consultant.

"The titanium on the moon is a mineral, not an ore. There is a difference." he emphatically and professionally declared, forming his words very distinctly.

"What is the difference?" I asked. To me they were about the same. If you find a mineral with lots of gold in it, you have gold ore. If you find a mineral with dirty salt, you have a mineral.

I did not understand. It was only clear to him.

I thought the difference between mineral and ore was purely emotional.

"An ore is relatively pure. A mineral is mixed with other things you have to separate." he explained.

About a decade earlier I had wanted to mine the moon for its titanium. In a very naive moment, I wrote in some notes what many know-nots write, that we could mine the moon for titanium.

But Dave Kuck said

"No, NO." It is mixed with too much of that other stuff, calcium and magnesium, that is way too hard to separate, *profitably*."

Another reason the moon was worthless, Kuck told me, was that there was no water to process the ore.

"The moon is much much drier than any desert anywhere," he asserted.

I never thought about it, but I guess he was exactly right. The moon is more than bone dry.

The next day at lunch with, Geoffrey Landis, my co-author, Wolfgang Seboldt was also amazed that people in the United States cared about Mars. He said no one in Europe gives a damn at all about space, and that includes going to Mars or the Moon.

"There is no interest at all." he asserted, in a strong German accent declaration.

"If we held this meeting in Europe, no one would be there. I am amazed at all the people here."

As the meeting came to a close, I concluded this was a very good meeting. This was my first publication of steam rocket travel to Mars. We found out about the water ice on comets that are always this side of Jupiter and moving slow enough to catch. And we found out that Mars has a deadly poison atmosphere.

What was really exciting was that the comets were a mix of water ice, something like very dirty coal or oil shale, and silicates. That would be organic permafrost dirt in space.

I had just learned how the space between here and Jupiter was full of water ice and organic dirt objects, any one of which would be a rocket fuel station and a place to stay.

We could inhabit the solar system.

Troubling, in the back of my mind, was that no one could point to a

specific object relatively near Earth's orbit that I could use. Just as troubling, the water in the near earth asteroid rocks seemed to be in rocks, not dirt. As I walked along the sidewalk I thought

"if those little asteroids are rocks, it's like this sidewalk I'm walking on. No good at all. Can't mine a rock in space. Need dirt. Near Earth Asteroids might be like a hard sidewalk."

Make your space ship out of ice.

What could I do with Ice? In space, what could I do with ice?

The little rooms with a phone and a window in the offices of the Village of the Damned masked our shame. Echoing over and over we all felt the same emotion: "We are worthless because we have no jobs." I could hear the guy in the next room telling someone on the phone how he is so very skilled and how much he wants to meet the person at the other end. He sounded so fake, so mechanical. I guess these offices were not that private.

At least the carpet was new. The chairs were new. The building was new. Sun Microsystems was filling the new building just like ours, but next door, with all kinds of cardboard boxes full of computers. They must be doing well. The sun was shining, the weather was nice. I had my Pentagon suit on.

None of that masked a strong anxiety: "I need to get out of here."

I sat there, waiting for the appointed time when I had to make a phone call myself, like the guy in the next room did.

I thought if I could not get a job, I might as well think about rocket science. A metallurgist back at Case Institute of Technology, when I was an undergraduate, made a remark one time that ice was as hard as steel when you got it cold enough. So, if there is ice out there in space somewhere, for example, on those comets, could I use it? To make a space ship? I wonder "How would I use it?"

Could I make struts and beams and space ships using ice? Space is sure cold enough. The ice should be like steel.

I wondered: How can I use ice as a cement, in space, for making space ships?

Hey, why not go to UCSC and look up data on super cold ice? That would help me see if I can use ice. I am out of a job anyway.

I wonder if I could make a spinning space ship and restore gravity, so we could live there? We rode the Gyroton once, long ago. It threw me against the wall and kept me there. It was like gravity. The equations of motion clearly show that when the diameter of the big squirrel cage is big enough, one can not tell the difference between gravity and being thrown against the wall.

So, I could spin the space ship to throw the guys against the wall. That would create an artificial gravity. It had to be at least as big as a Merry-Go-Round or everyone would get dizzy permanently, and be seasick all the time.

The UCSD campus was always nice. It was only 20 minutes away from the Village Of The Damned and going there was a nice break. It gave me time to think.

They were digging up the campus. I had to walk around a ditch in the ground deep enough to bury a few cars with no trace.

This was relaxing, being able to think only about how to do something in space. Deep in thought, I detailed an ice-ship starship.

I would make a huge wheel out of ice, just like a tire on a car, only huge, 100 feet across. As big as a big airplane. Or maybe as big as 10 football fields, 1000 meters across. I would need to calculate how big across.

Can I really make it out of ice?

But who knows? Maybe it won't work at all. Ice might be too weak.

Nobody was around to hear me figuring and silently talking to myself. I was alone. Everything went on just in my head.

The technical library had almost nothing about ice. To figure this one out I needed someone to have measured just how much weight an icicle would hold before it broke. The picture would be to imagine hanging on to an icicle, with gloves on, with steel studded gloves to get a good grip.. Now try to figure out how thick an icicle it would take to hold you up. That was the physics picture.

What would the library's technical articles have for titles? What would the subject be to look them up? I had no idea and could only guess.

Only one, unused and old book had some measurements in it. Apparently no one cared about ice. San Diego does not have any natural ice. Someone had cut nice little beams from river ice, stream ice and lake ice. They were careful enough to measure how much air bubbles, dirt and minerals each piece of ice had. Then they measured how much pull it took to break them. I don't know why they took these measurements. They had absolutely nothing to do with space. They were going into streams and rivers to get the ice. And they had real data.

I also found a few technical papers on microfilm. There was just so little data it was almost not worth the nickels it took to copy them. At least I found out how strong the ice would be.

Once I had the data, so I had to go back to the Village of The Damned. The thought of it made me start fretting again, as I walked to the car.

I am still out of a job.

"Looking for a job is a full time job." said several people, picking up on a saying that seemed to make us feel somewhat better. The feeling of worthlessness was quite strong.

Making space ships out of ice is not part of looking for a job.

I have to get back to the office.

I am expecting phone calls.

As I was driving the 15 minute commute back to my office I kept thinking about it. The ice was pretty weak. I think that person from the Metallurgy department, when I was at college during the 60's, didn't know what he was talking about. Ice is weaker than a brick. He said it was as strong as steel.

I still did not know the answer. I still had to figure how to make a cage out of ice. I wanted the astronauts to be able to walk inside the cage and think it was gravity. Unless I did the calculation, I would not know which way to make the cage. I was driving, so I could not do the calculation on paper. I could only do it in my head. All I could think of was more questions I would have to answer, instead of making phone calls to get a job.

I wonder which way is better.

Do I put an astronaut house at each end of a long cable, like Astronaut Buzz Aldrin said, and make the cable out of ice? Or do I make something that looks like a giant inner tube, a giant car tire, and make the walls out of ice?

Will the walls be 50 feet thick just to hold 3 or 4 astronauts?

I have to do a vector statics problem to find out. But was driving. Could not do it in the car. I had not done things like that in so long I could no longer do them in my head.

What a pain. If I did not figure this out, I would not know the answer.

I had never figured a wheel before. But it wasn't that hard.

If I were a sophomore in engineering school during 1962, I could do it.

All I would have to do is figure how much tension there is in a spinning tire, a spinning hoop, and a spinning cable shaped like a thin bicycle tire.

What was the equation relating the strength of the construction material and the tension in the strands of a spinning wheel, holding it together and preventing it from flying apart?

I had to derive all the relationships from vector statics. Fortunately, the equations were not that hard. It was only rocket science.

When I got back to the Village of the Damned, my favorite office was still available. My favorite office with a new, dark purple thick

carpet, a view of trees and brick 3 story office buildings with atriums built into the middle, covered by glass, like conservatories.

Instead of looking for a job, I started to daydream. Then the 22 year old secretary who dresses like a conservative but has a small tattoo on her ankle came by and told me that nobody called me and I have no faxes.

It was too late to call anybody else. It was 4 pm already.

With a piece of paper in front of me, it was easy. I analyzed it all in a few minutes, the rotating cage and Aldrin's two houses at each end of a long cable, both spinning in space. The vector stress and strain equations showed that it didn't matter if I made it like Buzz Aldrin did, two cages, one at each end of a long cable, or if I made it like a giant tire. I liked the tire because I could run around the inside for exercise during those long trips to Saturn. The tire would be as big across as a football field, as big across as a boomer submarine I had been in.

The tire would be more like a Starship Submarine, with the submarine bent into a hoop or tire and the nose connected to its butt. It would spin like a tire. The people would be on the inside, thrown against the inside wall of the tire as it spins. Then they would get up and walk around.

Of course, "getting up" would mean facing inward, towards the hub of the tire.

Once I wrote the equations, I had to put in the numbers, such as the strength of ice, how fast I thought it might spin, how much gravity I would want.

Suspense started to happen. What if it really worked?

When I specify how much gravity and how big it is, the equation tells me how strong the tire material must be to keep it together, to keep it from flying apart.

If it turned out that the tire was much smaller than a football field, then their heads would spin a different speed than their feet, and they might just get dizzy and throw up all the time, like the Russian Cosmonaut Georgi Grechko said.

If I didn't spin it fast enough, their immune system would stop working, their bones would become brittle like chalk, and they would die.

I wondered what the answer would be.

I was thinking:

I can't go home now.

I have to finish this.

If I go home now,

I will probably

try to push the calculator buttons

while I am driving

and

crash into somebody.

*I am
so close to finding out the answer.*

Suspense was building, because I knew that if it worked out, we could make huge space ships easy. If not, oh well, I'd be home a little late.

My thoughts were racing as I fiddled with the hand calculator:

*Will the ice
be so weak that the thing
flies apart?*

like a tire made of wet clay?

will hold together?

Suspense.

Pushing the calculator buttons was like slow motion.

Rules of engineering were darting in and out of my head:

*Be sure to put in
the right value for G,
gravity.*

*Do all the numbers in metric,
meters.*

No mistakes.

I want to know the answer right away.

No Mistakes.

Make it one football field across.

*Put in the number for the strength of ice,
the best one.*

*what was that best one?
the one with the strongest ice.*

press the "equals" = key.

Suspense, in slow motion.

Hey!

It worked. The voice in my head said things to myself:

*Just barely.
Just barely flies apart.*

I had put in a spin speed that just barely made it fly apart. Since I could slow the spin down just by pushing calculator buttons, my mind said "it worked."

Almost as fast as dialing a phone number or selecting channels on the remote I thought:

Slow it.

don't spin it so fast.

Put in Moon gravity instead of Earth gravity.

Press Equals.

The answer was good. The strain on the ice was less than the yield strain I had just looked up at the university.

Wow.

This could work.

Just to see how bad it might be, I used the worst value in the technical paper they found for the strength of ice.

Sure enough, use bad ice and the ship flies apart.

Bad ice would not be strong enough to make an ice tire space ship. I could make the ship out of bad ice, but if I try to spin it, the ice would break and the ship would fly apart. I could use good ice and spin it, but I would only get as much gravity as I would get on the moon. That's not so bad. Probably enough to keep us healthy.

It would work.

As a reward for finding something startling, I allowed me to daydreamed a bit, to fantasize about what it would look like when the ship might break.

Maybe some meteor hits the ship and breaks it. The mind picture was fun. Sparkling pieces of ice tumbling in space, chunks of space ship slowly separating, slowly rotating and discombobulating against the dark vacuum, with stars in the background, astronauts floating with their mouths open and their eyes bloody as all the air rushes out of their lungs, the blood vessels in their eyes popping, the blood doing that cold boiling of a vacuum, leaving in frosty, bright red bubbles on their faces.

The parts would fly apart at the tangential speed, slowly, like a few miles per hour.

That was fun.

But if I used good ice and a backup, safety cable, we ought to be able to fix that.

I heard that humans needed at least half the gravity they get on Earth, or their bodies won't work correctly.

This triggered a flashback memory, to the first time that I heard that our bones can't take the zero gravity. I knew we would have to fix that if we would ever go to space. I had just fixed that, with the ice tire. But the flashback took over.

Flashback: Dr. Bill Bishop told me how our immune system fails. During the mid 1970's he came back from Washington DC to Sandia in Albuquerque to visit after he left Sandia and went to work for NASA. We were sitting at an expensive restaurant near the airport. He was visiting and he asked me to supper.

We were talking about those fantastic pictures the NASA space probe sent back from Mars. It was just stunning. I got all excited and told him that we could live there. I told him how I saw those Mars pictures that looked like dried up river beds. They looked just like we see from an airplane looking down at New Mexico when we are flying back to Sandia from Las Vegas and the Nevada Test Site. The space probe also showed some kind of ice at the poles of Mars, and clouds.

"We could live there. It's another Earth." I blurted to him, completely excited, trying to convince him that NASA should try to go there.

Then I saw a tear starting to come out of his eye that he was trying to hold back. he was all emotional and choked up.

"You see." was all he could say. He was choked up that I saw that humans had found another Earth, and that we could go there.

That's why he left Sandia, to go to NASA and make a program to occupy a New Earth.

Bishop was there with me when Dr. Mell Merrit led both of us into the big hangar at Jackass Flats, a the Nevada Test Site, where they had the little nuclear rocket NERVA on a stand. He was there when Mell Merrit proclaimed "That rocket could take us to Mars."

Then he became technical again and he told me "With no gravity your immune system quits, and you die."

The astronauts learned that bones loose calcium. Bad things happen if I don't get enough gravity.

The Flashback was over.

I wondered where Bill Bishop was now. He had later quit NASA because their competent guys went away. That's what he said.

I tried to summarize as I started to put my things away in my briefcase to go home.

**Dirty ice from a regular frozen river won't work.
Pure ice with no dirt and no bubbles will work ok.**

Fantastic! With that pure ice, I could make a ship as big across as one or 3 football fields.

I knew that because I had calculated it quickly, I could have made a mistake. I would check the calculations, later, when I got home.

But it worked, and the new concept kept generating its own flashback all the way home.

I can make a Starship Submarine like a giant stadium, out of ice.

ice would work.

• **INEL hires me, and the comet book**

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Department of Energy and Killer Asteroids

Mid May

INEEL hires me.

The plane was landing as I was about to interview for a job, after 5 months of no salary. And I found an error that might end the whole thing, Vision and all.

It was mid May 1991. I was sitting in a cramped window seat of a fully packed, small jet airplane on my way to Idaho Falls, Idaho. Looking out the window, I saw clearly how Idaho was still way out there in Badlands Nowhere, Northcold, USA. Bitter cold. Dreary. Clouds. Boring. I could see it. The hills and mountains below were clearly not the majestic Rocky Mountains.

I was travelling to a real job interview for the only rocket scientist job I could live with. With excitement and passion in my voice leaking through the "professional self image," I had told every person I called about the steam rocket.

I would even go live in Idaho if that is where I would need to go to make this Exodus Vision come true.

Everyone seemed to know that Idaho was both isolated from all the technical leaders, technical activities and all the valuable colleagues in the world, and cold. This was the least desirable locations of all the possible places to work. Dr. Roger Hagengruber and I visited Idaho Falls once, back in 1973. The place was a national laboratory of the United States Department of Energy. It was called "NRTS" in those days, for Nuclear Reactor Test Site. Then they changed the name to "INEL," Idaho Nuclear Energy Lab. Then they changed it again, to "INEL," Idaho National Engineering Lab. During the early 1950's, the Atomic Energy Commission located the buildings that housed the 52 nuclear reactors and a radioactive waste processing plant 40 miles west of the town. They deliberately located the site on a barren desert that was typically frozen a good fraction of the year. I thought it was a bleary place then. A colleague told me the bleary dreary part had not changed yet.

Of all the people I talked with on the phone, the Idaho guys were the only guys who had the right connections, the same connections I did: to Col. Pete Worden in the White House. That was my reason for talking with these guys.

Just to be completely sure of every detail of an impending encounter, I was doing just one more check, looking for weak spots in my story, while sitting in my narrow, uncomfortable seat on the

packed jet airplane from Salt Lake City to Idaho Falls. It was the preparation for the battle: try one each of every variation, double check everything, make sure all possible questions are known and answerable.

I always calculated on an airplane. Just my calculator and me in the cramped seat, with nothing better to do. Calculate. Figure. Do the algebra to model things. I really enjoyed that kind of time alone.

However, something was not working out. Anxiety began to panic me.

The simple algebra was not showing clearly that my rocket was the best rocket. All I changed for this talk was adding a fuel tank to hold the fuel. That was all. It should not have made much difference. But the calculation was not working out.

My entire Vision depended on the fact that the rocket had a set of best operating conditions that were neither too hot nor too cold, but somewhere just right, in the middle.

The calculation was based on the fuel, the payload rocket ship, and a fixed amount of energy from my reactors. It was exceptionally simple. It was so simple I could do it on a single sheet of paper on a bouncing airplane. All I did was to add a tank to put in the fuel. For simplicity, all the previous calculations just had the fuel, with no tank.

When I added the tank, the equations changed a slight bit. But I could not manipulate the algebra to show the answer I needed. I needed the equations to say "there is an optimum that is not too hot, not too cold, but somewhere in the middle."

As I glanced out the tiny aircraft window I saw the grass and pavement. It was getting closer and closer to the airplane, moving by faster and faster. As our wheels touched down on the landing strip, I was still not finished figuring. It was supposed to be a quick check, and it wasn't.

This felt horrible. I had to stop and get off the plane. I did not like it. I needed more time. Did I overlook something fatal? Or was it just damaging?

I still didn't know the answer. For the first time in 4 years I felt doubt. Was the whole concept I conjured up of the "optimum rocket exhaust" baloney?

Waiting in the cramped aisle of the airplane, with everyone else also trying to get their luggage down and anxious to get out of the claustrophobic cabin, I started to panic.

Are the rocket scientists here at INEL going to laugh at me?

Did I pass up the other job opportunities in San Diego for nothing?

Will I go broke now? Am I finished?

Is this going to stop everything I dreamed of?

This is the interview for a job.

I have been out of work with no pay since Jan 1, 1991, and it is May already.

I am using up money fast.

The mortgage is \$2200 per month.

Terri's job just barely covers Jennifer's college.

The rest comes from savings.

In the calculations, I had been leaving out the weight of the fuel tank. When I was figuring how well my rocket would perform, I only calculated how much rocket fuel it would take, and left out how much of a tank I would need to hold the fuel.

Because I left it out, I got a wonderful answer. It was the answer I got back at Vail, 1987 when I hurt my arm skiing. But when I included the rocket fuel tank, its weight was proportional to the fuel.

Unfortunately, the tank does not squirt out the back of the rocket and go way like the fuel does.

OOOOhhhh. Bad.

The tank was still there, dead weight, and my rocket still had to push it, sopping up rocket fuel to do so. This was the first time in the 4 years that I had been figuring this that I included the tank.

Any real rocket scientist would have included the tank.

It was about 5 pm and John Rice was meeting me at the airport. John Rice had lived across the street from us in Albuquerque several years earlier, before I went to San Diego. And now he was working in Idaho Falls at the INEL and in the same group that I was about to interview. He was a still a rocket scientist, but not in the Air Force.

As he welcomed me I noticed that John Rice had not changed much since I last saw him. Idaho Falls welcomed me with its cloudy overcast sky and cold air. It was May and spring had long since

bloomed and flowered in San Diego. But it was cold and bleary here in Idaho Falls.

John drove me for about 15 minutes through a part of town that looked like it was still in the early 1970's and still dirty from snow and mud. Trish, John's wife, was all smiles to see me. Their new home, with wood railings and smooth wood floors and fine carpet was warm, tight as a drum, heavily insulated against the cold.

Christina greeted me with a smile, and I almost didn't recognize her, she had grown so much. Trish served a hearty supper, and we talked about Albuquerque and what we had experienced since then. But all I could think of during the whole time was the calculation I had not finished.

Jon and Trish showed me to a warm and cozy room with a huge, fluffy bed in a fully finished basement, complete with a little desk, chair and a desk light. And all I could think of was the calculation I had not finished. Everything special about what I was doing depended on this. I must know.

I knew I had to be fresh the next day, but I had to stay up till I finished this. Instead of sleeping and getting a good rest for the interview, I was still trying to figure the equation, to see if the fuel tank screwed me.

At 11 dark thirty something, which was very late for me, especially after a long airplane ride and the hassles of getting ready for the high anxiety interview, I finally got the equation into some form I could test quickly, just to see if I was screwed.

Finally.

So, what is my answer?

I started to enter some typical weights for the rocket ship, payload, fuel and tank into the calculator. As I was pushing the little buttons on the calculator I could feel my blood pressure rising.

Suspense. Anxiety. I was tired, dreary, worn out. My ears were ringing. And time was starting to stand still.

And the Answer is...

I could almost hear the drum roll. And the numbers on the calculator worked out, somewhat.

Nature was kind.

I'm ok

My anxiety dropped a bit. That tank mattered, but not so much that I would be screwed.

I'm only partly screwed.

Those damn tanks do matter.

Often enough Nature had been mean to humans and animals. This time Nature was kind and it permitted me to talk about a

steam rocket, as long as I would add some fine print, using some minor weasel words.

Good sense took over:

I have to sleep immediately.

I did.

But we had to get up too early, 6:30 am. That was less than 7 hours sleep. I was not fresh.

John drove me to the INEL, the Idaho National Engineering Laboratory, while I watched a dreary cloudy sky and shivered from the freezing cold.

When a scientist or engineer would come to us for an interview, in San Diego, we would expect them to give a talk about what he does. It is a chance for us to see how he or she would project themselves in public, under stress. An interview is stress. So now it was my turn.

They billed me as some kind of important rocket scientist. That's what John Rice told Marland, that I was important.

The conference room held about 50 people. Not that many people came by to listen to me, first because it was just before their lunch hour and second because it was rocket science. About 20 people came in. It was pretty straight forward. I gave my talk.

One scientist spoke up as soon as he could sneak in a question. He knew all the details, he thought. He just had to show the audience how smart he was. He was that type. Warren Madsen, Doctor Professor Warren Madsen, always had to show you how he really knew his nuclear rockets backwards and forwards. He really didn't believe that water rockets could beat a hydrogen rocket. But he listened and didn't get too argumentative, and he didn't argue in public, either. He waited to argue until after I was done.

He mentioned "Rover" and "NERVA," and that got my attention.

Marland Stanley, John Rice and I rode up the escalator after my talk. It seemed to take a long time because I was stressing. The escalator zigzagged up the middle of a 4 story building with a hollow center and large skylights. I was going to talk with this Marland fellow.

I was fretting from the anxiety. My head was saying things:

*If only I had paid more attention to this tank detail.
Tanks weigh a lot, which is bad for rockets.*

*My tanks don't weigh a lot.
I could have driven a big spike in my competitor's hearts,
if only I had been able to show them.*

*Show them how their tanks are huge and heavy,
and mine aren't.*

*I know this happens a lot to everybody.
screwing up.*

not being able to show what's important.

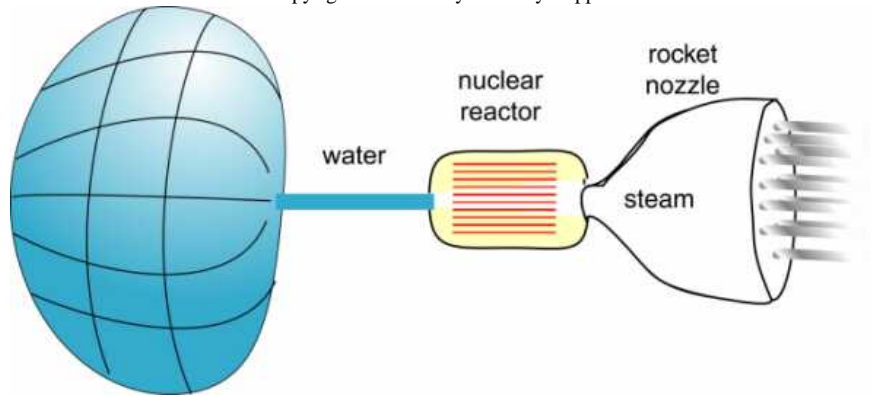
*The other guys know a lot about what they are doing,
but I know something that can change everything
huge,
completely huge.*

Marland Stanley, my prospective boss, was a physicist, tall, smart, cocky and looked like a tall Anglo-Saxon invader, only from Kansas or Idaho. Marland and his group were going to make the 5 Megawatt electric power supplies in space for the Star Wars guys, the U.S. Department of Defense, DOD. That 5 Megawatts would have been huge, absolutely huge. This is enough to power 50 space stations.

Col. Pete Worden, United States Air Force, in the White House, was one of their contacts. Worden was my White House contact. Stanley and his group were also part of the NASA nuclear rocket program, to make the nuclear engines to take people to Mars. Marland had all the right programs.

We walked into a dark hallway and Marland swiped his special badge in the special security lock, and then punched in the special security numbers, and the door opened. We entered a room big enough to hold about 10 desk cubicles. There were two offices with doors off to the side. And a conference room large enough to hold 10 people around a table was at the end. The lights were an unfamiliar, somewhat orange color, designed to save electricity and not give off much heat. There was not a single window in any of the rooms.

Marland and I then sat alone in the conference room. Excited about my Vision, I told Marland about the steam rockets, and how a nuclear reactor could heat the water and boil it into steam. I explained how the nuclear reactor could be something like what they tested and developed for the U.S. Navy right, there in Idaho.

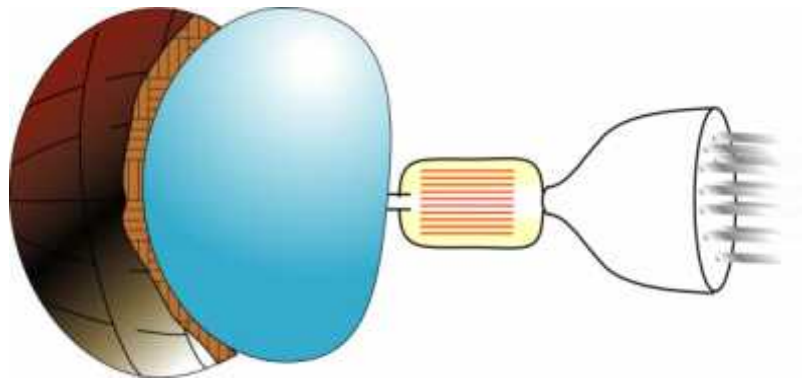


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These were the right things to say, because the one thing Marland really knew how to make were nuclear reactors to heat water and make steam, for the U.S. Navy. That is what the entire INEL was all about, nuclear heated steam generators to power submarines.

And I was here to tell him how I would just bolt a rocket nozzle directly on one of their devices, and make them all famous.

Then I reached over to the chalk board. He still used chalk, not felt pens. The chalk was a clue that they were a little behind the times there in Idaho.



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Drawing a cartoon picture of a little rocket engine, a bag-like water tank and a payload on top, I showed Marland how we could take 500 people at a time to Mars.

He saw a quantum leap. He saw how to transport 100 times more people than anything he had ever seen or heard of. And it was so simple that we could do the rocket science calculation in less than a minute, using just chalk on an old fashioned chalk board.

Marland Stanley saw the entire Vision, the entire picture. His eyes told me he was experiencing a strong burst of excitement. His spirit came alive.

The payload was more than anything all of his NASA buddies put together had ever seen. Marland saw instantly how to completely out-do all the old timers who worked on NERVA.



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Marland mentioned the ROVER fuel rods but didn't carry the baggage of the NERVA rocket crew, or of the NASA old timers. He wasn't part of that crowd. He was from the Idaho lab, where they did nuclear reactors to make steam, to power U.S. Navy submarines. Marland saw the entire picture right then and there.

He hired me on the spot.

But I could not start work till later, months later he said, because he didn't have the money yet.

Comets Of Unlimited Oil Shale

Late spring on the campus, 14 May 1991, UCSD (University of California at San Diego). The air was wonderfully moist and warm, coming off the ocean just a short hike to the West. The sprinklers were still irrigating the newly planted ground cover along the path to the Urey Hall university library as Jennifer and I were trying to get past.

Other than that, it was like a little walk in the woods . Every campus I knew of had a little walk in the woods somewhere, mostly between the buildings. Not much of a walk because land was expensive. But a university always lets the trees be and the bushes grow up along some path, somewhere. Like a resting station. And, the sprinklers were still on and I was wearing a good Pentagon suit and black wingtip shoes, and a tie that would ruin instantly with any water spots.

Jennifer was with me. Timing it just right, we were able to run on the path just when the sprinklers were turned away and not squirting it. It's a trick that works most of the time. When it doesn't work because you timed it wrong, there is no escape from being squirted from two sprinklers at once.

Jennifer came along to help. I wanted company, she was home from college, and it was a nice day. As soon as we were in the library, I verified that sure enough, a few more of the comets



those Italian astronomers were looking at did indeed have very convenient orbits.



I had returned to the library again because I had to make sure of that.



I was preparing to talk about using these comets for water for my steam rocket, at a near Earth asteroid meeting this coming July.



I had talked to Ruth Wolf, USGS, Flagstaff, (U.S. Geological Survey) who works with and for Gene Shoemaker, on comets and their orbits. She was excited about what I was going to talk about, and she knew Gene would be excited, too.

Jen Xeroxed and I took home just a few more pages with a few more close comets.

Our work quickly finished, so it was time to go to the bookstore, get a snack and look around. There was always something interesting at a college bookstore. Mechanical pencils. Calculators. Ultrafine pens you can't get anywhere else. And most often, books. Real books. Not storybooks. One can get storybooks somewhere else. University bookstores had books with real depth.

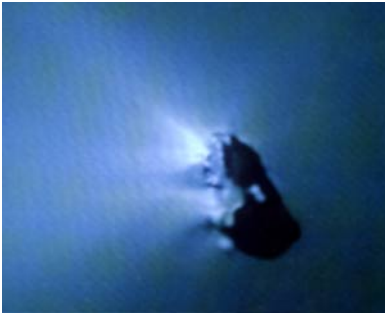
Looking through the astronomy section of books, I saw one with a title I was looking for. It startled me. Like it jumped out and bit me.

Sure enough, here's one with "comets" in its title.

Huebner, Walter F. (Ed.),
"Physics and Chemistry of Comets,"
(Astronomy and Physics Library) Springer-Verlag, New York, 1990, ISBN
3-540-51288-4 and ISBN 0-387-51228-4 Springer-Verlag New York

I picked it up. The cover was pretty blue.

What a clear picture of comet Halley.



I started to page through it. It had real data.

I promptly went into a focus-trance and started to rapid-scan for all data.

This is intriguing.

*Europeans sent their satellite to chase comet Halley,
Took pictures of it.*

That was nice of them.

It was clear this was **NOT NASA** at all. It was **Europe**, without NASA's help.

Then a key piece of data popped out.

They collected some of its dust.

The sensor was a physical thing that caught the dust and analyzed it.

Hey, what is this?

I saw it was hydrocarbons.

How can this be?

This is carbon - hydrogen polymer chains, xylene polymer.

The Europeans found that the comet was made of something like kerogen, oil shale, dirty coal dust. Just like the young fellow working for Bose said, 6 months earlier at that conference in Tucson.

And what's this other stuff in there? Oxygen and Nitrogen?

I was reading that the comet was made of something that looked and felt like it was made from organic things.

And look at how much is there.

They gave the dimensions of the comet and the fraction of hydrocarbons. That was enough for me to calculate. There was always a calculator on my body somewhere. I immediately calculated and saw that the comet had more than 300 cubic kilometers of hydrocarbons.

The United States uses about 1 cubic kilometer of oil per year. I had calculated that one just for fun.

*That's 300 year supply of oil.
Hey!*

I realized that this comet could be something like an oil field in the sky.

*And what is this nitrogen stuff? and the sulfur?
Their descriptions ... like pee.
It should stink.*

But then I realized it would be more like dirty coal.

*They're calling the stuff CHON,
carbon hydrogen, oxygen nitrogen,
and amines.*

After reading the composition, I imagined the comet could be more like a dirty something, stinky, maybe something oily rotten pee smelling.

The comet was about equal parts superfine silicates, like clay, water ice, hydrocarbons, and mixed with about 1% of amines, like urea or ammonia or some kind of nitrogen compounds.

I started to laugh.

*I bet the closest thing on earth to this stuff
is cat poo.
But frozen cold as dry ice.*

And then I clarified my conclusion, to be sure that it was accurate.

*Not dog poo,
dog poo is brown.*

Imagining I was the speaker at some L5 Society meeting, I began to fantasize what I would tell them.

See here,

I would say, pointing to the overhead projection of my transparency,

*- the water is the moisture
- the slimy is the silicates, the clay dust
- the black is the hydrocarbons, the organics
- and the stink is the nitrogen compounds.*

and then I would say

"The closest thing on Earth to this comet is cat kaka in a dry ice cooler."

More data jumped out of pages scanned fast.

4 times blacker than soot in a chimney at night.

That was not a figure of speech. Data showed the albedo is 4 times darker than soot.

"Dad, can I have this sweatshirt?" Jennifer said, breaking my trance.

"What?" I replied, startled.

"Yes." I agreed, because it was fun to let her pick something out and buy it, as a reward for going with me. We all need souvenirs.

"The sweatshirt. It's pretty. I want it." she asserted.

"Ok. Lets go eat." I replied, as we went to the checkout, Jen with a sweatshirt and me with a prize comet book, and an Engineer-In-Training Manual. I was going to be an engineer now, at the INEEL, so I needed a refresher book on how to be practical.

As we were watching people and eating, my mind wandered.

*Here I am out of a job,
and I am buying an expensive, \$50 book on comets.*

A technical book, yet.

*This is crazy.
Well, maybe not.*

Marland Stanley in Idaho says he is putting the paperwork through to hire me.

Technically, I have a job.

So \$50 on a book is not so bad.

This was incredible. We humans had just found unlimited oil in space. Hydrocarbons. Stuff that looks just like dirty coal, very much like stinky oil shale.

I wonder where it came from?

P.S. I never did ask if the "shale" was "racemic" or not. If there are mixed right hand and left hand hydrocarbons, they are not due to DNA as we know it.

That means the oil shale from space might not be *exactly* the same as ours.

• **San Juan Capistrano, KT event, and the 3 Month Night**

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also see http://impact.arc.nasa.gov/reports/spaceguard/sg_1.html

First International Meeting On Killer Asteroids

This NASA meeting only wanted to talk about killer asteroids.

"This is how the End of the World happens. It happened over and over, at least a dozen different times already," say a couple of them wandering about the meeting. This is how just about everyone died, back in the days when we were still prehistoric animals, before we developed into human people.

The sun was shining gently into my driver-side window and the air was not too hot, not too cool. Almost no clouds in the sky and almost no wind, it was like it always was in southern California. All the houses I could see on the hillsides as I drove on the freeway to San Juan Capistrano had that clean, California look, where carefully groomed coastal trees wrap neat rows of curved streets on clean hillsides, and where all the cars are new and red tile roofs cover expensive architecture. I could see that everyone in San Juan Capistrano was well off. I could see their nice clothes as they drove by and walked the streets.

It was such a pleasant sunny summer day in this quaint little tourist town, where the swallows return every year on the same Spanish missionary holy day to the tiny, cobblestone Franciscan mission a block up the street. It was such a nice day to have a meeting just 83 years to the day after a 15 megaton bomb from space detonated without warning 4 miles above Tunguska Siberia, flattening an area of hills the size of San Diego, where I had just driven from.

All 180 of us wandered comfortably into the meeting room in the back of a tiny, light-colored half modern building with the impressive sounding name "San Juan Capistrano Research Institute." This space meeting had more near earth asteroid astronomers than I had ever knew existed.

I met the comet mission Program Manager from NASA whose program was cancelled. I talked with a few planetary atmosphere PhD astronomers. I met half a dozen of the recognized best space geologists in the world. I chuckled at seeing at least a dozen rocket scientists all looking for a new mission to some nice little new thing in the sky, like an asteroid or comet. I even met some of the journalists from the respected science and space magazines.

I had never seen that many journalists at a meeting of so few people, only 180 of us. It didn't seem like 180 people until the last day when they gathered us all together and made us all pose for a picture. That's when we were counted. The conference organizers were amazed at the turnout.

Almost no one wore a suit. This was very different from the meetings I had been to during the last several years. Earlier this year many of the same people attended the big NASA meeting in Tucson, Arizona. At the Tucson meeting, the German space scientists I had lunch with wore suits. Wanna-be space mission designers wore suits. The guys from the aerospace industry all wore suits. Even the professors wore suits. Only some graduate students, a few clearly rebel scientists and the young astronomers from Kitt Peak Observatory who stayed up all night and slept during the day wore casual clothes, at that Arizona meeting.

Important people who control expensive space missions wear suits. People who do research under contract to the important people all wear suits. If you are at the meeting you are one or the other, or you are trying to get money from the important people who control expensive space missions. So, why did I see almost no suits?

I wore my Pentagon suit. I always wore my uniform to these meetings. My dark blue suit with the 3/4 inch thin white stripes, and my wing tip black shoes and my Pentagon tie on a white shirt, clearly stated that I was a Professional Scientist and an important Program Manager with Visionary Ideas. My purpose at this meeting was to work the crowd and meet the Important People who control expensive space missions. I brought a New Vision, a new way of moving through the solar system, and a breakthrough in payload size. However, I could not figure out who or what rank these people were by their clothes.

A thin, interesting lady scientist astronomer from Eastern Europe caught my eye, partly because she was an attractive female, and partly because of the simple elegance and clean and simple lines of her light weight clothes. She put on a sweater-like light wrap when she left the building with several of her colleagues, and they all seemed to be wearing the simple, elegant but frugal clothes.

The foreign scientists I met at the other aerospace meetings seemed to all wear heavier, out-of-fashion, bulky wool things that made them look coarse. But these people wore clothes so frugal that I kept thinking, "they're poor and they come from Eastern Europe." Their names were unfamiliar. I never heard or read of them. This entire group of people was pretty much new to me.

Whom should I meet? My last employer taught me how to seek out and stalk the Big Boss, the General who controls the money and makes the big money decisions. We would be able to determine who the General of the group was by the clothes. The "General" meant either a real general or a very important person VIP of a company.

The markings of the uniform would indicate who they were and how important they were. The uniforms of all the people in the business sent the signals about who they were and their position. A sloppy suit meant a low position. Perfectly pressed meant an advisor to the high command, whether a company high command or military. A plain uniform meant a technician. I was taught to send the signals by wearing the right uniforms. And at this meeting, I could not read these signals. There did not seem to be any suit signals.

Almost everyone here seemed to be casual, unfashionable and clean cut. Not one single person wore after-shave lotion or cologne. Not one of them had bad breath, or shaggy hair, or pigtails, or a solid gold chain on a hairy chest poking through a half unbuttoned bright colored shirt. Not a one had torn pants. I saw every one of those signals at an oceanography instrumentation meeting in Hawaii, and another time at some technical labs at the Navy base in San Diego. Oceanography was far more physical than astronomy and space, I conjectured.

Everyone here except the Europeans was plain, bland, vanilla.

What a perfect day to talk about the near Earth asteroids that hit Earth every once in a while and make big holes in the ground, like that one we read about at Meteor Crater, Arizona.

The last big meteor to hit and explode that we know of happened on July 3, 1908, at Tunguska, Siberia. It blew up about 4 miles above the ground, in the air. If that meteor would have exploded above Los Angeles it would have leveled the entire city and its suburbs. Instead, it exploded in a remote Siberian forest, where it leveled 1000 square kilometers of trees. Lucky us.

I presumed we were here in San Juan Capistrano, California, because everyone could get here easily. It was also near to the Mt. Palomar telescope. It was close to the California Institute of Technology's Jet Propulsion Lab. It was right in the heart of Aerospace Country, a thick, rich belt from north of Los Angeles to San Diego. It was easy for me.

Why would those British fellows, those eastern Europeans and some Latin Americans come here? I didn't know there was any astronomy in Latin America.

Perhaps the organizers chose our meeting dates of 30 June through 3 July so that most of us could fit it into our schedules. Perhaps I didn't pay enough attention to what the meeting was about. Supposedly, the meeting was about near Earth asteroids.

The roster said we would get to hear about killer asteroids. I really could not tell by the random conversations of people milling around if that was the main reason we were here. General Dynamics taught me and other Program Managers to eavesdrop and carefully listen for common themes and rumors in the hallway, or restaurant conversations, especially the late night hotel bar restaurant, because that is where everyone would go after a long, annoying airplane ride.

General Dynamics taught us the Eavesdrop Game. It starts with the situation of an aerospace person on travel. The plane was always packed, the seats were always narrow, the space between the knees and next seat always caused the traveler to crumple. People were annoyed, legs were always cramped, the air had that air conditioner-cleaned smell, and the heavy luggage didn't quite fit. It's late, the hotel is somewhere else and the sign-in line is long. The uncertain receptivity of the people one must see too early the next day causes anxiety. After a few drinks at the hotel bar one can stagger back to the hotel room without having to flag a cab or wait or think. The effort and hurdles of the trip bond the traveling partners to each other. Alcohol and exhaustion loosens the tongue and increases the speech volume. So, General Dynamics taught me to shut up, listen and quietly take notes on what the poor, tired fellows are saying and don't know that I am listening while they sip their double vodka at the restaurant bar. I always took notes.

People would always talk to each other as if nobody else could hear them. What my aerospace mentors taught me was called "gathering G2," where you gather bits and pieces of information. Like a puzzle, when you put them together the secrets appear.

The game was not quite working at this near earth asteroid meeting like it did with the Pentagon crowd. There were no hard liquor drinks and no late night restaurants for this meeting. These people drank beer, not martinis or Chevas Regal, and they got together at the closest hamburger joint instead of going to an expensive restaurant. They were friendly, too. I had no trouble at all inviting myself to lunch with key players. The hamburgers tasted as good as a steak, to me. And I did not have to eavesdrop.

At lunch a fellow named David Morrison, who was obviously in charge even though he wore a casual shirt and business pants, was abrupt with me, hard to engage, and made it clear he would be intolerant of any bozo out-lier concepts or statements, regardless of who he was talking to. It wasn't just me.

This personality difficulty he had was typical of the smart ones. Also typical, Morrison seemed to be free of that annoying arrogance and smugness I often found in corporate bosses. Morrison lacked that need to control and manipulate people. However, he did demand preciseness and accuracy.

One errant word by anyone around him would trigger him to raise his voice. He was difficult, even with his colleagues. He acted like a public prick. And it was clear that he saw me as an application person, not a creator of new knowledge in the field of near Earth asteroids or astronomy. I could feel that to him I almost did not exist. I could feel how he put me in the category of "other," not mainstream. I could sense how I agreed with his categorization of me, because I was only a user of what these fellows discovered. I would only use the near Earth asteroids and comets, and he is in the business of finding them, finding out about them, and science.

Dr. Ted Fay and his wife Ann Fay insisted I stay with them instead of a hotel. He had an astronomy PhD. specializing in planetary atmospheres and knew just about every technical thing about the topic of asteroids, near earth asteroids and comets. He knew the name of nearly every single technical person at this meeting and knew many of them personally. I was low on money, and I just got hired to the Mars nuclear rocket science position at the Idaho National Engineering Laboratory of the Department of Energy, but had not collected a paycheck yet.

Ted and Ann me offered me their home, and Ann Fay cooked a 7 course Louisiana meal. Ted was the one who told me "we will get you your ice" about a year earlier, as we were leaving the lunar solar power meeting. Ted and Ann met with me at the University of California San Diego library 6 months earlier when I found the data on those dark and close comets almost nobody seemed to know about and which had the ice I was looking for. These two had personalities that made instant friends.

The only G2 I could pick up anywhere was "near earth asteroids."

I was here because it was a meeting on asteroids, because the organizers accepted my paper, and because I made sure I would be there at the same time as the key person, Gene Shoemaker. I was excited about telling of my new way to haul huge, 10,000 ton payloads to and from near earth asteroids and comets.

Some of us were here to make spacecraft to go prospecting on one of those asteroids. Dr. David Bender, an older, retired rocket scientist, that I had met at General Dynamics was here because he was an expert at cosmic billiards. He would send a spacecraft past a moving planet or moon and arrange for it to gain or loose speed, with no rockets at all. He was bent, frail and soft spoken. Chris Cassell was here, too, looking for a Ph.D. thesis project. He was a young colleague who did the work for the Exofuel project at General Dynamics with me. Most of the other rocket scientists were looking for a new space mission. I was here to create one.

I felt comfortable here because I knew several of the people who made things happen and several more who knew nearly everyone and about nearly every topic. I felt like I could work this meeting like a good Program Manager and make the right contacts. I had done my homework, just like General Dynamics had taught me.

Before this meeting, I had talked on the phone with at least half a dozen of the key people here. John Lewis, the Professor who gave me the White House contact October 1990, was here and friendly. Prof. Jim Arnold from UCSB, who put me in contact with the entire

near earth asteroid group, was here and very glad to see me. I didn't know what Gene Shoemaker looked like, nor what Glo Helin or Don Yeomans looked like, but I had talked with each of them.

Not one person mentioned that about 70,000 engineers and scientists just lost their jobs. They had worked in this southern California belt from Los Angeles to San Diego, before the cold war ended a couple of years earlier. Not a single person said a thing about that. At most of the other technical meetings, people recruited and other people sought new jobs. At recent meetings, during 1990 and 1991, smart engineers with Ph.D.'s were looking for a job. The only thing I heard about here was "near Earth asteroids."

The organizers seemed to have enough money. They served us expensive cookies and tasty fruit snacks once, during the time when we were scheduled to wander the front part of the building and read the posters and scientific papers pasted on boards, like a high school science fair. I noticed that not a single big aerospace company had a booth, and in fact, nobody had a commercial booth. The place was too small. Everything I saw was a theoretical concept or a measurement related to near earth asteroids and comets.

This was the "First International Near Earth Asteroid Conference." Dr. Clark Chapman expected about 30 people to show up, so he and a few of his colleagues booked this small place run by one of his friends, with small meeting rooms on the second floor, and a conference room on the main floor that was about the size of a typical 8th grade classroom in Idaho. Everyone knew this was no Mars conference. This was just a meeting of people who liked small, tiny, vermin asteroids.

Someone in Congress was paying for a few of them to be there and write a nice report about something or other. Nobody said anything in public about Congressional money. But I listened carefully and gathered G2. I heard that in the hallways. Nobody said anything about the money. The person who got the money, David Morrison, made a few unclear comments about some kind of report, but it was clearly unclear.

So, we filled the only meeting room when the first speakers started telling us the story of the one particular time 65 million years ago, when the world ended again.

*Again?
Ended?*

What? A totally unexpected shock.

The American professor spoke so plainly, without any emotion, so matter of fact, so dull that I almost missed it.

A British professor spoke with some emotion, mostly about how comets did violent things to earth and about how ancient humans tried to tell about and ancient history tried to record, and we should pay attention and get excited. I didn't get excited about ancient history. I still don't care too much about ancient history.

The ancients were primitives. They didn't know anything. We know more than they did. They are irrelevant.

Victor Clube, from Oxford, was trying to tell us that comets caused catastrophes, often, and especially during times when humans could write. I didn't care much about that either. I thought I heard him say that when the Earth goes through the "beta Taurid stream" we would be hit by about 100 Tunguska explosions per century on Earth.

He said that kind of battering by these huge bombs caused the Dark Ages. He said that we are in a quiet period now and the cycle is 2500 years long. The beta Taurid stream is apparently a band of debris in the orbit of a comet, and we are not going through it now. He spoke with emotion, but we were not due for killer comets right now.

I don't have to be politically correct when I think to myself.

I can think anything I wish.

*I don't care about this guy's
comet-crash story.*

His comet-crash, ancient history stories were just not so relevant because the comets didn't cause the end of the world, and the rock layers proved it. Everybody could see the rock layers when they drive along the highway. I even dug for fossils myself along some roadway rock layers. The geological record is continuous from now to backwards in time to before slime worms were the only living animal on Earth.

Therefore, I ignored what he said about our needing to pay attention.

*We lived through comet crashes just fine,
if there ever were any,
from before the time when we were lizard people,
or mouse people,
or cave people,
from then till now.
That's what I think*

It was politically incorrect to say you didn't care about ancient history. So I didn't say it. I thought it, sitting there in the back of the room.

Sitting in the back of the room by the entrance, I could intercept any person going in or out. General Dynamics taught me to strategically position myself at the meeting, so I could meet whomever I need to meet. I could leave without being noticed. I could see who talked with whom. It was always useful to know who attracted all the people around them, and who worked alone. Most of the time, sitting there in the last chair, I had time to myself to think. Most people delivered such boring presentations anyway. Most of the useful things that went on at a meeting were not in the presentations. It was in the hallways.

These plain people in vanilla clothes talking in dry tones clearly expected that every single person in the audience knew the names of the rock layers, and that they were talking about the hot damp days when dinosaurs were big and the biggest mammals were like mice.

Gene Shoemaker, the charismatic leader of the comet and near Earth asteroid scientists, showed slides of his hand pointing to an inch thick layer in the rock layer formation on the side of a hill, somewhere in the world far from here.

*I gotta listen to this guy,
what he says,
so I can talk to him
about what he talked about.*

Gene Shoemaker told us he thought this was the layer of dirt and soot that was laid down during the one or two years after the comet or asteroid hit Chixilub, Mexico. He was showing a picture of himself along a river embankment and pointing to a layer of some kind of dust up to an inch thick and laden with soot. He was trying to tell us that this dust accumulated nearly everywhere on Earth.

He showed us a what he thought was a root embedded in the muck mud soot layer, which he said proved that the whole event happened suddenly, during something like just one year. He used words and emotions that made me imagine the soot from all the fires burning all over the world. He was trying to convince us that a big meteor hit, and that it caused global catastrophe.

It had only been a decade since a wild-idea kind of professor named Luiz Alvarez, who had won a 1960's Nobel prize for physics, and his son Walter had published a paper claiming that an asteroid blew up and caused the extinction of the dinosaurs. Gene was talking about it. Gene was interesting.

The Alvarez's measured the amount of iridium metal in that one layer that divides the geological era of dinosaurs from the next era where there were none, ever again.

*I didn't know that,
that the dinosaurs **suddenly** disappeared,
so fast.*

Iridium is very rare on earth, but is not so rare at all in a typical rock asteroid. The only place one could imagine getting all that iridium all at once is from a large, exploding asteroid. That's what they said.

That's what Gene was talking about, and trying to convince us. I remembered reading about that during the 1980's, and I did not think it was very important then. Even while Gene was talking, I still didn't think it was very important. Interesting, though.

I didn't know Gene Shoemaker was a geologist. I thought he was a comet astronomer. Everyone told me to see Gene about the comets. When I had talked with Gene on the phone, it was all comets. No dinosaur geology at all. No earth rocks. I guess Gene

must have been helping these fellows tell the story and had gotten to tag along on some of their field trips.

It was interesting, but I didn't really care whether the dinosaurs died over a 5 million year time span or over a 5 000 year span. Who cares?

I thought they died by evolution, when something better ate their food and took over their territory. It was irrelevant. But, everybody likes dinosaur stories. Gene was trying to convince us that the asteroid made such a big bang that it started fires on Earth. And the fires were so intense and big that soot covered the whole Earth,

That dust-winter connection Gene made, using an asteroid that exploded like an atomic bomb, made me wander off and daydream. I had worked at a nuclear weapon laboratory for 18 years, most of that time working on spy satellites that look for atmospheric nuclear explosions, so I knew secret details Gene didn't.

Gene's use of words like "explosion" triggered me to remember sometime back during the Cold War that Carl Sagan talked about how world war with atomic bombs would stir up dust and cause a "nuclear winter." Sagan said blasting all that dust into the high atmosphere would change the weather into winter, no matter what time of the year we had our all-out global nuclear war. Sagan was trying to tell us not to have a nuclear war. He was trying to convince us that the atomic bombs were more than just very large explosives. He was warning us that we could change the weather.

But Sagan was an activist and almost certainly exaggerated the whole thing.

I was daydreaming because soot in the rocks was not related to a steam rocket to occupy the solar system, and I wanted them to hurry up so I could get my turn to tell my steam rocket story to the audience.

I didn't much care about nuclear winter because it was very clear that we were not going to have any global nuclear war. This is 1991 and the cold war was over. At least 70,000 of us lost our cold war jobs. Both the Russians and the Americans knew that whoever won the global nuclear war would still lose more than half of their own people, because the other side would immediately launch rockets to shoot back as soon as their satellites detected the other guy's rockets launching from missile silos. The winner's cities would be leveled, there would be no work, and all the retirement plans would be lost. Then the survivors like myself would blame, maim and slowly kill whoever pushed the button to "win" the nuclear war.

Only now, Gene Shoemaker was telling us that Nature Herself caused at least one "nuclear winter," without the atomic bombs, just with an asteroid.

He seemed to be telling us that here was some data suggesting that all those geological periods we heard of, with strange names like Permian, Cambrian, Devonian, Silurian, Triassic, Jurassic, all may have each ended abruptly, without warning, one bad day.

One day?

Stun. Shock.

Now that kind of thing would certainly be relevant history I would pay attention to. That could be scary. Gene's black and white picture of a root that got buried 65 million years ago was in a layer that represented just one year, just one event, not thousands or millions of years. That startled me.

When I would drive on a highway I would see the geological layers on the embankment where they cut away the dirt to make the road. We were taught to think that each layer represents thousands or millions of years. Gene was saying that instead of millions, this layer is just one year, a very bad year.

*All at once?
One year?*

He had many slides, all from different places. He was showing how the dinosaurs ended all at once. Only a few of scientists in the audience knew that it happened this fast.

A British fellow showed some similar pictures. A few more scientists with strange names showed slides of rock layers from all over the world, from places I never heard of, too many of them, and all with the same story:

*"it all happened **one day**, without warning, when the whole world caught on fire."*

Nobody had spread the word before this meeting that we were going to hear fantastic things.

Gene Shoemaker didn't tell me that about the meeting, and he and I discussed months before this meeting how I would use one of the many comets between Mars and Jupiter that almost no one else knew about. Only Gene and a small number of astronomers knew about those comets. That's what we talked about.

We didn't talk about dinosaurs and killer asteroids at all. I thought this conference was about using near Earth asteroids, and going to them with big space ships, and occupying them. I had discovered how to push those space ships. I could make and push space ships of the same size as the Queen Mary cruise ship. I could take 1000 people at a time to those asteroids, and I was going to prove it when my turn to speak came up. Even better, I was going to show them, the crowd of important astronomers, how I could extract and haul as much rocket fuel in one of my steam rockets as a super tanker could hold, like one delivering oil from Saudi Arabia to the United States.

I had a clear agenda: "Sell my steam rocket space ship."

Suddenly the words of the speaker, a professor, shook the ground beneath me.

He created an image of the sky above me burning. My heart rate did not raise. My breathing didn't change. It was like often

happens that we hear something and it doesn't register. Only our subconscious mind completely and fully comprehended.

*meteor crater,
so what.*

What he said jumbled all the ideas in my head something like tumbling raffle tickets in the rotating barrel cage with a handle on it. The professor was cranking the handle.

What he was saying was really strange.

"Things change suddenly" read the winning ticket he pulled out of the cage.

He explained that no matter where you go in the world you see this boundary in the rocks. Above that boundary layer you only find small mammals, and below it you found dinosaurs of all kinds. I never knew that all the geological periods were so abrupt.

"When the asteroid or comet hits, your 30 million year turn is over. A new species takes your place," he said.

I didn't know that one year there were dinosaurs and the next year there were none.

The room didn't change. At the conscious level, he was just someone talking, telling stories. No one else in the room showed any emotion, either. No one showed even a single picture of a dying dinosaur.

The speakers really were showing us data that Earth apparently has another type of severe weather, *Cosmic Weather*.

The room was not even quiet. I heard a reasonable amount of low level commotion in the hallways. You could NOT hear a pin drop. It seemed that people were just sitting there like they were listening to the description of grass growing.

The devastation is worse than the Bible's version of the End of the World. Their data suggested this had happened over and over. This one time 65 million years ago was just a particularly easy one to observe.

His words described a bomb fireball the size of Texas. And I guess everyone else was reacting like I did:

*big bomb,
big hole,
bad weather,*

Thrilling Story, but Dull in the Hallway,

Such a thrilling story going on.

Meanwhile, everything I heard people talking about in the halls was as boring as watching paint dry.

This was the first time in my life I ever felt a science story thrill me. It wasn't scary to me. It was just a really great, thrilling story. It had just the right amount of relevance. It could happen to me right now, when I walked outside the building. With less than a week of warning an asteroid big enough to end humans could explode on Earth and a new species would get to take over. Dogs maybe. But it probably would not happen.

This had just the right level of scary.

We were all in this story and it was real. It was the story I had been looking for. I had been a public speaker on space topics for two years. I had gotten on talk radio. I had spoken in public many times. I always wanted to communicate the excitement and wonder of what I was talking about. It was pretty hard to do with science. But this story sold itself. This story was starting to be really good.

This feeling was different from the mania that I would too often fall into, over some concept or idea. The Mania I experienced was a severe anxiety that would come over me. It was similar to 20 cups

of coffee. I could not sleep. I would be restless and could not sit down. This was common and happened to many people. Emotions would overtake us, like crying, anger, sadness or shock. Mania would come over me when I thought I had invented something that would change the world. For example, I thought I found out how to make antigravity one Saturday evening during 1970, after a several, late night shots of whiskey. The extreme anxiety came over me. I could not sleep. There was no antigravity, only an incorrect minus sign.

This space story was different. I did not become excited or manic. I became completely attentive.

This was just one heck of a good story that I could tell school kids and audiences when I talked to them about my space ships.

I could not see the thrill in anyone else's face. It seemed like everyone was sitting through the words like it was just a meeting, just one more meeting, and we were here to talk about what spectrum they measured in their telescope, or the infra red data they analyzed from the NASA space probe. That was the only kind of thing I heard in the hallways.

The hallway blabber had everything except the exciting story.

"The orbits are chaotic." said Don Yeomans.

Yeomans was from the Cal Tech Jet Propulsion Lab, "California Institute of Technology." That was astronomer-speak for:
the objects in the orbits go around in their almost perfectly elliptical orbit,
and then one day, after they come close to one of the planets,
they suddenly change to a different orbit,
and they would do that often.

"The dynamical lifetime exceeds the physical lifetime of the cometary bodies." said George Whetheril. That was astronomer-speak for:

"The comets evaporate long before their orbit goes completely crazy."

"The infra-red telescope detected a clear dust trail in the cometary orbits that you can not see with a visible light telescope." said Dr. Professor Mark Sykes, passing out free beer, in a Hawaiian shirt, mocking the killer asteroid show that Morrison was putting on. That was astronomer-speak for:

"The comet orbit is strewn with debris, the whole orbit, not just where the comet is."

"I want to build and launch a multi-CCD scanner." said Dr. Coleslaw from the U.S. Department of Energy national laboratory in Livermore, California. All the astronomers wanted him to just go away. Just one satellite like he wanted would cost more money that it would take to fund all the astronomers at this meeting all at once for their whole career.

"What story do you think we should take to the people?" I asked Clark Chapman, the fellow who handed out the announcements for this meeting.

"I have no agenda whatever for what news we should take to the people. Scientists should only communicate facts." he asserted, bluntly, and looking at me with some sort of disdain for even asking that kind of question.

And that was that. I had asked him point blank. He told me point blank. I turned and walked away.

*You know what Clark,
you can just go pay for your own research.*

*If you don't tell everyone,
so they will pay for what you do,
then they won't.*

*They will pay for what someone else says,
until they run out of money.*

Get an agenda, or go broke.

But I didn't say anything to him.

Nobody was excited, nobody was manic, nobody was talking about the killer asteroid story in the hallways, and the speakers kept

feeding me new asteroid or comet data, new facts. The data injected directly into my head and stayed there.

I walked back into the meeting room. The hallways were still noisy. People were still going outside and talking. I found a chair in the back, the left side this time, closer to the exit.

A shorter, thin, mild mannered science type professor in a plain, light-colored shirt was describing how the fireball was so hot that the nitrogen in the air burned with the oxygen. He said the burnt air mixed with water vapor and made nitric acid rain. That was sure new concept.

He described the dimension of a fireball as big as the state of New York. He described thick choking smog over the entire Earth.

I didn't know if I was hearing this right. I could see him if I moved myself just right because the chairs were all the same height, I was in the back of the room on a plain chair, and the people in front of me were taller than me. I was looking at my notes and hearing only his conversational narrative voice.

"When you breathe air with a little nitric acid in it, you cough and cough and choke, constantly."

He spoke American English, not British like some others, as he described how nitric acid rained all over the world and leached the poison heavy metals out of the mountain dirt and poured that poison into the streams.

Nitric acid rain?

*meteor explosion causes
intense, global, thick choking smog nitric acid air.*

I thought of that awful metallic taste of the well water, in Avon, Ohio, long ago when we were on the farm, drinking from our shallow well. I forgot I was in a chair in the back of the room. I forgot there were people standing behind me. I was tasting the metallic water. I was coughing the choking acid air in a real fantasy-like fleeting hallucination.

He was telling us about what happens when a mountain sized thing from space hits Earth. Nobody at the meeting knew whether it was a comet or an asteroid that hit. It didn't matter. It was big, massive, 10 or 15 kilometers across, and bigger than the center of any big city.

I couldn't see the speakers. The room was crowded with people. Many were standing in the aisle. I heard another speaker say that the smog and fires were so intense that the surface of the earth was dark. I thought of the darkness that came over our farm when we had one of those severe storms, during 1950's. He said it was darker than that.

"The brightest spot on earth was probably no brighter than a moonlit night."

Really?

Choking nitric acid air, fires, soot and smoke and dust so thick the sky is dark like moonlight?

"This lasted for few weeks."

"Then the dust reflected the sunlight and cooled the Earth. It started to snow. The snow lasted for 3 years." He kept describing the technical effects in terms I could understand.

Really?

"After the fires burned nearly everything and the intense smog choked nearly all the animals, snow fell and everything froze," he continued.

He was saying the words, but without the gestures and voice. He sounded like a college engineering professor reading a people-story to the class. No emotion, just clear, accurate descriptions.

"We estimate that everything over 50 pounds died."

Wow. I was not excited. No one seemed to be.

I was entranced. This was a super story. And it could happen to us right now, without warning.

But it won't, probably.

I thought that if an asteroid hit the earth it would just make a hole like Meteor Crater, Arizona. Just a big hole in the ground. Not so interesting. Or maybe a gash like the Grand Canyon. Or maybe an explosion like a Kraktoa. Blows a lot of smoke. Makes a big boom. Not a big deal unless you live next to it. We'll watch it on CNN while we eat supper.

But no, another British speaking, casual and plainly dressed, vanilla-voiced taller thin fellow described how the explosion was a searing, vaporizing, ultraviolet purple, white hot plasma, exactly like the inside of an atomic bomb, like a nuclear detonation, with a fireball big enough to cover a state.

He didn't use those words. He said it his way, and my mind translated it, because I knew more about atomic bomb fireballs than them. I knew the physics because I worked for 18 years at Sandia and I needed to know all about the physics of the fireball explosion. I didn't learn that much about making nuclear weapons themselves. I learned about what they did, so we could detect them and snitch on the sneaky atheist commie pinko rapist errant nations trying to detonate a weapon in secret.

As soon as he stated the meteor impact speed I was able to calculate the "energy per mass." All I wanted to do was compare it to a blob of high explosive of the same size. This was a sanity check that physicists do and that I would always do, while you were talking to me. I did it in a flash. I carried a calculator and used it to think with, like any other prosthetic device, like magnifying glasses or a telephone.

Physicists always made the sanity checks, fast. They used to do them in their heads, figuring in their heads. But now they do them with the calculator, while they listen. If someone would make a statement, the physicist immediately would do the quick calculation in his head and ask:

*how fast,
how far,
how big,
how much,
should I care?*

I squirmed in my chair. No one else seemed to squirm. The chair was uncomfortable. The staff brought extra chairs, different from the more comfortable ones up closer to the front. The hallway was still not quiet. People were still milling around. The building was not that big, with only one conference room and a hallway to a showroom.

The speaker droned on with some dry physics about the bolide energies.

*Bolide?
new word.
Must mean meteor ball thing.*

"Bolide energy" meant "the energy of the meteor." I understood instantly and completely, of course. Each speaker was feeding me a number here and a number there, each filling in a different piece of the puzzle. I had my Radio Shack, low cost scientific calculator in my hand. So I estimated:

*how much
..... compared to high explosive.*

In less time than the speaker took to finish the next sentence, I got:

10 times more than high explosive.

That was still not enough to make things interesting. I needed to know how much high explosive. Otherwise, it might only be enough to make a big hole in the ground. Or maybe it would only be big enough to wipe out Los Angeles, like the Tunguska Siberia event did, back during 1908.

Then he said "kilometer" size.

*Easy one step calculation...
answer is 3 billion tons times 10,*

I did not need my calculator for that one.

that's 30 billion tons of high explosive.

That is at least
10 times more than all the atomic bombs in the world.

Tell that to Carl Sagan

Very nice. Scary. Not exciting, just really 4-letter-word scary. This was a good story. And it was real, too. It could happen now, and it did happen then, and before then, and before then, again.

About 4 or 5 of these speakers, new names and faces I had never heard of, were describing something familiar to the atomic bombs physics I had worked with 15 years earlier. What they described was like what the spy satellites I had worked on just several years earlier at Sandia National Labs were looking for. Our satellites looked for the fireball when someone detonated a nuclear device, an atomic bomb, in the atmosphere.

The "bolide explosion" effects were nearly identical to a very large nuclear weapon detonation. Instantly I knew what they were talking about. After a few microseconds, a classified number of microseconds, the fireball acts exactly the same as if an atomic bomb made it.

Then, another plainly dressed and thin Ph.D. fellow described how the sky over the North American continent was like the inside of a fire-hot furnace. The exploding fireball blew white-hot lava into a sun-like bubble 150 miles wide and into the sky, splashing sheets and streaks of white hot melted rock and dust vapor high over the clouds.

He didn't use those words. My kind of language would be more than just the facts. It would be sensationalism. And since I could *think* anything I wished, I translated his facts into what I thought it looked like in the sky. I was fantasizing again. I could barely pay attention because of all the heat and fire in the sky.

And then someone mentioned the shock waves. That sent me into temporary hallucinatory fantasy again. I could see an image like those old 1950's Atomic Energy Commission movies of megaton atomic bombs going off. Sitting in the chair in the back of the room, making room for one more chair as someone else wanted to sit, I was dreaming while awake, fantasizing, remembering my atomic bomb physics 18 years earlier at Sandia and Los Alamos, that the shock wave races out ahead of the fireball, at 10 times the speed of sound.

Someone said that the shock wave boom was so sharp and strong that a family of dinosaurs, moms, aunts and babies, were found laying there, with grass still in their mouth.

*Probably lightning,
but you're telling the story, not me.*

Keep talking guys, I'm listening.

That made me daydream some more. I knew what I would tell an audience:

*"They died suddenly.
They could not hear it coming.
Everything that was as close to Chixilub Mexico as West
Texas, where it hit,
was like sitting 10 feet from a hand grenade,
or, more like hugging a car bomb.*

*The sky was silent during the seconds it took to turn into
white fire,*

and broiled their faces.

*Then suddenly without warning
the shock wave killed them."*

*That's what I would say.
Yeah..*

Andy Smith from Kirtland Air force Base, Albuquerque, New Mexico, was quietly taping the session with a little, black and white video camera he parked in the far right rear corner, as out of the way as he could get and still have a clear view. I wondered if anyone would care or if they were even smart enough to ask him to tape it.

Now I could see why the reporters were here. The conference organizers, probably David Morrison, were pushing their agenda. They wanted national press coverage of their findings. They were here to tell the world that the sky is falling and we better pay attention. If they would have billed the meeting as "First International Meeting on Killer Asteroids" instead of "near Earth" asteroids, no reporters would have shown up. Not real enough.

My Turn: A Monster Steam Rocket in Space

I had elbowed my way into that meeting to tell them how to bring back huge payloads from local comets using my steam rocket. I was there to lead mankind into space. But I had to wait my turn, till the end of the day. I was the last speaker. They were there to tell the world how the End of the World is a repeating event and how asteroids cause the catastrophe when they collide with Earth.

John Lewis introduced me with a compliment and told the audience this would be fun. However, the meeting was running late. I was the last speaker. The audience was obviously hungry. They were restless. I could feel that I needed to hurry. I tried to hurry.

After a full day of hearing the speakers tell of the killer asteroids, even I could see that I was just a user of asteroids, and their purpose was to find them, characterize them, and see if any were going to hit Earth. I felt somewhat crippled, out of place, like a puzzle piece from a different puzzle. I spoke anyway, because I had a breakthrough and I was going to tell it.

I showed how I would saunter up to a near earth comet, one of those 100 or so comets between Jupiter and Mars that everyone here in the audience obviously knows about because they are astronomers. I would dock with it. Then I would heat chunks of it and melt some of its ice. I would take the water and put it into a big bladder tank the size of a blimp or dirigible on my space supertanker rocket. Then I would use a nuclear reactor like what we use on a navy submarine to heat the water to superheated steam and run it through a rocket nozzle. I told them how utterly simple this was compared to those complicated schemes where one makes rocket fuel by using electricity to split the water into hydrogen and oxygen.

The surprise I showed them was a rocket that would haul 30,000 tons of stuff, which was more than what the total whole world had ever launched into space up to that time, and the rocket only weighed 200 tons, which is only about as much as two Shuttles. Gene Shoemaker was sitting right in the middle of the middle aisle, blocking the aisle, with some friends. I could see he was smiling and commenting with a smile. But everyone wanted to get out of there and go eat. So I got almost no questions and everybody left as soon as I put down my last slide.

Even though I felt like I didn't impress anyone, my colleagues were kind and complimentary. Prof. Jim Arnold told me that they reviewed my paper before they put me on the schedule and they thought I was right.

"We are heretics also." he said. That made me feel much better. When he told me that, I realized that I didn't elbow my way into that meeting at all.

I earned it.

Feeling much better about being part of the group, I noticed that some of the people there had names that were the same as some of the comets I had chosen to use for my steam rocket. I wondered, are they the same person?

Dr. Ed Howell said "Yes, I have a comet named after me."

Holy Cow.

I just met somebody with a celestial body named after him.

He found it, so he got it named after him. That thrilled me

"Oh, many people pronounce my name in the vulgar way" Howell said after I pronounced it in the non-vulgar way and asked him to pronounce his name for me.

This is the first time in my life I met someone who had a celestial object named after him. Then he said the Shoemakers had several comets named after them.

Wow.

this is exciting.

Just about any person can usually excite me anyway, but this is really exciting.

I 'm in the middle of people who have celestial objects named after them.

I didn't know that Gene's wife Carolyn was a comet hunter, too.

Then I met Klim Churyumov. He told me he was delighted that I mentioned one of the comets he had found, to use it for rocket fuel.

"You mean you have a comet named after you?" I asked.

"Yes." he said, in some kind of European accent.

"Would you sign your name in my notebook?"

He looked at me strangely, as if I were an FBI agent or something. But my excitement over meeting someone with a celestial object named after him was so transparent that he signed the notebook with a smile. Then he invited me to the October Kiev meeting. He was from the Ukraine, USSR.

Victor Clube told me he enjoyed my presentation very much and gave me his Oxford address. When he gave his presentation, he told everyone about the shower of Tunguska events that hit earth every 2500 years. I didn't tell him what I thought about his killer comet fragment topic.

I still thought that if the bad thing isn't going to happen while I am alive, heck with it. Clube told us that we are in a quiet

period, where we only get a Tunguska explosion once per century or two. His story was too weak.

*Where is the imminent catastrophe?
Not enough right-now type of catastrophe*

Clube was a delightful fellow.

Then I found out that Gene Shoemaker was a geologist who got his own money to go on his own field trips. Gene told me that at least one of the near earth asteroids was probably a comet. He said Oljato, one of the near Earth asteroids that the Native Americans could see, meant "moonlight water." He said they probably saw it when it had a tail, a comet tail. Gene knew before almost all the others that I needed water to make the steam rockets work.

I tried to get the reporters to write about my rocket. They ignored me because but my stuff was just not as much fun as the killer asteroid story. My story, a way to push space ships as big as aircraft carriers through the inner solar system, was not as interesting as a:

**"killer asteroid that could end civilization
like it ended the dinosaurs,
suddenly,
one bad day."**

--- -----

The leader, Dr. David Morison of NASA Ames, got the United States Congress to pay for the meeting, and Congress expected a report. He was going to give them a good one. At this meeting he was supposed to tell Congress authoritatively how the collision of an asteroid with earth would kill civilization and be like a reset button for the Earth. If this meeting went well, I heard in the hallways, the next meeting would be to examine what we could do about it.

It would be very much like David Morrison to command his speakers to deliver the facts, nothing but the facts, and only their calculations of what happened or would happen when a big asteroid collided with Earth and killed the dinosaurs. All they were doing here was droning on about what they were paid a tiny fee to deliver to him. The tiny fee he could give them was only the cost of the paper and postage, not the trip expenses.

Morrison was apparently delighted that 180 of us in the room were there to prove that what they said was "peer reviewed." He only expected the 30 leaders in the field to show up. His 30 smart fellows did the technical review.

The rest of them didn't seem to get very excited. The movie makers got excited. So did I.

• Drobyshevski's Exploding Moon

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The ice would burn.

I am so glad the Russians were communists for 70 years. They are such intense thinkers and superior engineers with such superior intelligence that if they would have been capitalists, they would have beat us completely.

The dull white light of the room competed with the sunshine leaking into the hallway from the San Juan Capistrano summer outside. We were wandering the hall, standing outside the meeting room on the second day of the meeting. People were milling around.

During the day, after my talk the late afternoon before on steam rockets, a casually dressed fellow in short sleeves came up to me, barely able to speak any English, and said:

"Eee you shood use heedrogen and oxygen for yoour rawket."

"How do you pronounce your name, again?" I replied.

*That accent is clearly Russian.
Has to be.*

"Drobyshevski, Ed, cawl mi Ed" he said, again and with a deep Russian accent.

"Ed Drobyshevski," I said.

not so hard

I pronounced it back to him with a somewhat good Russian accent. He was from St. Petersburg.

I got these rocket scientist types a lot. They always wanted me to do something stupid, such as getting the hydrogen and oxygen out of the water. I knew what this conversation was going to be like. I would spar with him and trap him, like I always did. I would quickly zero in on the key thing he didn't know about. I would snap the trap and eat his lunch.

Then I would typically find out that he would be a nobody, anyway. These types typically are nobody. Then I would look for somebody else more powerful to speak with. The powerful ones listen. I would probably waste time with this Drobyshevskii fellow, like it always is with rocket scientists. Rocket Scientists don't know much physics.

I started in on him:

"How do you get the electricity to make the hydrogen?"

This was a trick question, like a chess move. I was setting him up to trap him.

"Not generating electricity," he said, shaking his head "no," and pausing carefully to give me time to think about it.

What?

How?

How is he going to get hydrogen and oxygen without electricity?

His move countered mine and I knew it. That caught my attention. If they say "yes, electricity," they loose. I eat their lunch. These Russians play chess. Maybe he is tricking me.

"Where do you get the hydrogen and oxygen?"

"In the ice."

I didn't understand him. He came out of the blue with that. He got me. It didn't figure.

"How does the hydrogen and oxygen get there?" I said, speaking rapidly, excited to find out how the impossible would happen.

I stopped, and started over, speaking slowly, just one word, at a time, to help him with his very poor English:

"Gasses," I said.

and then after a hand motion describing gasses coming out, and a pause, I said

"How?"

I was trying to - speak - in - few - words, because he - no - speak - English - very - good.

"Electrolysis." he said.

That completely puzzled me. He said he was not generating any electricity. Where would he get the electricity?

And then he won the game. This was why the Russians often beat the Americans. They knew Physics. They knew Principles.

I did not completely understand his physics, but he explained. The only way I could describe what he said was to paraphrase the little story-tale he told. He told it in a way that was like translating physics into a 4th grade story language, and that made it understandable, even though his English didn't work:

Ice moon in orbit around Jupiter cuts through electrically charged plasma of Jupiter.

It also cuts through strong magnetic field of Jupiter.

This acts like electric generator, sending huge current, like continuous lightning, through whole ice moon.

Electric current decomposes ice into hydrogen and oxygen.

Is exactly like just plain standard electrolysis that you can do in kitchen with battery and glass of water, where you make hydrogen and oxygen bubbles.

But ice of an ice moon of Jupiter is so cold that ice is hard like rock.

Hydrogen and oxygen gasses can't go anywhere in rock.

Gasses are trapped in extremely cold ice.

He paused to let me think about it. He had discovered that a moon orbiting close to Jupiter has continuous electricity shooting through it.

*The electricity splits the water, for free.
The ice is so cold that the gasses get trapped there, for me to go use.*

Slick.

Slick commie bastard.

If there is any electricity like he says, then he is right.

Then he continued, and I paraphrased his little story into my own English:

*Remember you are out by Jupiter.
There is no Sun out there to speak of.
Is very cold.*

*Ice is so cold, is like stone.
Gasses are frozen in stone.
Hydrogen and oxygen can't go anywhere.*

*Just accumulate.
For millions upon millions of years.*

In moon ice.

*Pretty soon,
ice has so much hydrogen and oxygen trapped in it that when you melt it, gas could bubble off, and gas would burn if you light.*

He stopped again, this time watching my facial expressions and confident that he had my full attention. He just told me that ice from an ice moon of Jupiter would burn in a vacuum jar. Any physicist would be instantly puzzled and captivated.

"How much?" I asked.

"How much, what percent, hydrogen and oxygen, in the ice?"

I asked again, trying to use as few words as possible to help him understand.

He replied

I calculated up to 12% of ice would be hydrogen and oxygen.

No air needed.

Pure energy.

His voice clearly showed he was excited and it was clear, even with his bad English.

Free.

In space.

Just what would want.

A whole moon of it.

*But if you don't watch out,
ice explode like dynamite.*

*That's what happened to moon of Jupiter,
it exploded.*

Wow. A fellow at UCSD talked about a moon of Saturn exploding, and making the rings of Saturn from its debris. This could be why it exploded. He was describing exploding, burning ice.

How do you like that. An ice cube would burn, with no air at all.

Wow. I was estimating and calculating in my head as while he was describing it. I knew how to relate the concentration of explosive gasses to the energy trapped in the ice.

"That much is like high explosive," I blurted out.

He smiled.

He waved his hands up towards the ceiling and started another story.

Moon of Jupiter exploded.

He told me that one time, long ago, a whole moon of Jupiter exploded. It blasted moon parts all over its orbit, making rings of Jupiter, like rings of Saturn.

*You could see in daytime,
was so bright..*

"Why?" I asked.

I always ask "why," without first thinking. It is a knee-jerk question I always ask.

I expected some collision explanation. I didn't really comprehend the fact that he had just explained clearly why.

"High explosive." he replied, immediately.

I thought he was trying to say it was dramatic and violent, like high explosive. His English was so poor I couldn't understand. But he didn't mean that.

He meant exactly what he said, that the ice was high explosive, and that it would blow up. This was completely new to me. I never heard of exploding ice.

Then he told me the rest of his story.

*"In sky,
as big across as hand"*

He spread all five fingers and stretched his arm out to show me that the ring around Jupiter would be as big as your hand at arms length,
in the sky, at night. Wow!

*"You would see in daytime,
daytime."*

Gees. What a story.

He kept it up. He could tell by the excitement in my eyes that he had me entranced.

"One Tunguska every day."

Now he really had me. This is really fun.

Everyone at this meeting knew what a "Tunguska" meant. It meant 15 megatons worth of bomb, like what happened on July 3, 1908, at Tunguska, Siberia.

Drobyshevski explained

*Huge cosmic explosion,
blast rock, debris,
away from Jupiter.*

"Debris" means chunks of moon ice the size of football fields, and maybe some chunks the size of small mountains. He calculated that once free of Jupiter, some of the debris would end up in the ecliptic orbital plane. That's where we live. All the planets live in the ecliptic orbital plane. You live in the ecliptic orbital plane.

"Smashed into Earth."

Another stunning story. This was one stunning meeting.

Of course, all anybody cared about was:

How Big? and
How Often?

So I asked, and he said

*"Tunguska,
one per day"*

Not being able to speak a foreign language sometimes helps. You say only what counts. That's what he did. With a mere four words:

*"Tunguska,
one per day"*

He was telling me that a good fraction of this debris was on a collision course with the orbit of Earth. Some debris would crash into earth. So he calculated how much would crash into Earth and how big the pieces would typically be.

Lots of them smashed into Earth. One a day.

I translated for my self immediately:

*A meteor with 15 megatons of bomb energy,
enough to level and melt an area as big as any one of the top
10 big cities in the world,*

just like the one that hit Tunguska Siberia, 3 July 1908.

*That one did some quick urban renewal on a 1000 square
kilometers.*

*A bomb that big would drop randomly somewhere on earth
roughly once per day for at least a year.*

A 15 megaton bomb every day for a year, hitting somewhere on Earth, with no warning, at random. Too small to see in a telescope until it is too close to stop it.

Great Story.

And if I had any illusions about landing on an ice moon of Jupiter, I would have to imagine the whole moon as a bomb, and the ice as high explosive.

*When you land,
don't strike a match.*

*Don't bang on the ground,
please.*

As it turned out, the energy in the ice was probably low enough in most places that it would take a really big meteor crashing into the moon to trigger the explosion. And furthermore, if the ice would get "warm," as warm as the temperature of dry ice, the gasses would ooze out and it would not be so explosive. If the ice churns, like it apparently does on Europa, it would never get a chance to build up enough explosive gasses to matter much.

So, not every ice moon would be a bomb.

I personally did not know enough to comment on his assertion that the planet exploded.

I later calculated that any piece of space stuff would collect enough Galactic Cosmic Ray energy during 1 Billion years in its top 1 meter layer to dissociate the amount of gasses he said, and would definitely be ready to explode. That would include the ice, the hydrocarbons or hydrated mineral rock that one might find in the thousands of near earth objects between here and Jupiter,

I calculated that he could be right about at least some ice somewhere accumulating explosive mixtures. That meant at least some ice somewhere out there would burn. If you bonk it, it will detonate, explode.

Space is dangerous. Watch out. That smart Russian Physicist sure made me think carefully about it.

This turned into a great meeting.

Buden's trick

Space is very radioactive

I would get more radioactivity in a solar powered, Greenpeace space ship to Mars than on a nuclear powered space ship.

And that's the truth.

We were attending the In-Space Assembly / Servicing Workshop, NASA Langley, 24 thru 26 July 1991. The weather was partly cloudy, sunny, and warm. There were soft-needle pine trees and green things everywhere, not like Idaho where we had just come from. It was more like San Diego .

We were walking east across the gravel stone parking lot, crossing some green grass. The morning sun was shining through clouds. We were walking towards a one floor auditorium-like building engulfed by tall trees. This NASA site did not seem to have the large, complex rocket engine test facilities like the NASA Lewis Research Center in Cleveland had.

I was finally working, at the INEEL. I had been on the job for two weeks now. I was walking with Dr. David Buden, an expert and prominent person for space nuclear electric generators. He coauthored a book on space power. Anyone who wrote a book was important.

Buden had a deep, authoritative voice. He was taller than most, and impressive when he walked, looked at you or spoke. He wore a suit. He spoke slowly and clearly. And curiously, he was very easy to approach.

"Hey, I got a question for you." he started.

He would often start with a trick question that way, usually with a smirk and a smile in his voice that would cajole you into interacting with him.

"You're on your way to Mars, and you have a choice of what kind of space ship to take.

You can take a space ship powered by a nuclear rocket, or you can take a chemical powered rocket.

Which one gives the astronaut 3 times more radiation?"

And then he shut up, baiting me. We were walking casually over some mowed grass, towards that meeting building. He did puzzle me with the question. I stared at the green grass for a moment, trying to figure the answer.

"That's a trick question." I responded, halting for a moment.

I wanted to make sure Buden would think I knew at least something. I could not come across stupid.

Buden loved to ask this kind of puzzle question. I heard him do that to Marland twice, and to John Martinell. It was clear he would spend some time composing and rehearsing what he was going to say.

"Just from the way you are asking it, the answer must be the Greenpeace ship." I responded.

We were making nuclear rockets. So I could not figure why he would ask a question where the answer would be that the competition would be better, where the chemical rocket would be safer. He must be trying to show that the nuclear rocket is better, or he would not ask the question.

The Greenpeace guys would want us to use "no nuclear" in space, or anywhere I presumed.

The answer to his question must be that the nuclear rocket would give the astronaut less radiation than the completely green, totally safe, non-nuclear chemical rocket like the astronauts used to go to the moon. That does not figure.

Since Buden would typically respond in a calculated way, I had time, another second, to ask:

"So, why would the nuclear powered rocket give you less radioactivity? How can that be?"

"Well,"

he started, with a slight smirk that turned thoughtful, as he always did when he asked those intriguing trick questions,

"The chemical powered rocket takes 3 times as long to get there, so you get 3 times higher dose of cosmic radiation.."

"Oh?"

I was obviously puzzled.

"Space is pretty radioactive, you know." He reminded me, he thought.

"No, I didn't know that space is that radioactive. How radioactive is it? Are you talking about a solar flare?" I asked.

I really did not know that space would be radioactive. I knew that the once every 11 years during a sunspot cycle the sun could spit out some solar flares that could be radioactive enough to give an unprotected astronaut a lethal dose.

Must be the flares.

"No, its not the solar flares. The Galactic Cosmic Radiation gives them a dangerous dose." he replied

"So, why is the nuclear rocket safer?", still puzzled, I asked.

"It goes 3 times faster. They are exposed 3 times less."

"But what about the nuclear reactor?"

"Oh, you shield the reactor."

No wait at all for that punch line. He had memorized and rehearsed it.

Then I remembered, it all came back. A few weeks ago a retired Navy officer fellow who hired on the same day as I did told us a radioactive submarine story in the lunch room.

Three of us were eating in the lunch area on the first floor, in the sunny corner of the first floor of the building. The sun was actually out. The retired Navy officer was going to have to work out at "the site," 40 miles to the west, and get up at 5:30 in the morning to go wait for a government bus to take him there. He was unlucky.

I was waiting for them to refill the container of that chili they made. The proprietor was a handicapped, older female. The government got a "3-fer" in her: 1) age, 2) physically challenged and 3) gender. Sometimes the lady hired rather attractive local younger ladies to take money and make the food. They were all nice, very friendly, and I liked all of them, even the older, uglier, nastier one. The proprietor somehow picked people that made you want to come and visit and leave money. But I liked the chili more than anything else.

Bruce Schnitzler knew about space. Space was radioactive. For every year in space, we would get 10 times more radiation than they let a nuclear garbage man get at one of the leaking spent fuel tanks at the Department of Energy over there at Hanford, Washington. And that would be under the old rules where they used to let workers get enough radiation every year to make some people's hair fall out, literally.

A year in space with the Galactic Cosmic Radiation would cause a 1% chance of deadly cancer.

Now that was dangerous. That was 100 times more dangerous than driving a car for a year. He impressed me with that.

The retired Navy fellow said he had a real story about radiation.

"I was an officer on a submarine where the radioactivity alarm went off when we surfaced." he said.

"What happened? Was there a bad leak?"

I asked, because everyone likes to hear a scary story that happened to someone else.

"No. There wasn't any leak at all. That's why we got into trouble."

That sure puzzled me. He had been telling this story quite a few times to sympathetic ears. I could tell. I was obviously sympathetic.

A person at the Nevada Test Site told me back during the 1970's that they made them drink a case of beer, as many cases as he could stand, free. The AEC (Atomic Energy Commission) paid for it when he got a dose of radioactive tritium. The beer would make him pee out the tritium. I thought it was tritium leaking when the submarine officer started telling me the story.

But there was no leak.

"So what happened?" I asked.

"The officer in charge forgot to turn down the radiation sensor when we surfaced. So the radioactivity detector went off." he said.

He waited for enough time to see if we knew enough about submarines to know what that meant. Neither of us made any face motions, so he knew we didn't know.

"The regulations say you have to turn down the sensitivity when you surface. Cosmic rays set it off." he continued.

I caught on immediately, and understood why the guy got into trouble. The U.S. Navy is one Big, **Regulation**, everywhere and for everything, and especially on a nuclear powered submarine.

The Galactic Cosmic Radiation was reaching the surface of the earth. It was about 100 times less than in space, but it was still there, easily measured. And just a few yards of water completely shields it. So there isn't any radiation in the submarine.

Going deep under the water would be analogous to turning off the lights on the darkest night and looking for a glowing child's toy. Much easier in the dark. It was radiation-dark a few fathoms underwater. That meant they could turn up the sensitivity on the radiation detector and detect tiny amounts, way less than the background at the surface. They could tell immediately if even the very slightest leak occurred from their submarine nuclear reactor power supply. If the nuclear reactor would leak even just a few atoms, they would be able to detect it.

Navy regulations would tell them to make sure the radiation detector does not yell "RADIATION !!!" when they surface, just due to radioactive Galactic Cosmic Radiation. The regulation says "turn it down when you surface." The poor Captain of the submarine had to file a report telling why the radiation detector screamed "RADIATION !!!" because his team wasn't paying attention.

I asked him to verify what he just told me,

"So, 117 sailors get more radioactivity at the surface of the ocean than they do

cramped inside a nuclear submarine, next to an operating nuclear reactor, driving around hundreds of feet below the surface. Right?"

I would often try to repeat what someone told me in my own words, so I could quote them, especially if it had something tricky and opposite in it. This was opposite.

"Right." he said.

He seemed to be happy that he told me the story.

Before working at General Dynamics, with the United States Navy, I thought that all the nuclear reactors leaked some radioactivity, and that one had to breathe it or you would not get to go on the submarine ride.

Everyone would want to go on a submarine ride, so you would just do it and shut up. And of course, the radioactivity doctors decide out how much radioactivity they think you can have and still be ok, and that's what they tell you. So just do as you are told.

NO.

No, *that is not the way the U.S. Navy has been doing things.*

The U.S. Navy was the most safety conscious place I had ever seen, anywhere. They wanted that submarine so safe that one would get more radioactivity outside the submarine on the surface of the Earth than you would cramped up in the thing next to a nuclear reactor.

I snapped out of my flashback of a few weeks earlier.

We were here at NASA Langley, located in Hampton, Virginia. We were supposed to learn about in-space assembly. There was a lot of U.S. Navy facilities near here. We were just not near the heavy technical buildings. We were walking to a conference room.

We finally got to the building with an auditorium big enough for a couple hundred people. No fancy technology demos in the entrance. No fancy architecture. Most of the seats filled. A nice podium and stage. This was the working NASA, not the Public Relations kind.

Positioned in the back of the room, just like General Dynamics trained me, I met a few new people. I met Dr. Stan Borowski, the nuclear rocket fellow. He talked about his nuclear rocket ways to go to Mars. Buden introduced me to George Abbey the invited speaker, some big wig at NASA that Dave Buden knew and talked with. I met Ralph Eberhardt, the guy at Martin Marietta who led me to the Idaho job was there, and all I said was "hi". I met Theresa Kennihan, a pretty younger lady scientist that Dave Buden immediately started talking with, because they used to work together somewhere.

And at an adjacent urinal just outside the meeting room I met this vaguely familiar guy carrying a lunch-pail sized box with a telephone attached to it, and also carrying a 2 inch thick, 6 x 8 inch organizer.

"You look familiar. Are you Buzz Aldrin?"

"Yeah, hi." he said.

I had just met him last fall, at Dan Greenwood's meeting. He somewhat remembered me. Amazing.

That proves the adage I learned at General Dynamics, for Program Managers who have to position themselves to get to influence customers:

"You have to be close enough to use the adjacent urinal."

At this meeting, Dr. Buzz Aldrin told about his ways to go to Mars.

All day long I kept recalling what Buden said about the GCR:
"1% chance of cancer for every year in space."

Buden's casual retort:

"We shield the reactor."

19910714 ISAS 91: In Space Assy/Service Facility
Workshop 24-26 Jul 91, NASA Langley, Bionetics
Meeting Support Div, Attn: ISAS-91, 2 Eaton St, Ste
1000, Hampton VA 23669, charlie cockrell chmn,
buzz aldrin cyler, george abbey inv. spkr, stan
borowski, buz sawyer hq safety, jim russell
aerobrakes, george nederauer, dave buden, ed dean,
ralph eberhardt, (dick coleman ops, dr. john buckley
heater, kevin mccooy gd, roy decker telerobot

• **Teller Nuke-em**

Space Power Symposium in Albuquerque

The well-planned-for meeting of nuclear rocket scientists where Big Money and Big Deal Excitement was supposed to happen, was just a shark fest with blood in the water and no shark food. And the completely unprepared-for meeting of killer asteroid people up the street, with feeble space rock astronomers trying to proclaim the sky was falling, now *that* could change the world, without a falling sky.

I learned I could move killer asteroids out of the way.

Unfortunately, I would not figure out how to do it a 100 times better than my competition until now, almost 20 years later. Nature tricked me. I am too old now and nobody cares.

It was winter, early January 1992, Albuquerque, New Mexico. The weather was nice, compared to Idaho, with a nice warm 35 or 45 degrees, mostly cloudy, no sun, but a nice evening.

Everybody who counted in the space power and propulsion game was here in Albuquerque and the Department of Energy, manned space travel meeting. The important ones were especially not at the other, NASA meeting up there at LANL, the famous Los Alamos National Lab. People came to this meeting from all over the world, including the Russian nuclear rocket inventors.

We were all feeling the excitement of making the nuclear engines to go to Mars. We all wanted to make the electric generators to power everything in space. Professor Muhamed El Genk of the University of New Mexico hosted this meeting, like he did several times before and I didn't know it. I would have gone if I would have known. On the surface, it looked like he sure knew how to draw a crowd.

But behind the curtain: *Money*. Most of the crowd were the aerospace contractors looking for Big Time Government Money, just like during the Cold War.

I followed the money.

If we went to Mars, the cost would be something like \$100 Billion. That's as much as a fleet of 30 big nuclear submarines. That's \$40 per year from every man, woman and child in the United States, for 10 years. Sharks from the Military-Industrial complex were in this water. The real draw was the taste of blood in the water: money. None of us would be here if there weren't huge money dangling in front of our eyes.

The Russians had already done the nuclear rocket experiments very well 2 decades earlier. They copied what we did, but definitely not how we did it. Theirs could be much better, judging from what their technical guys told Marland and me and others at INEL. The

Rooskies wanted our money, too. The Cold War ended. Now we were friends and they were broke ex-commies.

The USA had already tested the basic nuclear heated, hydrogen propellant rocket, two decades earlier. Our nuclear rocket would be a repeat. Theirs would be new.

President George Bush had declared that we were going to Mars, so I guess we were. Everyone wanted Bush's money.

I wanted to attend that other, NASA meeting, as well. The other space meeting was different entirely from this one. Dr. David Morrison at NASA Ames had convinced someone in Congress to pay for two meetings on killer asteroids. I went to the first meeting, where world famous scientists declared that near Earth asteroids were a real danger to mankind. The second meeting was looking for ways we could prevent the asteroids from hitting us.

My motel was downtown Albuquerque, a 2 minute walk to the convention center. My hotel room was a historic, 3 story building about 50 ft x 100 ft in dimension, from the Spanish days of an earlier century, a true part of history. The somewhat thin, stained wood doors were small and rather short, because the Spanish were rather short. The lock on the original knob was a 4 inch square piece of black metal hardware designed for a large, classic antique key. The room was rather small, but I could feel how it was a perfectly preserved and maintained original, pre 1900's room. I liked the feeling of the Spanish type of New Mexican ambiance. The wood and the window and the hallway all felt good.

Soon after dark, on the first floor in the reception area Marland Stanley, John Rice and the rest of them from INEL came to my hotel for a drink, and to meet some others. The entire INEL space division was showing up at the Space Power Symposium here.

Marland and the rest of them had modern rooms. They got rooms in the new, 50 story hotel with modern architecture and a dark and shiny stone facade, because they reserved early. They were teasing me, telling me I left my wife back in Idaho in the biggest blizzard of the decade. I laughed.

"No I didn't," I said.

"Terri asked that you call her." said John Rice.

"Sure." I replied. These guys knew I was rather gullible.

John had talked to Trish, his wife, and Trish talked to Terri. I guess they weren't kidding. Wasn't snowing when I left.

Sure enough, the blizzard was so bad that Terri almost got lost and stranded trying to find her way back from the mailbox. The

description of that situation would be a little deceiving because the mailbox was down the hill 210 feet. The only neighbor was at least 500 feet away, further down hill. Up the hill east and behind us was no one, for about 10 miles until you got to the outpost town called "Bone" that had no telephone lines and was proud that you got to use their genuine, stinking outhouse that did not use chemicals.

Down the hill at least 6 miles away was the town, glistening and shimmering in the chill air. The wind nearly always blew hard, uphill, towards the east, 50 mph. The water in our toilet bowls went up and down, often, most any day you choose, because of the wind flowing over the house.

Terri told me that it was just towards evening, the snow was waist high and the blizzard wind was blowing so hard it was hard to tell which way the house was.

"I thought I was going to die here, up to my waist in snow. I almost couldn't move, up the hill." she complained.

I guess it was true that she almost got lost in the blizzard.

The people at this rocket science meeting were the guys who wanted taxpayers to pay for sending people to Mars and to use nuclear powered rockets to do so. I was definitely one of them. This was an important meeting, because this faction knew how real the idea could be to send people on missions to "deep space."

NASA called anything past the moon "deep space." I called that "the solar system," and the solar system is not deep. Another Galaxy is deep.

The guys here at this meeting also knew that if we would not use a nuclear rocket then we would be stuck here on Earth with the terrorists and tax collectors until Greenpeace quit. Hopefully, Greenpeace would not quit, and we would be able to use nuclear rockets to travel the Solar System.

I found out about the meeting here too late, too late to publish, but I did prepare something. I had with me a written hard copy of a paper on steam rockets. Just in case. You should always have a written copy with you. The normal rule was that to go to a meeting one must present something, give a talk on something, and publish it, to prove you actually did it and other people saw you do it. I had just gotten hired several months earlier, so Marland gave me an exception.

We from INEL were really popular because we would be handing out money, when it came in. We were deciders. We would decide who would design and make the nuclear rocket.

Aerospace contractors swarmed around us, trying to influence us. Our group would get to choose who would make what nuclear rocket part, and how much money they would get. At General Dynamics I was a contractor. Now I was one of the deciders, not one of the contractors.

I saw people elbowing their way to talk with me, and some recited their own elevator speech to me.

Exciting.

This was how most of the government contracting I knew of worked. The government would hire people who think of themselves as smart and whose only real qualification was that they had a high opinion of themselves. I would not name names in public, and I had seen many of this type.

Usually, the Boss somewhere higher up would dictate to hire someone, by name. So the underlings do, and they hire some more people from within, choosing friends and whoever was standing around. I had been with Sandia, a U.S. Government National Lab, and I was standing around, so to speak, so I got chosen. My group of government guys got to choose. Great system.

We were evaluating everyone here. Our "national lab," INEL, was slated to test the nuclear reactor engines out at our semi-desert site. What we wanted and needed was the smartest and best contractor around.

The government has to have people to really do the real work. I saw immediately that these contractors knew a lot more about the nuclear rockets than we did. And we were the choosers. If we chose the not-so-smart or not-so-good contractor, then things would go wrong, schedules would slip, costs would rise, everyone would look stupid, and Congress would get mad and take our money away.

Then, I would be stuck in freezing cold Idaho with no one to buy my house and no job. What would I do?

Would you want to be stuck in Idaho with no job? You would have to become a Latter Day Saint before you could even be considered for ranch or farm work. I would be too far from anywhere to look for a job. I made damn sure I looked for the smartest, most competent contractor people I could find.

Immediately after the last presentation of the first day, everyone filled the lower floor hallway. Loud talking, everyone greeting old friends, meeting new ones, talking about everything. Everyone was crammed into this first floor area.

Dave Buden from our INEL group was sitting in a chair right in the middle of the crowded display area, with bright TV lights in his face, getting ready for a TV interview. He was trying to get popular support for the Government to make a hydrogen propellant, nuclear heated rocket.

I carefully watched everything he did and how he did it. I wanted to get on TV myself and tell my story. He was doing it and did not even know that he was showing me how, by example. I was trying to get converts to the steam rocket. I needed to know how to do this. I was really watching closely.

It seemed easy. Dave had a yellow pad with his notes on it, so he knew exactly what he was going to say. He was practicing right there in the chair. It was very simple. He was helping the

reporter lady who was about to ask him questions. He had to ignore all the people standing around.

There would always be all kinds of people standing around because the TV wants them as "atmosphere," even though they are distractions to the talker. The lights and camera seemed like just another thing going on. I could barely hear him when he was talking. The TV people interviewed the Russians, too.

We were too busy to watch the TV news report of this space meeting. The TV people said they would send him a copy, so we could see it when we got back to Idaho. Nobody said anything about the interview, so it must not have been such a big deal.

The next morning was relatively cloudy, unusual for Albuquerque, except that this was January. The winter month. The weather was

different all the time, but it was not a bad form of different, like Cleveland.

The smell of pinon smoke from the Albuquerque fireplaces was so enchanting it invigorated me. Albuquerque and New Mexico were always enchanting. The smell of desert cedar and pinon was like some kind of fairy dust that made the whole state "enchanting," just like their yellow, New Mexico license plates say.

"I can't remember a single day of bad weather in Albuquerque." I would declare, to people in San Diego who said theirs was the best weather ever. This was better weather. And I was quite ready for a day of stalking at a meeting. I would get to use my skills.

Crazy Roger's Secret Nuclear Rocket

Certainly the flashiest event was the presentation about the secret nuclear rocket. The big, Defense Department, nuclear rocket secret had been leaked almost a year earlier, and the perpetrators were now giving their public, unclassified technical talk.

The second floor, large auditorium room had a long, 40 foot podium, and seemed to have about 1000 chairs. 40 seats wide, 25 rows deep. There were probably 3 seats left, somewhere. I was standing in the back by the door, where everyone had to pass me to get in. I was looking at all their name tags to see who was there. I was stalking.

The speaker was a notorious, "Crazy Roger" Lenard, Colonel, U.S. Air Force. This was the guy who gave me and Jim Powell \$5 K to document the nuclear heated steam rocket. He was my benefactor. I liked him. But he had a reputation.

Marland Stanley did not like him at all. Apparently, Jim Powell and Crazy Roger Lenard said or did something that the Department of Energy bureaucrats didn't like.

I saw one of the DOE Bureaucrats, whose name was familiar, standing in the back, about 20 feet away from me. He was younger, maybe younger than me, thin, slightly taller than me, rather good looking, and he walked confidently, not arrogantly. He was well dressed but had a light color suit, not Pentagon style suit at all. He was probably not that bad, because he knew enough to stand at a strategic location.

Crazy Roger began bragging about the performance of the formerly-secret rocket. Everybody in the audience wanted to know about it. He showed some viewgraphs that almost showed secrets. He was careful, but he was close to the edge.

The room was standing-room only. Roger was talking like he knew science. He didn't. He was in charge, but he didn't know science or engineering very much at all.

He was telling the audience "40" megawatts per liter. But he didn't know enough to realize that the "40" was about 10 times more power than what it would take to melt the rocket engine. If he would have said "4" he would have been credible.

That "40" Roger was bragging about was huge. It meant he could get about 50,000 horsepower out of a quart of nuclear reactor rocket. Some physicists in the audience besides myself immediately figured what it meant.

That 50,000 horsepower would be too much power in such a small volume. Everyone listened even though it was crazy, because Roger was entertaining. That was why they called him "Crazy Roger."

Besides, no one was going to let him actually fly one of those nuclear reactors in our atmosphere.

I imagined a car like that. About 1/5 of a teaspoon of engine would give 50 horsepower. I compared it to an airplane engine. 1 quart would give the same power as an L1011 or a Boeing 747 jet engine hanging in the big pod from the wing.

Marland and the INEL engineers had several different kinds of measurements showing 3, not 40, would be pretty good and pretty much all one could safely do.

Any more than that and the data and calculations show it would melt, or it could melt at the first jostle. Even "3" would mean 4000 horsepower per quart. These were all astoundingly high powers.

I knew this detail because I needed my steam rocket to produce at least 1 or 2 megawatts per liter. I found out we could do that, because the technology had been tested.

Of course more was better. I would have loved more, like 10 or 20. But, data showed we could not.

Everyone knew Crazy Roger exaggerated. Not everyone knew how much. Marland did. Marland always had a nasty word to say about Crazy Roger and his buddies. Jim Powell is one of his buddies.

"You are judged by your company," the saying goes, and my "company" was Jim Powell.

It is always that way. You are always treading between your bosses and other bosses at war with each other.

Actually, that was why Marland and the INEL did not like Roger. The DOE paid Marland and the INEL was to dissect the aftermath of Crazy Roger's experiments, and the results were not what Crazy Roger was saying. Marland told Roger, but Roger wanted to cover it up. So, Marland told the Department of Energy chain of command.

It did NOT get covered up, but only at the Secret level where it belonged. And, we didn't say a thing in public. Saying much more in public would probably be close to being secret, and we did not want or need to divulge secrets, or even get close.

Just outside the door I saw someone with a name tag "Steven Aftergood." I knew the name.

*Aha.
He is one of the "Anti's".
Anti-nuke.
He is on my list of people to meet.*

Steven Aftergood was part of the Federation of American Scientists, FAS. He was thin, not wearing a suit, had black hair, dark rimmed glasses, about the same size as me, and almost looked like a graduate student in law or business. He was taking some kind of notes on a question someone asked Roger.

The FAS people are "anti" most of the scary things we wanted to do. I agreed with pretty much of their arguments. The FAS was mostly reasonable. Marland did not like them.

"Hi. Got a minute?" I asked, not loud enough to disturb Roger's presentation.

He made some motions, so I told him I could wait till questions were over, because I saw he was taking notes.

When Roger was done, I asked him:
"What do you think of using a nuclear rocket to go to Mars?"

I expected he would let us do it, "depending" on things. This group of anti's were usually reasonable.

"If you do it safely, it's ok." he replied.

See, just like I thought. We exchanged some physics and engineering language about safety, which described "depending." No adrenalin at all happened between us.

"What do you think of Crazy Roger's rocket?" I asked, knowing I was poking a hornet nest with a stick.

Adrenalin started to appear in his face. His face got a bit red.

"You can't run an open reactor in the air." he said, holding back emotion.

He tried not to use emotion in his language. It leaked out with the throbbing of his neck arteries.

Then we had a probably somewhat classified conversation about that nuclear rocket of Roger's. Aftergood had access to some secret data, and I think he should not have had that access. I did not tell him. It thought something he found out may have been Secret, Restricted Data. But one does not let on. That would be "confirming or denying," and I had a Secret Clearance I was not going to spoil. NOT Good. I would know if he knew, and I was not going to tell him.

And Aftergood was reasonable.

When I told Marland who I talked with, he smiled a bit, and with a hard-to-hide worry on his face, he said "The Enemy."

Then I reminded him how Crazy Roger paid \$5 K for Jim Powell and I to document my steam rocket.

"Boy, you do hang out with the Enemy." he said.

"Hey, they got connections." I replied.

All four of the connections were present at the meeting:

- the Anti's,
- the Department of Defense (DOD),
- NASA
- and the Department of Energy (DOE).

Both the FAS (anti) and Crazy Roger (DOD) are the enemy to all of: Marland, the INEL, DOE and NASA.

Crazy Roger hated the FAS, NASA and Department of Energy. They all hated each other a little bit.

I thought each one was ok. They were all different. I didn't care if Crazy Roger lied a little. I could work just fine with all of them..

Crazy.

Everybody who was anybody was here, and I was busy meeting as many as I could. General Dynamics had trained me on how to work a meeting and stalk. I had come from the Military

Industrial complex. I fit. I fit perfectly. I met everyone I could and wrote their names down. My entry in my computer proved it:

920105 SpcPwrSym92, Space Power Symposium, Albuquerque, New Mexico, January 5 approx, 1992; aftergood, steven allen, george angelo, joe barnhart, dennis belogurov, al benjamin, ben bhattacharyya, samit borowski, Stan buden, dave Clark, john coomes, ed dagle, jeff ernst, don finn, dr. tom finger, harry fragola, joe gallup, don george, jeff haloulakos, bill hooker, oniel jacox, mike & wife kaltenstein, bonnie keaton, dr. paul kelley, jim lenard, col roger x leonard, ray ludewig, hans martinell, john mathews, dr. bruce mc kee, john nozette, stu oderman, mark olsen, dr. chuck pavshoock, dr. vladimir a. pelaccio, dennis picker, nancy powell, jim presentine, roger ratliff, jim rawlings, pat artist, rieb, marvin & barbara, redd, larry rice, john roy, dr. don segna, don stanley, marland stepnoi, dr. nokolai n. ponomarev stillman, gene struthers, dick warden, col pete walker, jack watts, ken wuchte, tom zavadowski, richard zubrin, bob

Focus, Focus, Focus:

The bottom line was that the FAS would let me use a steam rocket to travel the Solar System.

Coincidences Are Not Random

And then coincidence happened. Calculated good luck coincidences.

Walking in the lower level hallway looking for someone important to talk with, Jim Powell showed up. Of course. I should have put 2 and 3 together. His Star Wars Program Pentagon Boss, Col. Roger Lenard was here giving a paper on the nuclear rocket. Powell invented Roger's rocket.

As soon as Jim saw me he blurted out:
"Hi Tony!"

He smiled and we both were very happy to see each other. Immediately he asked: "Are you going to that Los Alamos meeting on killer asteroids?"

"Well, no. I wanted to go. But I told somebody, Don Yeomans from JPL, to talk about my concept to move killer asteroids out of the way." I replied.

This was my excuse for choosing not to go there and be here instead.

"How would you do it?" he asked, meaning: "how would you move the asteroid out of a collision course with Earth?"

"With our steam rocket." I replied.

Jim was obviously very much interested because he was the steam rocket co-inventor. This would make him look very good.

"How much delta V do you do you have to give the asteroid?" I asked him.

In plain language that question meant "How hard a shove do you need to give the asteroid so it won't hit Earth?"

"Surprisingly small." he said, in his scientist-curious tone of voice. "Only centimeters per second."

In plain language that answer meant if we could change it's speed by only the speed of a turtle, literally, it would miss Earth.

I already new the answer. Anyone could do that calculation with a simple scientific calculator. I was baiting him, setting him up so I can win something.

I just wanted Jim to reassure me that I was using the correct numbers. If that "only centimeters per second" was really the right answer, I could do it. It didn't take me long to figure this. I had done this before and the numbers worked out. I had already figured that a steam rocket could move a 1 kilometer space rock by 10 centimeters per second. We both had figured how changing the

typical orbit of a near earth asteroid by only 10 cm/sec would be enough to make it just miss earth if it were going to hit.

I had my handy pocket calculator programmed to do this. Very simple. It is just like the problem we are all here to solve, to go to Mars and back.

I showed him right then and there how our steam rocket could blow enough steam through its rocket nozzle to move a 1 kilometer, killer asteroid by 10 cm per second. .

Jim Powell was delighted.

"I'll take you up to Los Alamos, my self, in my car."

"But I need a place to stay."

"You can stay at the motel I'm staying at, in Santa Fe. They have room."

"I'm not registered at the meeting." I begged, knowing that there was always a way to get in, especially if you know someone.

"I'm the chairperson for the propulsive deflection session. I will put you there myself." he bragged. That was a key session.

My boss, Marland Stanley, was all for the deal and authorized my change in plans on the spot. I was glad he authorized the deal. My emotions were glad.

Bureaucracy had to do that you know.

You can't just have people just going anywhere they want on government money, you know.

You have to have a nice bureaucratic reason.

Why did Marland like the idea of me going off with the enemy? The thought crossed my mind as I was asking him. And I had a ready answer, but Marland was there ahead of me.

Marland already knew the reason: Jim Powell was the key scientist for Crazy Roger's super secret Pentagon's Star Wars nuclear rocket, and those Pentagon guys *had tens of millions of dollars*. We both knew the reason:

Money. Sharks. Blood in the water.

So, Jim Powell and I sat there in the basement underground hallway that connects the convention center to a hotel 100 yards away, on a convenient, fat old flea market sofa they dragged in just for this meeting, and figured what we would say.

I had to scrounge a picture of a nuclear heated steam rocket from the technical paper I conveniently brought. We made up a viewgraph, and that meant we had a presentation for the meeting. I was official because I would present our work in public.

Late that afternoon we drove up to the motel in Santa Fe, 2/3 of the way to Los Alamos. I got a room at the same motel as Powell. There was snow and ice on the hillside road, and Powell's rent-a-car almost got stuck.

We needed some spirit-food to fuel us for the next day, so we got burritos for supper.

Los Alamos National Lab

The Nuke 'Em Meeting

Why were we here?

To intercept near earth asteroids headed for a crash with earth.

To prevent a Cosmic Catastrophe.

To save the world.

Yes, to save most of the people in the world from a slow death by starvation.

Obviously, we are here to nuke 'em.

It was now time for the second meeting, the meeting on how to deflect celestial bodies out of a collision path with Earth. They were holding the meeting at the Los Alamos National Lab (LANL), in New Mexico. LANL was just up the street 100 miles from Albuquerque. It was a sunny day in Los Alamos in January. The weather was just right, with just a little snow here or there. We were at the Los Alamos National Lab, at our meeting in second floor area above what seemed to be a public access library. A nice, clean architecture, nice, rather modern furniture, clean, clean floors and walls. This was not one of those old buildings erected during the 50's and 60's.

Now why would anyone hold a such meeting at the lab that invented, and specializes in atomic bombs? Of course, you hold it there because everyone there thinks you can just blow up the asteroid with an atomic bomb. These scientists focused on using atomic bombs to save the world from cosmic destruction. The scientists I knew from LANL who did this seemed to be mostly non-connected, pure scientists.

I knew how to deflect the asteroids *without* using atomic bombs.

The asteroid guys didn't have any connections worth much, nor any money. That was why I didn't press Marland to let me give a paper here, at Los Alamos.

The Santa Fe, New Mexico, burrito's were better than anywhere else. The reason was that they were made *Tri-Culturally*.

New Mexico was about equally populated with 1) Gringos (white honkey guys like me), 2) Spanish (not Mexican) and 3) Native Americans. Tri-cultural.

If you mix the cooking style of all three you get 1. gringo high grade, low fat beef and pork, 2. Spanish chili peppers and spices, and 3. Native American beans and flour tortillas. The Gringo's brought the idea of expensive ingredients. The Spanish brought spice, and the Native Americans brought substance.

I expected to see Don Yeomans here, from the Jet Propulsion Lab of Cal Tech. All during the Albuquerque meeting I had pondered that Los Alamos meeting, because I had sent Don Yeomans a short, email note on my steam rocket and how it would do a non-bomb, killer asteroid deflection..

On the second floor where the meeting was held, somebody was checking who was allowed into this meeting and who was not. Two hall monitors were standing in front of the meeting room door. They were scientists I had seen before.

Jim Powell insisted that I be let in. The main hall monitor resisted. Fortunately for me, it only took a few insisting sentences. I recognized the fellow, but I could not remember his name at the moment.

This was a well manicured attendance. I didn't see any crowd trying to get in and being turned away.

These guys were serious about not letting just anyone in. I thought they would let in anyone who cared. But no, they were carefully screening.

Once I got in I could see that every one of the people here had to know something about the topic. I recognized most of them. Our peers had to certify that each and every one of us here could and did figure, often, and accurately. That was sure different. Screening for competency.

"If you can not figure, you can not be here."
How nice, that each of us has to be a Certified Reliable Figurer.

What a concept. If what you figured was heresy, that would be quite ok. I saw a few of the heretics here. Somebody started off the meeting by reviewing the San Juan Capistrano, first meeting. I remember all about this San Juan Capistrano meeting because I was there. It was epochal and life changing for me. So, while they were talking I was going to review my presentation.

The speaker caught my attention when he started talking about killer asteroids. That part was the fun part. He said when the killer asteroid hits it causes at least one global winter to last all summer, preventing crops, and starves most of the world. Everybody here knew that. We all know that if one of the bigger near earth asteroids hits, that's what it would do.

Everybody here knew the probabilities, too. It only happened about once in 100 to 300 thousand years, at random. He was saying at random. Of course at random. What else could it be? He said over a 100 year lifetime, your chance of dying by killer asteroid would be about 1 in a thousand or 1 in 3 thousand.

I knew he was cheating with his descriptions of those numbers, just to get Congress and the Journalists attention. I should compare this to 1 in 2 for dying by cancer or heart attack, or 1 in 100 for dying by car crash, or 1 in 300 for dying by guns. He said 1 in 10,000 per lifetime and then compared that to an airplane accident. He was playing with us.

"We have to deflect those killer asteroids." he said.
On that we could all agree.

*That's a blackboard behind him.
Chalk.
How primitive.*

A brand new building, and they have a chalk board, not a felt board.

Professor Reines was the head of the physics department when I was at Case. He was here, at Los Alamos. I could not resist and just had to at least say hi to him.

He smiled when he saw me, as if he recognized me. Then he told me "You're making quite a name for your self."

I could tell he made that up. It was so obvious. Nice of him, but obvious. He could barely remember me. He remembered my face, like we all remember student faces. He personally had got me a solid state pulse height analyzer, to replace that old 3-refrigerator wide, always broken vacuum tube one. He was head of the Physics Department the whole 8 years I was there, but 30 years earlier.

Here, he introduced me to his son, who as also standing next to him. Reines still did not have his Nobel prize for finding the neutrino. He would get one someday, we all knew. Reines was there to listen. Lots of Los Alamos scientists got to listen. They guy at the door didn't stop anyone with a Los Alamos or Sandia badge.

I should have shown my INEEL badge. That was the good part about these National Labs. One could wander around and glean gems of knowledge about nearly anything.

I was deliberately meeting everyone I could who knew about the near earth asteroids, and everyone who knew how to nuke them out of the way. After all, we were at Los Alamos National Laboratory, the place where the atomic bomb was discovered and invented.

I wrote some of their names in my notebook:

920105 NEO Interception Jan 92 ahrens, dr. thom cratering
barnhart, dennis leep vehicle @phillips bowden, lt. col joe
SAC bowel, ted boyer, keith burke, jim
canavan, gregg chapman, Clark cox, andrew
geherls, tom hammerling, p. helin, glo hills, dr. jack
jenkins, lyle kinsey, jeffrey lemke, larry maise, george
marsden, brian maryniak, gregg mendleson, edgar
meyer, harris nozette, stu ostro, steve powell, jim
prosnitz, don rather, john reines, dr. fred remo, dr.
john richter, john shoemaker, dr. gene solem, dr.
johndale super orion stern, dr. martin tagliaferri, ed
teller, dr. edward 5006 tholen, dave tillotson, brian
yeomans, don

The Gigaton Bomb

"We should make a gigaton bomb, said Dr. Edward Teller, Father of the H-bomb." wrote the Journalists, **deliberately lying about what he said.**

They hid behind "Freedom of Speech" to lie and manipulate. They could not figure things. That's why they became Journalists. On the other hand, they did chose a more interesting job, given their handicap.

All of us in the audience were focused on trying to find out just how big of an atomic bomb one would need to push a killer asteroid out of the way.

A thin professor in a suit from California or the east coast, I don't remember which, was showing a viewgraph of an asteroid, and off to the right of his asteroid was a tiny dot of a bomb.

He said that since asteroids can be made of dirt, rock, iron or oil shale, and you did not know which, you had somewhat of a problem. You had to vaporize and explode some of the surface of the asteroid to make the killer asteroid move. But how?

Without saying so, he made us think "What if it's made of rock? What if it's iron or nickel? Are we done for?"

Then he stated explicitly: what we really needed to do was to explode the bomb deep inside the asteroid. We all knew we could not do that, and he knew too.

I had learned about the "explode it deep inside" during my Sedan Crater visit at the Nevada Test Site. They buried the bomb 100 or so feet deep in the desert sands. The buried bomb blasted a 1000 foot crater into the Earth. But the same bomb 100 feet above the ground would just make a shallow depression.

He said what I expected, that if we could bury the bomb into the asteroid, that would move the killer asteroid out of the way.

Then he asked some key questions:

"how are you going to land on the asteroid?"

And, how are you going to drill into it?

A drill rig doesn't work in zero gravity and a vacuum, and it is too heavy to take there anyway."

I understood the part about landing on the asteroid. I learned this at Sandia, too. All I needed to know was how fast the asteroids were typically moving relative to a rocket we would send there, and I did know. Unfortunately, they were moving way to fast.

The problem was that the rocket bringing the atomic bomb was typically moving too fast towards the bad asteroid. When the rocket would try to bury itself into the asteroid, it would, instead, smash so

hard that it would break the bomb. Worse yet, the crash speed was so fast that whatever the bomb was made of would turn to vapor. It would not be a bomb. It would be a gas of vaporized bomb parts.

It was not like the movies at all. One can not just land on a random asteroid. The rockets don't have enough fuel to slow down enough. They would need as much or more fuel as it would take to launch them from Earth. Imagine that one, in space. A launch rocket as big as we see at Cape Canaveral (Cape Kennedy) just to *land* on the asteroid.

If you don't do that, then the spacecraft smashes so hard it turns into exploding purple-white-hot vapor. That's why it is so hard to intercept an asteroid.

The actual speed when the two meet is typically between 5 and 30 kilometers per second, as a "closing velocity." That speed is higher than the typical speed of burning rocket exhaust. That is why the rocket becomes vapor. The speed is therefore "too fast".

While he was talking I was imagining how I would say this, instead of him saying it.

I would say

*"This is NOT like dropping a TV set off the top of a big building.
It's much worse.*

Its worse than trying to land on the highest power bullet fired from the highest power rifle pointed right at you.

It's even much worse than flying a supersonic jet fighter as fast as it will go, straight down into a concrete driveway.

It's much worse. ."

The actual speeds of what I would say are real numbers. But I was naive. Nobody cares.

He was the one talking, not me.

That's why Captain Kirk and Spock could not really land a shuttle and drill rig on an asteroid. They would turn into purple-white-hot vapor first, and blow up in a brief flash..

*So what are we going to do?
How are we going to save the Earth?*

I was wondering what he was going to propose.

He continued:

"We are forced to detonate the atomic bomb just the instant before it hits the asteroid. It will vaporize some of the asteroid

surface, hopefully dirt and rocks. Then we can use another bomb we conveniently send right behind the first, to blow up and vaporize the rocks we just stirred up. This would impart the required momentum to the asteroid."

I imagined that I would have said "It would give the bad asteroid a good whack." But he was the one talking.

Then he said "it could be made of iron or some other very hard, dense material."

"Oh, no!"

I panicked.

"What if the asteroid is just solid nickel and iron, or just a solid hard rock. What happens?"

I thought, with no answer. I could see others in the room thinking the same panic.

Then the professor showed us the bomb energy and the resulting momentum figure, and proclaimed with loud and clear frustration:

"You can't move this asteroid with an atomic bomb, because you would need about a gigaton atomic bomb."

In zero milliseconds everyone knew that half the Earth would starve to death. They all saw his numbers. They all understood. We were doomed, and we all knew it instantly.

A "gigaton" is a 1000 megatons, a million kilotons of atomic bomb. All the nuclear power of a missile field all in one bomb.

If anyone here couldn't figure that one, they would not be allowed in the meeting. We were all here to shoot atomic bombs at the killer asteroids, and now the physics shows it won't work because ***our atomic bombs are too puny.***

Half the world is going to starve during a year of deadly food wars.

But in zero milliseconds flat, the Father Of The H-Bomb Himself figured it. I knew what he was going to say, because I was thinking the same thing.

I was one chair behind and 2 chairs to the left of the aging but intellectually sharp Dr. Edward Teller. I was arranging to talk to him, of course. You might say I was stalking him. I wanted to talk with him again. He's the one who told me and Terri a dozen years earlier that Dyson's Orion "took way too many bombs."

"Yes, we can too make a gigaton bomb."

I thought, as Dr. Edward Teller immediately stirred out of his front row chair.

I worked a similar problem for my bosses at Sandia Labs, for Bill Goodsmirk and Bob Kadiddlehopper, back in 1970. They asked me to design an atomic bomb powered rocket delivery system, to

deliver a 5 Gigaton Bomb to blow up the whole evil empire all at once. I knew one could make a 5 Gigaton bomb.

Dr. Edward Teller, ***The*** Dr. Edward Teller, Father Of The H-Bomb, computed everything in his head, lightning speed.

In the front row, to the left of the viewgraph machine, and no one sitting on either side of him, he slowly stirred and started to pull himself up.

Of course, everyone else stopped talking. This was the Father of the Hydrogen Bomb speaking. The guy responsible for starting the Lawrence Livermore Laboratory, the Famous Dr. Edward Teller, the one who snookered President Regan into trying to make an X-ray Phasor Beam to kill Commie Pinko Rapist ICBM's with a single atomic pop.

He grabbed on to his 2 or 3 inch thick, slightly crooked tree limb cane, stripped of bark and polished smooth and fitted with a hand sized leather mitt, to lift himself up. He was shorter than me and somewhat bent over, and his eyes were bad. He always wore an expensive dark suit.

He hoisted himself to a stooped stance by leaning on crooked cane. He slowly turned to his right, to the room jammed full of experts and with people standing in the back and against the walls.

With a thick Hungarian accent he slowly pontificated:

"Ve mus not exclude unlimited energy."

"Ve CAN make Gigaton Bomb."

He leaned on his cane and tipped down slightly when he said "can." He slowly looked to his right and scanned eye contact to each in the crowd.

His emotion was clear, and he emoted it with the assertive head and body motions of an old wise one:

"To save humanity itself, we must not just give up,"

I knew immediately he would be misquoted.



Supreme super-bomb. In 1994, while attending a conference at Russia's Chelyabinsk laboratory on possible means of avoiding meteorite impacts, Teller posed with this model of a 100-megaton hydrogen bomb (the largest ever exploded).

The Professor from Somewhere was almost certainly right. It really would take a Gigaton atomic bomb. Even worse, the asteroid was going to hit us with 1000 Gigatons of energy. Meanwhile, our 1 Gigaton bomb was puny by comparison, even though it was literally big enough to wipe out the entire state of Florida and break windows in Michigan, if it accidentally blew up on launch from Cape Canaveral.

This would be a tough choice for us. We could make a Gigaton bomb, and take a chance on blowing up half a continent if there would be just a slight mistake when we tried to launch it into space. Or we could let the asteroid hit.

Another choice: we could hoard food for 260 Million Americans, and protect it with 1000 nuclear weapons in our missile silos and 10,000 more somewhere else, like on nuclear submarines. One would expect starving Russia and China to start bombing us with their nukes, and they would not stop till we gave them our food.

But we were at Los Alamos National Lab, and most everybody here knew we could just toss an atomic bomb at the Killer Asteroid. It would be simpler. Why else would we be holding the meeting at Los Alamos?

Medusa, the Atomic Bomb Powered Rocket

A new face appeared and started to talk about what looked like an Orion Starship propulsion.

Look at that.

Sure enough,

someone here really is talking about Orion and atomic bomb propulsion.

Dyson's Orion was what got me interested in space in the first place, 25 years earlier.

That is really far out.

He is telling us how he will shoot atomic bombs behind his rocket ship and blast the asteroid with the rocket.

The rocket itself was his explosive. That was clever. He would smash the rocket itself into the asteroid.

The fellow was Dr. Johndale Solem.

I could see from his figuring that Johndale's rocket would use way too many bombs. I could see now what Teller meant when he told me 15 years ago that it would take "way too many bombs."

Immediately after this session was over I went right up to meet Johndale Solem. He, Keith Boyer and someone else got all excited that I cared and they told me of the modern day version of Orion, which Johndale called "Medusa."

Medusa?

Three of them crowded around me told me that this was the real way to make an Orion nuclear rocket.

"You mean it could work?" I asked.

Then, all excited, they told me the Medusa Story.

I would have to tell Jim Powell that "Medusa" story, later. It was too exciting. But later.

neofuel And The Steam Rocket Alternative

Now it was my turn to talk.

Teller wasn't there when it was my turn to talk. He skipped out. I wanted Teller to hear me and see how smart and clever I was. I wanted him to hear me tell how to move the comets out of the way using a steam rocket.

Jim Powell did me a real favor. He gave me a time slot that was just wonderful, perfect. Not the first talk after lunch, because that is when everybody is about to fall asleep after eating. Or maybe they come in late because they took a long-lunch. And not the second talk. He gave me the third slot of the afternoon, just when everybody was back awake and at their peak. That's when Powell and I got our chance to speak. Of course, Powell's guy went ahead of me. He showed how a hydrogen propellant, nuclear heated rocket would deliver the bomb to the asteroid fast.

I had a very simple message. "Let a steam rocket push the killer for 3 months, and it will move by 1 meter per second, missing Earth."

I needed some fraction of a megaton of water to do this. It should have been obvious to everyone there where I would get the water, but it wasn't. I thought everyone in the room knew about the

periodic comets, and how one can find one just about wherever you needed. So getting water from them, half a megaton of it, would be simple.

But no, the only ones there who knew about the dark and close comets were Glo Helin, Gene Shoemaker, Tom Gehrels, Don Yeomans, and maybe one other. Almost everyone else didn't know what I was talking about. I failed to communicate because I never told them about those periodic comets.

Nobody I knew of had a picture of these comets and their orbits. I only had the data that I got from the University of California at San Diego library. And the data was just tables of orbital elements.

Everyone who listened to me could only think

"Comets? They move too fast. How are you going to dock with one of them?"

They didn't know, mostly because I failed to show them. I wish I had a picture of the dark and close comets. It would have said it all.

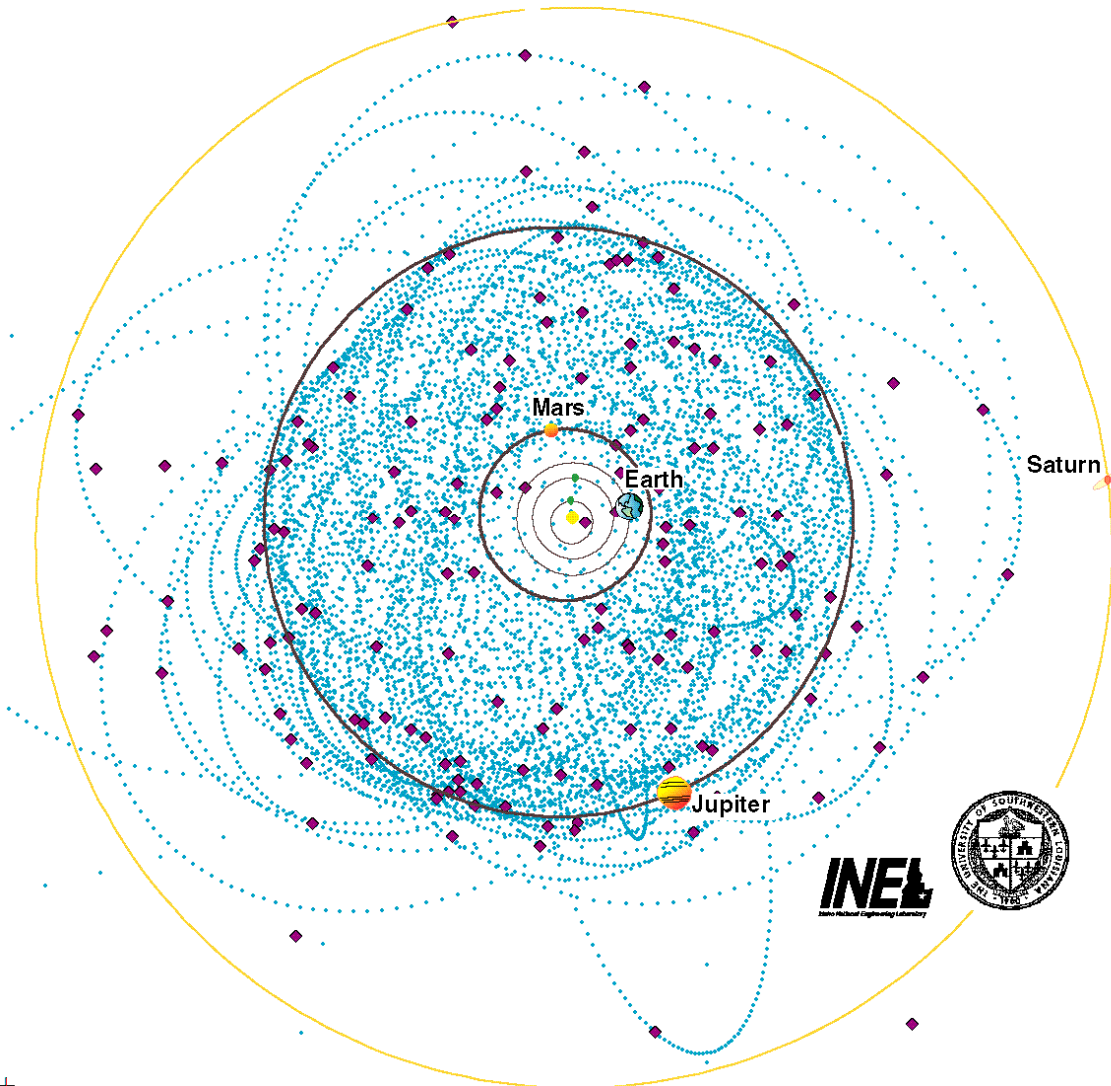


Figure xxx. The Dark and Close comets. We can nearly always find an accessible comet close to where we need it. The comet has plenty of water ice for us to melt and use in our steam rockets.

My picture was simple: park a nuclear heated steam rocket on the asteroid and turn it on.

My nuclear heated steam rocket would have a chunk of ice that we would melt into water and put into the nuclear reactor. The reactor would heat the water to steam. The steam would go out the rocket nozzle. The rocket would produce a force, and it would push the killer asteroid out of the way.

No one there questioned me about how I was going to dock with the bad asteroid. They should have asked. I would have choked.

We had all just been reminded that morning how one could not land on the asteroid so easy. And now I was proposing to land a Megaton on the asteroid.

I would have choked on the correct question.

On the other hand, no one there knew enough about the problem to ask me the right question. This was the first meeting in the world of such experts on such a topic.

If they would have asked how I would dock with something moving at 10 km/s relative to me, I know *now* what I should have told them *then*. I would not have been smart enough, but I should have been. So should they.

Every damn one of us was effing stupid!

It should have been obvious to all those smart fellows in the room. If I were carrying 500,000 tons of water I had just removed from a comet, why not just let it smash into asteroid? If it turns into white hot vapor, that will sure give that killer asteroid a good whack. That would move it, like everyone in the room wanted, and it would be exceptionally simple.

Furthermore, the calculation was so simple anybody here could figure it, probably with no calculator at all.

But I failed.

It was entirely my fault that no one took it seriously.

First, I should have told them about the periodic comets, and how many there were out there. First. So we could all see what I saw.

Second, I should show them how a single nuclear heater could nudge a megaton chunk of ice or dust or a bag of rocks and pebbles, into any nearby orbit because you could always find a comet in nearly any orbit. You would not need to nudge your giant ice cube very much.

Third, I should have shown them how much an asteroid moves when you hit it with half a million tons of mass moving at those speeds. It wasn't that hard, but I didn't do it.

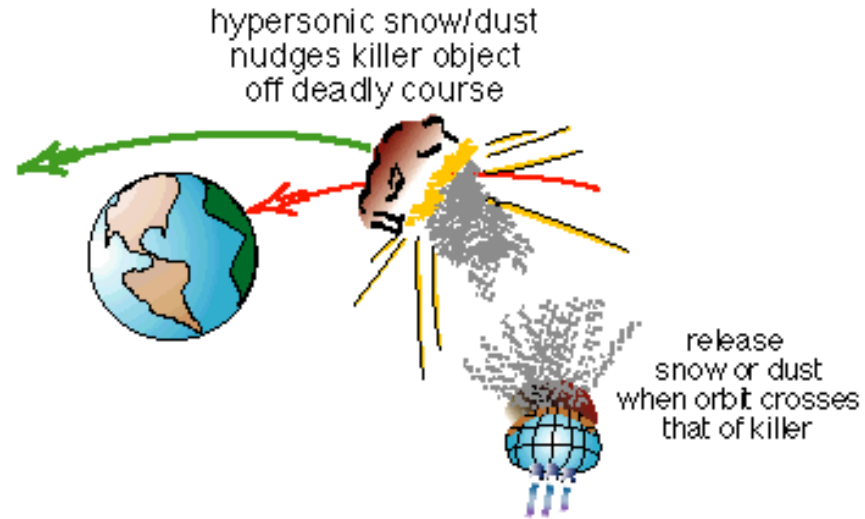
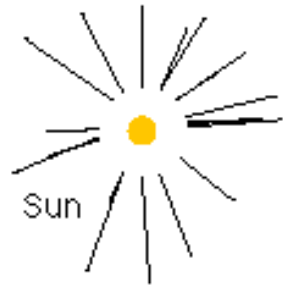
They took me as seriously as they took Johndale Solem. Johndale Solem would hit the asteroid by smashing into it with his rocket.

You think maybe there are not enough comets to assure you that you can find a convenient one?

How about the near earth asteroids? They are much more numerous, and much easier to get to. At least several people at this meeting knew exactly how many there were and just how easy they were to get to.

We were all stupid.

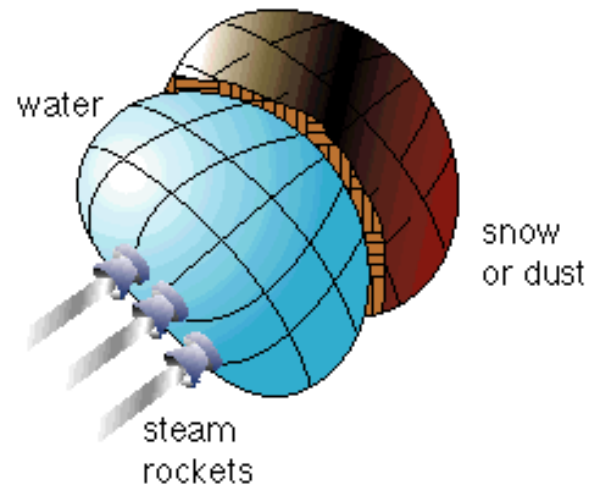
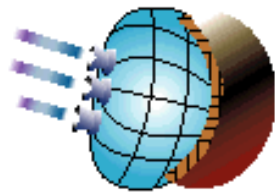
Deflect Celestial Objects by Leveraging NEO Resources

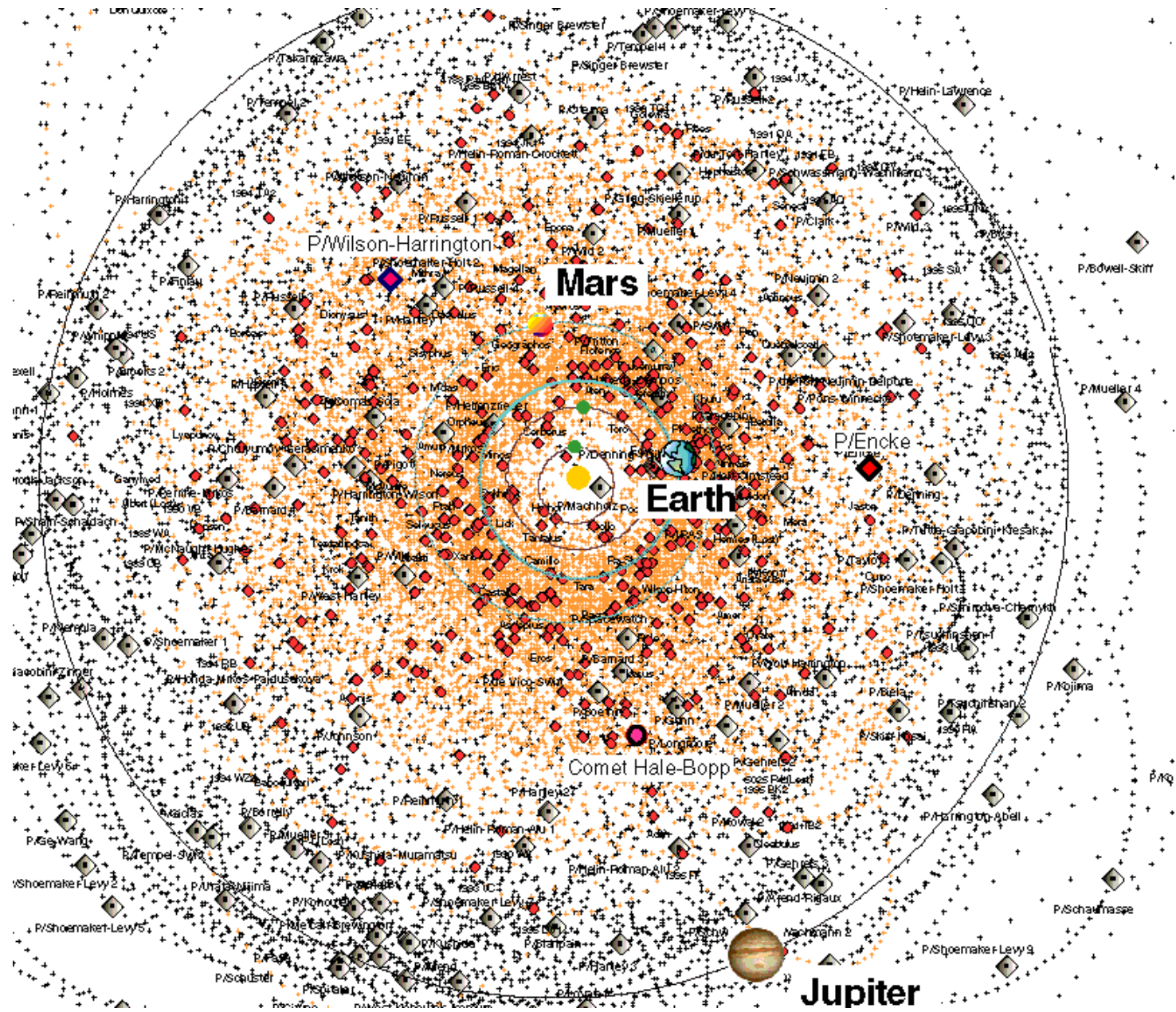


Near Earth Comet

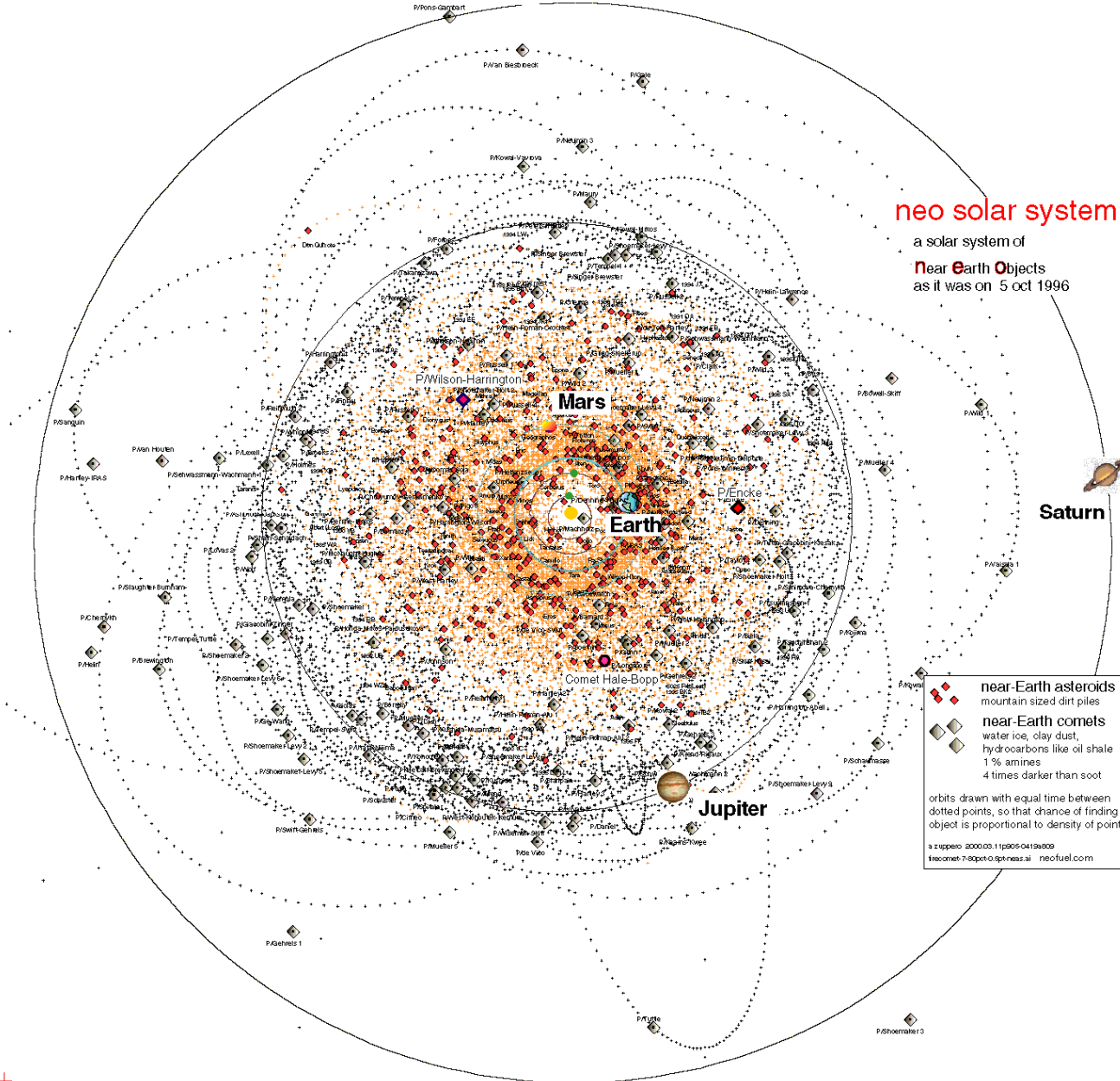
typical makeup:
1/3 water ice
1/3 hydrocarbons
1/3 dust

tanker removes "small," million ton chunk of snow or dust from comet





The space relatively near Earth is filled with near Earth objects, a good fraction of which are water-bearing.



We all failed.

And we could have saved Earth without using atomic bombs.

After everybody told their favorite way to deflect an asteroid, we got together and summarized what we found out. When the report would come out it would say that we might under some conditions be able to move small asteroids from hitting a big city, if we hit the asteroid with atomic bombs.

Bad News: the report also should show how even if we have 5 years notice, we could not deliver a bomb big enough or fast enough to move a 2 km asteroid out of the way. It will hit. Most of us will die.

Supper at Teller's Birthday

It was Edward Teller's birthday. What a coincidence. Glo Helin named a celestial body after Edward Teller for his birthday. I had lunch with Glo and Shoemaker and we ate hot New Mexican green chili, served in a Los Alamos cafeteria. We talked about steam rockets, of course, and how those comets were just not that hard to get to. Shoemaker had calculated it, and would fax me the equations. They both knew there were a whole passel of comets between here and Jupiter, all the time. I never realized there were so many so close.

Glo and Gene understood what I was trying to do.

And that evening, Glo presented Teller with his birthday present.

"People will remember you as a celestial body, in addition to your great accomplishments"

She was so diplomatic.

Since Glo Helin discovered it during 1989, she got to name it. She named it 5006 Teller.

Teller gave a speech that seemed like it was prepared for the occasion. Maybe she told him, maybe not. But he is good at giving on-the-spot speeches.

I talked with him a little after the supper and speech. He thought we should tell everyone our secrets about the atomic bomb. He thought secrets hindered mankind.

I never dreamed I would meet Edward Teller here, or that I would meet someone who worked on a modern day Orion and claims to have made it work.

- **Medusa: the New Dyson Starship of Johndale Solem**

The Medusa Story,

I called it The Solem Sail

"How long will it take before we get an ounce of antimatter?" I asked Jim Powell.

I could make a million bomb Dyson Orion Starship with a million specks of antimatter. And that way Dyson's Orion wont take too many bombs anymore.

We were driving back to Albuquerque after the meeting. I saw white top mountain ranges 20 to 50 miles away any direction I looked. The sky was overcast. I saw red walled, brown walled, and black and white walled pumice and lava plateaus in every direction. If I didn't mind walking 1/2 mile, or 5 miles, then you might say they were everywhere within walking distance. The air was so clear that hillsides 5 miles away looked like they were only a few blocks away.

We could both easily see the trace of the Native Americans before us, the black smoke of their fire pits in the cozy dig outs in the cliff wall of a 300 foot high, pumice plateau.

It took 2 1/2 hours to get to the airport from Los Alamos. When we started on the road to Albuquerque, the horizon stretched out to 150 miles in nearly every direction, and the air was clear. When the sun goes down, the sky would nearly always turn red and painted with splashes of clouds at this time of year. The vastness and color of New Mexico took over. The nearly grassless hillsides by the road sometimes put me to sleep.

Jim Powell and I were talking the entire trip. I started talking about those guys who figured out how to make an Orion Starship. I was telling Jim Powell about the conversation between Johndale Solem, Keith Boyer and me.

This was the Medusa Story.

"We were in the conference room, during the break, just after Johndale's talk. I ran up to Johndale because he talked about atomic bomb propulsion." I said.

"I asked Johndale Solem if he knew about the Orion." I told Powell.

"Johndale Solem was the one who told us about the atomic bomb propelled rocket to move a killer asteroid. He was the one who said

his rocket itself, smashing into the asteroid, was the bomb. Nice idea." I told Powell

"Of course. But it had serious problems." Powell countered,

"Yeah, but Johndale started to get excited, because someone took his atomic bomb propulsion serious." I said.

"His rocket isn't the thing that got my attention. He told me about Medusa" I emphasized. Then I started talking.

I never met the legendary Keith Boyer till now, standing next to us. I only heard of him. I was so surprised to see him in real life. He was so short, so old. I thought he was some imposing figure, from the way people talked about him. This old wise one got all excited when he saw that I understood all the key bomb secrets that make the Orion work. Maybe I used some key phrases that let him know I knew Secret Restricted Data. I don't know. I forget. He could see from my questions that I knew about some details, and that I had figured it.

Keith, Johndale and I started talking about Medusa, the right way to do Orion, right there, on the spot, right by the chalk board of the main meeting room. We stood there and the room emptied. We were all totally focused. We didn't notice we were alone till we were done.

I couldn't help but be focused. Finally, after 22 years of searching, I found the guys who knew exactly how to make space ships go really fast.

Solem had the most amazing way to make atomic bomb propulsion work.

I was telling Jim Powell about this encounter, and not letting him say anything. But Powell wasn't even trying to interject. I think this was the first time he heard the details. Powell had figured Dyson's Orion Starship, too. This was new. He was driving and listening.

"Boyer volunteered and interjected that Johndale had figured it out. Boyer said Johndale did it right, and turned the Orion inside out. Instead of a "pusher" like Freeman Dyson figured, Johndale used a puller.

Dyson would have the bomb go off behind you. Johndale had it going off ahead of you. Figure that one."

I tried to bait Powell into volunteering how in the world that would work. Common sense says that if the bomb goes off ahead of you, it pushes you backwards.

But Powell just kept listening, so I volunteered the answer:

"He's using something that looks like a parachute, but BIG: 1 or 10 miles across."

As I motioned "BIG" with outstretched arms, my left hand nearly hit Powell in the shoulder, and I almost distracted him from driving.

I tried to give Powell a clue. He was still driving, and shook his head once just a little, meaning "No, don't know."

"Jim, you have to imagine what this is like. There is this huge parachute in space, one or five miles across. He has you sitting in this tiny gondola space ship, 10 miles away."

I have one hand open like a parachute, by the right front window of the car. I have my other hand closed like a fist, meaning a gondola, reaching behind Powell into the back seat. This is supposed to show that he and I are very far from the atomic bomb.

"And instead of parachute strings, he used 1 or 20 mile long bungee cords. And instead of a megaton bomb like Dyson did, Johndale uses a 20 ton bomb, tiny. He calls it "Medusa." "

My right hand was a parachute, and my left hand was the gondola, and the motions were of a gondola being yanked by a bungee cord.

"At the end of the parachute bungee cords he has this shielded gondola full of atomic bombs and scared people."

I laughed as I said this. I sure as hell would be scared out of my mind that the bungee cords would snap, or that the bomb would go to full yield and blows up the parachute. Then we would screwed, in space, lost forever.

"A tiny atomic bomb goes off two miles from the parachute. That's way far away from us. The atomic bomb completely vaporizes everything around it, which is only the bomb's parts. There is nothing for miles. This is space. Half the vapor of the bomb parts explodes right into your parachute. The other half blows away into space. "

I am moving my hands like a parachute. I am exploding a bomb with my fingers.

"By the time the exploding plasma atoms and debris hit the parachute they are just fast moving stuff, so they just push it. What's really neat is that don't blow it to bits or vaporize it."

We both understood. That was all there was to it. The bomb goes off behind the parachute. Far enough away so it doesn't melt it. The parachute strings are bungee cords and yank us along.

"The good part of that is that the thing can get up to 50 km per second." I said.

In plain language, that meant one could go to Mars in a few weeks.

We looked at the hills in the distance. The Sandia mountain peak, 30 miles away was just above Albuquerque, which we could not see because it was 1000 feet below the horizon. The Earth is curved that much. But we could see the mountain, so we knew Albuquerque was there.

We could see the mountains over by Socorro, another 50 or so miles beyond Albuquerque. Socorro was a mile below our horizon, again because the Earth was round. But we knew it was there.

We saw Mt. Taylor to the west 50 miles. They mined Uranium there. We could almost imagine the radioactive sparklies sticking to the insides of the lungs of the miners. All we saw is a dark silhouette, because the sun was setting to the west. Down the hill was some green, away in the distance, by the Rio Grande. Everything in between was barren dirt and rocks, and some juniper trees. Once in a while some pinon trees.

We were passing Indian Pueblo's.

"Tiny bombs. The tiniest he can make them." I exclaimed, out of nowhere.

Powell knew what this meant, as if by telepathy.

An atomic bomb almost can't be made smaller than about a kiloton, a thousand tons worth of high explosive. A thousand tons is enough to blow up all the high rise buildings in San Francisco.

"He has to be careful. If he doesn't watch it, he will get a kiloton. Then his parachute and the gondola and everything will get nuked." I joked. Powell laughed.

We both know this was very possible. It's a little like the clutch of a race car, exploding. Every once in a while it happens, it explodes, and blows up the driver, almost without warning, and just when the car and engine is going as fast as it can.

What Johndale and Keith Boyer conveniently forgot to tell me, even though they knew, was that it's too hard to make an atomic bomb that small, 50 tons worth. I knew. It was so hard to keep the bomb from making a tremendous big explosion that about 1 in 20 would accidentally blow up with 1000 tons, or more. But I had listened to them anyway. It was too much fun.

Then Powell defended the concept. "You're 10 miles away in a tiny gondola. You only intercept a very small part of the bomb debris, and the gondola has a shield facing the bomb, so you don't get any radioactivity, either."

"That's pretty clever what Johndale did." I said. "The bomb atoms and electrons and vaporized stuff whacks the parachute but doesn't blow it up. He catches atomic bomb vapor. Then he has a

parachute yank on the 10 mile long bungee cords, with you at the end. Clever."

"And then you start to sling towards the parachute." says Powell.

"Yeah, and if he doesn't hurry up with another bomb, you will fly right through the parachute and break it. Now you're screwed." I shot back.

"So he's tossing atomic bombs out of his gondola towards the parachute. He's got to time each one to go off just when the parachute and you are in the right place." He said

"Over and over, every few seconds or tens of seconds, another yank. This can go on for days. Probably kind of annoying when you try to get to sleep." I said

"He doesn't go that fast. 50,000 meters per second for a space ship. You remember 800,000 was his killer asteroid deflector. That's not going to any star. We can do 10,000 with the rockets everyone back at that Albuquerque meeting wants to make for you, right now." he observed. He was right.

I was calculating on my pocket calculator. He said 50,000 meters per second. How long would it take to go to Mars? It took a few seconds to figure.

"So, to go to Mars can be a 1/2 month trip instead of 3 months? And going to Jupiter is 6 month trip, even using this Solem Sail." I said, looking at the answer on the calculator.

"Well, it sounds exciting. But it takes too many atomic bombs." he said. He was right. I got mad at Dr. Edward Teller a dozen years ago when he said that to me, but he was right.

"Wait. I made a mistake." I exclaimed. "I'm off by a factor of 4." I forgot. If your rocket can go 50 km/sec, and if it has to accelerate till the halfway point and decelerate the other half, the average speed is 4 times less.

"Mars is 70 days." I said. and after changing the distance to figure Jupiter, "and Jupiter is 2 years."

"Well, it's an exciting visual. This is sailing in space, on the wind of atomic bombs." I said.

We were both evaluating. We were both looking at the sky and the horizon, and the 150 mile view. We were passing Indian Pueblo's. They used to live in the best part of town, by the river, on the nearby cliffs. Then we came and pushed them around. Now they make jewelry. We were passing a big silver and turquoise sales building the Indians, Native Americans built.

"I guess Johndale figured the details, Boyer kept checking his work. It's probably right." I said.

This was thought provoking.

"You don't really need atomic bombs. You just need fast moving vapor. Right?" I asked Powell.

"Sure, but how do you get the vapor? You need an energy source." He replied.

"He really wants a smaller bomb." I said.

"If Johndale could find a smaller bomb, his sail would not have to be 10 miles across." I explained.

Powell and I would both like to make the space ship to take people to Jupiter in a year.

"I got plenty of dust, asteroid dirt." I said, out of the blue.

Powell couldn't read my mind that much.

"We have plenty of asteroid dirt. If you toss a hundred pounds of dirt out there instead of an atomic bomb, and then shoot a speck of antimatter into the center of the dirt pile, through a little hole, you get something like a one ton explosion. The dirt gets vaporized." I explained.

"I suppose." he said.

I guess he was not reading my mind. So I asked Jim Powell about antimatter. It would give him a chance to think about it.

Then I explained, what I thought was more clearly, how a dirt and antimatter Medusa would work.

"Antimatter would make real neat micro-bombs, so Johndale would not have to use big atomic bombs and waste most of the fissionable material."

"Oh, yeah." he replied.

Powell understood. The antimatter mixing with a tiny bit of dirt makes pure energy. The energy would vaporize the rest of the dirt. Powell and I both know that to get the bomb to make a nuclear explosion you have to use as much plutonium or uranium as it would take to make a real bomb, enough to blow up a city. You have to choke the bomb to keep it from fissioning the uranium. You end up wasting almost all of the fissionable material.

Assuming he understood me, I went on and on about it.

"With antimatter, I could use a garbage-can-sized ball of dirt, throw a milli-gram, grain-of-salt sized piece of antimatter into it, and it would blow up like Johndale's atomic bomb. That would be antimatter propulsion with dirt for propellant."

"Yeah." he said. I thought his words implied "very good."

What I wanted to know was when will we have enough antimatter to make a space ship? Will it be in my lifetime? Powell knew about antimatter. So I asked him the key question.

"When do you think we will get an ounce of antimatter? Anti hydrogen maybe." I asked.

He started figuring. He was mumbling aloud about something, some friends of his, the rate of their progress. Then he got the answer.

"We will probably be able to do that in 50 or 60 years."

That was too long, too far away. Even my daughters will be old when that happens.

"Keith Boyer was emphatic on how Johndale discovered how it scales correctly." I commented.

We were both a little let down. We both didn't care that much because it would be too far in the future before we could get a ride on a Medusa. Besides, there is no way I'm going on that thing. I don't even go on Disney rides. They totally terrify me.

Boyer told me "The sail thickness stays constant when you make the sail bigger."

I knew that was a profound statement. That meant that if you figure how to make a small one work, then the big one will work the same. Animals DON'T scale properly. An ant carries 20 times its weight. I carry 1/5 my weight. An elephant can't carry 1/2 his weight. Animals don't scale.

"Johndale said 800,000 m/s for one of his machines." I recalled, and said to Jim. We were almost at the airport.

"So, how long would it take to get to Pluto?" he asked, motioning for me to figure it on my calculator. Pluto is 40 times as far as earth, so, about 30 seconds later, "86 days." I said.

"That's not bad. 3 months to Pluto." he said.

"No, wait a minute. I'm off by 4. It's really 347 days. A year." I interjected. I made a mistake.

So, we left it at that. When humans get a few ounces of anti-hydrogen, they can make a bungee cord - mile-across parachute space ship that will take them to Pluto in a year. And they will poop their pants the whole trip, hoping the cords don't break and the parachute doesn't rip.

Steam rockets to Mars seemed more realistic.

- **Griffin says "Jobs", not rocket fuel in space**

"Jobs" said Ms. Senator to the future head of NASA

They want the money, not a Vision to leave the Earth for new worlds. I thought leaders were supposed to bring their Visions to the people and then lead us there. That is not how it works. "... a clear profit ..." he said.

Test Area North (TAN) at the INEL was a bit chilly, but at least winter was finally over. After all, it was May 29 already, 1992. The sky was overcast. A wind was blowing dirt sand at us as we walked from cars to buildings. TAN was about 52 miles north west of town, placed there because the water table was 210 feet down through a few layers of rock and because only the elk and antelope would get irradiated if one of the thick concrete buildings would crack and spill something, or if something blew up.

Dr. Mike Griffin was visiting from Code X, NASA Headquarters, to look over the hoped-for future site of the completely enclosed chamber to test a full scale nuclear rocket. At one of our facilities we showed him a modest sized reactor concrete dome inside of which we would turn on and run the real nuclear rocket. We showed him a whole building made of 3 to 5 foot thick concrete with walls designed to shield radiation.

Griffin was appointed to the Assistant Administrator of NASA for Space Exploration job because of his brazen ability to get things done, as demonstrated on his DOD Star Wars job. Colonel Pete Worden in the White House had something to do with that appointment. He was cocky and confident, rather young and thin, and smart. This was not a good combination in Washington because I sensed he clearly lacked the necessary "treacherous" and "manipulating" character traits.

INEEL arranged for Mike Griffin and I to have some face time at lunch, by having me bring the Blimpie take-out lunch from town. We were waiting for the others to join us and were looking out a doorway window at the dull, grey sky and at the isolation of the mountains off to the west. I was anxious to show Griffin how we at the INEEL discovered something that would make him look good.

"Did you know that there is rocket fuel on Apollo and Icarus?" I asked him.

I took him by surprise.

"Oh," was all he could say at the moment, because I started with the elevator speech immediately.

"It could change everything," I claimed.

"We could bring something back from space, for humans," I said.

I blew part of my speech because I had practiced saying "bring something back for the human race."

"There are these near Earth asteroids that are accessible," I continued.

I blew it again, by not creating the mental picture of a swarm of near earth asteroids in orbits near Earth. He needed the mental picture of these objects flying around space, everywhere, near us. He didn't know what Apollo or Icarus were. He didn't know what "near earth asteroids" meant. "Apollo" was the name of space missions. "Icarus" was a strange word. I blew it again. But I kept going.

I was drawing a little picture on the back of a piece of paper that showed the sun, the earth and a near Earth asteroid which I called "Apollo," and then was pointing to it as I talked.

"We could bring back rocket fuel to Earth orbits." I concluded, successfully executing a badly delivered, short elevator speech.

He looked out the doorway window again, at the mountains and the desolation of the treeless miles in between. He was restless and distracted.

"They don't want rocket fuel," he said with clear and obvious intense frustration.

Not expecting such a strange answer, I was puzzled.

"What do they want?" I questioned.

"Jobs."

"Jobs?" I said, and I became momentarily distracted and looked at the mountains like he did.

"What do you mean, "jobs"?" I asked, a few long seconds later.

"All she cares about is how many jobs she can bring in to her district," he replied, still staring at the distant mountains.

"Who?" I asked.

"Mikulski," he replied.

He meant Senator Barbara Mikulski, Maryland, where the NASA Goddard Space Flight Center is located.

"You mean they wouldn't care about something that could bring back rocket fuel, unlimited rocket fuel that could completely open up space exploration?" I asked.

"No." he replied. He was not terse with me, but he did seem distracted.

He didn't volunteer anything. I found it hard to talk to him because he seemed so distracted.

*I can just puke.
No wonder he's frustrated.
Mikulski thinks we're just jobs.*

*Not something that adds to the nation,
just jobs.*

*Not occupation of the solar system.
jobs.*

*Sucking taxpayer money
for high paying, well educated supporters,
for her campaign.*

I can puke.

We wandered nearer to the meeting room.

My 8 foot dish antenna and my satellite signal receiver a few weeks earlier had picked up a CSPAN broadcast of a congressional hearing. I recognized the hearing room. I had been there. I had also just heard Griffin speak at a recent space meeting. So I stopped to see what was going on. Griffin was on the stand, answering questions. He shot back answers instantly. Crisp answers. The inquisitors could not trap him. He was good.

"I saw you on CSPAN at a hearing," I said, as Griffin was putting money into the candy vending machine while we waited for the others to get back and meet us for lunch.

"You answered them so instantly, like they couldn't hurt you," I continued.

"Uh," he acknowledged, as he banged his hand against the machine, to help dislodge the stuck candy bar.

"How did you *do* that?" I asked.

The he smiled like the cocky young guy from the DOD he was.

"They couldn't ask me a question I didn't know the answer to," he asserted, proudly, not arrogantly, but definitely cocky.

"How did you do *that*?" I asked, now imagining how theatrical, obtuse, manipulating, treacherous and lawyer-like the Congressional Inquisitors can typically be.

"I did my homework," he replied, tersely.

"I knew what I was talking about." he added, which did not give me much more in that direction to talk about.

He impressed me when I saw him on CSPAN, and he impressed me here the way he said "did my homework." I saw why both NASA and DOD wanted him on their team.

He paid me for the meal because NASA could not take gratuities from contractors. I was insulted, because we were *NOT* "contractors." We were a United States Government, Department of Energy, National Laboratory.

I never cashed his \$7 check. I kept it as a souvenir.

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Errors Happen, Plan on it

Don Yeomans error

"The relativistic term made me get an error. I retract the Apollo and Icarus water statements," said Yeomans.

It was late May, 1992. My office was in the middle of the bullpen, inside the secret area and in a room one could only get in with special access. My computer was a MAC SE, complete with connection to a network that included email. This was first class, especially for Idaho. The orange-tinted light fixture provided almost incandescent lighting but without the heat. The fixture took up a lot of room in my small office. It had an 18 inch cube metal box for a base and then the light was some kind of dome bulb almost as big as a zucchini squash, and all somewhat concealed under an 18 inch box about 4 feet off the floor. We had no windows anywhere near us.

I was getting ready to go to a space meeting, "Space 92," and I had my paper on space resources ready to present. Just one more time, checking everything, I called the one person at the Jet Propulsion Lab who was about to publish some data showing that there was water on a near Earth asteroid. I called Don Yeomans to ask him one more time about the find.

But he recanted.

"I'm not going to publish that," he said.

"Why?" I asked.

"I found an error," he said.

"You mean there's no water?," I asked, which was the only thing I wanted to know.

"I don't know about that. But I made an error. The relativistic term made me get an error."

He didn't want to talk about it.

I had just based a space resource paper on there being water on Apollo and Icarus. I based it on Don Yeomans calculation that the orbits of these two objects were slowly changing. Don had concluded that water vapor was slowly squirting from the hot sides of these two near Earth asteroids. The squirting vapor would act like little rockets, and would be moving them ever so slightly, changing their orbits. They would be comets in disguise.

That was just what I wanted. It also fit with what Gene Shoemaker told me, that "Oljato" meant "moonlight water" in some Native American language. Oljato was another, similar near Earth object.

But now, he retracted it. I was lost. Depression started to come over me. The orange light and the tiny computer screen, the Spartan office with no door, open to the others, the drab, 1970's chair and banged up file cabinet all came home to roost. I was stuck in Idaho, frigid Idaho, 1970's Idaho.

Water in space was nowhere close. I was screwed. I told important people about this, too. Like Mike Griffin at NASA Headquarters. Now he would know that I didn't do my homework properly. I would look bad. Very bad.

Nothing counted. If there were no water, if the closest water were some far away place deep out by Jupiter or Saturn, or some comet satellite of Jupiter, then this was too far out. This space steam rocket thing would not work.

And I was stuck here in Idaho.

I had to publish the Space 92 document with simply incorrect statements about any water on Apollo and Icarus.

• **Schmitt Fingernails**

schmitt-fingernails

Bloody Fingernails in Space

The "Space 92" Meeting:

•

I expected space to be wonderful. Instead, space is awful. Horrible. A person can go crazy trapped inside a painful space suit.

Denver was warm, compared to Idaho. The sun was shining brightly. The sky was relatively clear. It was May 31, 1992, and the American Society of Civil Engineers was hosting "Space 92." We were in a standard, somewhat modern convention building, which meant it had hotel rooms, a bigger conference room and a dozen smaller conference rooms. I was ready with my technical paper, even though the particular near earth asteroids I chose were not the right ones. I was ready for making contacts.

The place was full of rocket scientists and space cadets. Meetings were going on simultaneously in several rooms at a time. One had to choose which meeting to go to. I had to choose between meeting people and going to meetings. I chose to meet people.

Rather quickly Buzz Aldrin and I met and he introduced me to Chauncey Uphoff. Chauncey liked solar sails and was all excited about little tiny space vehicles that would perform far better than a rocket. Buzz took care of and fed Chauncey's cat once, and that was how Buzz introduced him. But Buzz earned his Ph.D. in rocket science. He quickly switched us back to solar sails.

The three of us discussed solar sails for nearly half an hour in a seating area in the main area right in front of the main conference room. Uphoff showed how a solar sail would actually beat other kinds of rockets because of the acceleration you might be able to get. Sun power would work. We sat there talking about orbits and flinging through the solar system on sun powered sails. Chauncey said problem was that no one could make the sail.

I didn't get it. Why should Buzz or I become interested in a space transport that can never take an astronaut anywhere? The solar sail would work ok for small things. But when the payload is 5000 tons, the sail would be bigger than an asteroid. Way too big.

Dr. Jim Blacic and Dr. David Vaniman, the Los Alamos scientists who wrote a book on moon resources were there, and I talked with them. I talked with Dr. Robert Zubrin about his way to go to Mars. Dr. Steve Gillette and Dave Kuch were there, trying to find a way to get into the mining and mineral extraction business in space. Steve Howe from Los Alamos was there, working nuclear rockets.

Congress labeled the Mars program the "Space Exploration Initiative," SEI. This was not just about going to Mars. This was about Occupying the Solar System. This should have been exciting. But something was missing, something I could not pinpoint.

I talked with all kinds of people, but not one of them had any money. No one seemed to have the kind of Congressional contacts needed to get the Mars program going. We seemed to be missing the Generals and Admirals of the game. Where were the Big Guys? Where were the important Senators?

All I saw were people with ideas.

The most interesting people were those who had actually been in space, on the moon.

Pry Off His Fingernails

Harrison "Jack" Schmitt, the last guy on the moon, was speaking in one of the smaller conference rooms. The room was the typical smaller dark conference room with no windows and stuffed with uncomfortable, metal fold up chairs. The lights were down but not so much you could not see. The projector light was bright enough to permit reading your notes or a book, if you were bored. Jack Schmitt wore a brown-ish suit and looked just like a boss businessman or a higher level Pentagon official. He was wearing a power uniform. I walked in after he had started and stood in a stalking position by the door.

I was surprised at how few people were in the room. I would expect that the room would be full. Everyone wants to meet somebody who walked on the moon. But there were all kinds of empty chairs, maybe half the room., maybe 3/4 of the room, maybe 40 empty chairs.

He was telling the college kids, young guys it seemed, space professionals and younger engineer types, about what actually happened out there in a space suit and about what it was like inside a space suit on the moon. Schmitt had a Ph.D. in geology and had been a United States Senator. And he was really enjoying talking to young rocket scientists about working on the moon. He was going to tell us all about it.

I expected he was about to tell us how they jumped and hopped around and how much fun it was. I didn't care about that.

"Your finger muscles really get knotted up. Your fingers must really work hard. Being in the space suit is like being inside a fully inflated inner tube. Try bending an inner tube when it's inflated. You're on the inside. Bending it is really hard to do." he explained, clearly, authoritatively.

*I see.
That's why tires work,
why inner-tubes full of air hold up a car without going flat.*

you're inside one.

Never thought of that.

"The reason the space suit looks like that, all puffed up, is that it really is all puffed up," he explained.

He stuck his arms out like we see in the moon photos. Then he bounced them up and down a few inches, still straight out as he explained it.

*I can smell the inner tube
right now.*

*I bet if he farts
he smell it instantly.*

I got the picture and understood the physics. It was 4-th grade simple. The space suit was inflated with air so the guy inside can live. That means the glove for the fingers is inflated, too. So when you want to bend a finger, you have to bend something that is inflated and wants to stay rigid.

*my nose itches.
what if his nose itches,
itches bad?*

what does he do if he sneezes?

*How does he wipe the snot
off the face thing?*

""Your finger muscles get really sore."" He said,
"After "4 hours of doing that, your fingers need a day to rest."

Then he said the fingernails lifted off because the glove wasn't quite correct.

*Did I hear him right?
Torture?*

"My fingernails lifted off, because the glove wasn't quite fitted right to my hand." he explained.

"Didn't that hurt?" someone up front asked.

I piped up from my stalking position by the door and asked him that, too.

"Sure it hurt." he said, without much more thought about it.

Then I asked him before the others did,
"What did you do?"

"What do you want me to do?
Call NASA and ask them to send up another glove?
There's no Kmart up there you know."

He answered just like that, instantly, a wisecrack, a well prepared line.

Lots of people must have asked the same question, because he answered so well and so fast.

When I went up and talked to him after he finished, I asked him to explain in more detail about his fingernail torture experience. I wanted to be able to tell that story to every audience I could.

Aldrin pooped his pants to be allowed to go to the moon.
Schmitt had his fingernails pried off .

I'm not going.

Each meeting with person who actually went to space was a lesson. This time it was
"*Space suits don't work very well and can torture you.*"

Each reality lesson about space, those where we would actually have to live there and experience the lesson, got worse every time I heard one.

Space was supposed to be nice, good, wonderful, great to explore and live in. Instead, every person I talked to who had actually been there had some new set of bad things. Aldrin had to poop his pants to go to space. Grechko the cosmonaut had to breathe the other guy's floating barf.

It was dangerous, too. The rocket guys still don't have a rocket that has made a 100 launches in a row without a crash.

This reality lesson with the one-time Man In The Moon, Dr. Harrison Schmitt, taught me that if your space suit caused excruciating, torture and pain, too bad.

This was bad news.

I just didn't find anything at this whole meeting that would get me excited.

Background

920600 Space 92 Amer Soc. Civ. Engr. Denver 31 may - 4 Jun 92,
aldrin, dr. buzz bini, dr. dante n. blacic, dr. jim cheney,
dennis cutler, andrew hall dewys, dr. jane eberhart, dr.
ralph English, elizabeth erb, dr. r. bryan finn, dr. tom

gertch, richard e. gillett, dr. steve (griffin, dr. mike) happel,
john a.howe, dr. steve jenkins, lyle jones, carleton h. jr.,
keller, rudolf kuch, dave leonard, ray s. mayer, jill steele
nowak, dr. paul s. post, jonathan vos pryke, ian reinhold, dr.
ralph r. sadeh, dr. willy z. schmitt, dr. h. h. jack schulz, jon
sharp, laura spencer, johns s. stuart, dr. james r. sture, dr. stein

takagi, kenji uphoff, chauncey van hofen dr. james d. a.
vaniman, dr. david t. white, wayne n. jr willoughby alan j.
(worden, dr. pete) zubrin, dr. robert

The Asteroid Is a Comet

It was the middle of July, 1992. Idaho was experiencing it's 2 or 3 weeks of summer. My office still had 1970's furniture and Idaho Falls was still in the early 1970's. We had been here in Idaho just about one year. We were still in culture shock.

Nothing was happening at all with SEI and the Mars missions. And nobody knew of any water or ice in space that I could get to. All the water was tied up in space dust.

Mark Sykes and I had gotten together to talk about it. Mark was a Professor at the University of Arizona. I had met him at the San Juan Capistrano meeting when he was passing out beer and making jokes, mocking the meeting that David Morrison was holding. Mark did the analysis of the new, NASA infrared telescope data. He was the one who had the real data on the dust trails of comets and asteroids. He also knew that these objects were concentrated natural resources in space. He was passionate about the near earth objects being valuable.

Mark knew that some of the space dust related to some of the near Earth asteroids had water. It was chemical water, not liquid water. The technical term was "water of hydration," which in plain language meant that one could roast the dust to release steam. He knew there were many near earth asteroids out there where we could do this. I didn't know.

I should have been excited because when we had calculated how much water we could get from just one little near earth asteroid, we got more than enough to send a city to Mars. But I wasn't excited.

Who could be excited by rocks in space? The near earth asteroid crowd of fringe astronomers kept passing me rumors that there were comets and little chunks of comets orbiting around near Earth, and these were ice, real ice. That's what I wanted. But they had not come through with their rumors.

Mark Sykes, Mike Jacox and I decided to tell our colleagues about how we could use these newly discovered space resources, and how to make affordable probes to get there and do prospecting. We prepared a technical presentation for the American Nuclear Society, the "ANS." We picked the ANS because Jacox had a dual mode, nuclear rocket and nuclear electric generator that would power and push the prospecting vehicle around the solar system.

Sykes, Jacobs and I explained how we could get water from near Earth asteroids. We were scheduled to publish it at the Jackson Hole meeting this August, 1992. We were planning to tell the audience of rocket scientists that we could go to near Earth asteroids, roast them in an oven like we use to bake bread or cookies, and water steam would come out.

We would then tell the audience "If we just used the water in the INEL nuclear reactors already designed to use water for the nuclear submarine fleet, why then we would change everything. We would be able to bring back huge amounts of rocket fuel to Earth orbit and fuel an exodus. We would be able to occupy the inner solar system."

Sykes was excited, passionate. Jacox could see a way to get money for prospecting missions that would use his dual mode, nuclear electric generator, hydrogen propellant arc jet thrusters and nuclear heated hydrogen propelled rocket. Jacox was excited.

And, I could see it was going to be a hard life, trying to convince people to visit rocks in outer space to get rocket fuel. Mike Griffin from NASA didn't care because the Senator from Maryland didn't care.

Zuppero, Anthony C; Michael G. Jacox and Mark Sykes, American Nuclear Society, Regional Jackson Hole Conference,

"Bootstrapping Spacebased Infrastructure with Recently Observed Water Objects in the Space Near Earth,"

"Bootstrapping Spacebased Infrastructure for manned and unmanned activities," Nuclear Technologies for Space Exploration, Jackson Hole Wyoming, 17-21 August 1992, Sponsored by American Nuclear Society, Idaho Section, NTSE-92, Vol III, pp 625 - 634

Then Gene Shoemaker called and said "Hey Tony, we just found your ice."

He told me that Ted Bowell discovered that the near Earth asteroid 1979 VA was in fact the same object as comet 4015, "Wilson Harrington." He said it was easy to get to.

Seconds after I hung up the phone I looked up 1979 VA and calculated how accessible it was compared to the periodic comets I had been using. All that mattered were two speeds that quantified the accessibility.

The first speed was how fast the rocket would have to go to leave the comet and change to an orbit that intersects Earth. I called

that the "rendezvous." The second speed was how much the rocket would have to slow down when it got as close to Earth as it could. I called that the "capture."

The near Earth asteroid space scientists had already given me a table of orbital elements for the NEA's. So, comparing 1979 VA to the comets I had been using was as simple as cutting and pasting in a spreadsheet.

Amazing

*1979 VA: 0.1 km/s to rendezvous, 3.0 to capture
compare to Comet P/Finlay: 0.3 rendezvous, 3.8 capture*

Immediately I knew what this meant. It was the most accessible comet known, and it was also accessible. That 3.0 number was like what we would need for a fast trip to Mars.

I immediately ran into Marland's office.

"Shoemaker called. He found the water. 1979 VA is a comet." I blurted out.

That had to be gibberish to Marland, unless he was reading my mind. But, Marland was used to my skipping most of the middle steps, taking giant leaps, assuming the listener has all the key facts I have and is thinking just as fast as I am, and stating just the final answer, so he acted like he knew exactly what I was talking about.

"What's that mean, we can send a buncha people to space? Fuel up your steam rocket?"

he asked, looking up from his MAC and smiling a bit, but not turning his head, and not wanting to let me know I was distracting him right in the middle of his concentrating on something.

"Yeah, probably." I answered.

"Shoemaker said Ted Howell was looking at some past slides of "1979 VA," a near Earth asteroid, so he could get a better orbit for it. When he went back to the Mt. Palomar archives of 1949, he saw it all right, but it had a tail. That meant it was a comet, not an asteroid. When he checked with Brian Marsden at the Smithsonian, sure enough, it was Comet Wilson Harrington. It turned out that Wilson and Harrington had seen it first, so it was named after them, "periodic comet Wilson-Harrington." They had been getting it wrong all these years after 1949 because it didn't show its tail."

"So what's that mean to us?" Marland somewhat interrupted at his first opportunity.

He was typically hardnosed and abrupt when scientists or engineers would bring up something esoteric.

"Well," I started to reply, knowing that I had to find a way to make the mere discovery of water ice something that would translate into money soon. It would take a manned mission to a comet to make a difference. But I plowed on anyway.

"The comet is close. I calculated it's orbit. We can haul a huge payload back to Earth orbit. The is the rocket fuel we've been looking for."

I made my case, I thought.

"Oh, Really." he replied, as he failed to stir from staring at his Macintosh monitor.

He didn't see it yet. I kept talking, mostly because I was so excited, not because I could make a good case for getting money soon. I had to focus. "Focus." I had an instant flashback.

"Focus, focus, focus."

Gary Masters said, back at Sandia.

My boss, he was.

Marland's like that some.

Gotta focus.

"The comet is 1/3 water ice. We heat it with a small nuclear reactor heater."

I pointed to somewhere outside Marland's office. Somewhere out there was a model of a small nuclear reactor heater. It was no bigger than a 30 gallon garbage can. Mike Jacox was selling a reactor that was just exactly that big. It would heat a thermionic electric generator and it would heat hydrogen for a rocket. It would do both. It was a "dual-mode" system. Several of the nuclear rocket people had been part of designing and analyzing the reactor. So, Marland could picture that in his head.

"Then we condense the vapor and get water. We put the water in a rocket fuel tank. We make steam with a nuclear reactor."

Marland could understand that part with no trouble at all, because that is what the INEL had been testing and working with since the INEL started during the early 1950's. The nuclear submarines use nuclear reactors to make steam, run the steam through tiny nozzles next to turbine wheels, and that powered the submarine propellers.

"Then we send it back to earth. When we get here, we turn on the steam rocket again to slow us down and get into an orbit around Earth."

Marland could understand that clearly, because that was exactly what a return trip from Mars would be like. And he was chartered to test the nuclear rocket engines to do that.

"But the payload is huge. 3,000 tons."

Marland had heard me say numbers that large many times. Any number between 1000 and 10,000 was huge compared to anything anyone had launched.

"10,000 tons. 30,000. I calculated that," I added, nearly immediately.

During the San Juan Capistrano meeting about a year earlier I showed Gene Shoemaker and his crowd of killer asteroid buddies how a rocket would do exactly that, bring back a range of payloads. Some configurations brought back 3000 tons. Some brought back 10,000 tons. One huge space truck even brought 30,000 tons at a time from some periodic comet. Only this time with 1979 VA it was far more realistic. Comet 1979 VA was far easier to access. Gene Shoemaker called me and told me because he knew it was far easier to access. Gene Shoemaker had also given me the most accurate orbital transfer equation, to calculate the access delta-V.

Marland could see why I was excited. The payload of the Shuttle was about 26 tons. 3,000 tons was more than about 100 times the Shuttle payload. I finally got through to Marland. He stopped what he was doing. He gave me his full attention.

"Is this real?" he asked.

"If Shoemaker isn't lying to me, it's real." I replied, hedging my bets.

Hesitating, because I did not know for a fact how real it was, I had to rely on Gene Shoemaker. I had been fooled several times before during the last 20 years, by colleagues who I thought were smart and said something I liked and believed, but were wrong.

"This comet is so accessible we could bring as much rocket fuel back to earth orbit as we would ever want. We could occupy the solar system," I replied, losing my focus and getting excited again.

It was an immaturity defect in my personality. I would get excited instead of acting like a leader.

"Are you sayin it's like finding oil?" he said, stopping a bit and trying to generate his own version of the marketing blurb he would have to use to his bosses.

"Well, yeah." I replied.

"I did the calculations. We could bring back 10,000 tons at a time. That's more than what we have launched since the history of space." I continued.

My numbers kept changing. 3000 tons. 10,000. 30,000. I had calculated mission variations that gave each of these. I might have sounded like I had not calculated the payload and maybe was pulling it out of thin air. I started to formulate how to be more specified.

"So it's a big deal?" Marland asked, ignoring the different numbers.

"I think so. It's what I've been waiting for since 1987." I replied.

"So what are you going to do? You gonna make something of it?" he asked.

"I'm gonna try," I replied.

I called Mark Sykes. He got excited and went to his computer. He calculated the orbit of 1979 VA. He put the sun in the middle, plotted the earth's orbit and earth, the comet's orbit, and the comet. Then he sent me the data and a picture.

This is weird.

Must be mistake.

Orbit intersects Earth.

Then I realized why Ted Bowell had been looking at 1979 VA. It looked like it would hit Earth. The comet missed Earth by less than the width of the line used to plot the orbit. That was also why the comet was accessible. Every 4.3 years it would pass close to Earth.

I told everyone I met what happened.

"Hey Chuck, you won't believe this," I said to Chuck Olsen, Dr. Chuck Olsen, nuclear reactor fuels expert.

Chuck's cubicle was across from mine.

"These guys found the water in space to run my steam rocket," I exclaimed, excited.

"Yeah? Where at?" he replied, always smiling, always seeming to be curious.

"On a near-earth comet. They were trying to find a better orbit for this near earth asteroid, and it turned out to be a comet. How do you like that?" I stated.

"Can you get to it?" he asked.

He heard me talking to Gene Shoemaker because his desk was less than 4 feet from mine. He knew it was a comet. He knew enough about comets to know that most are too far away or too hard to get to. And he surmised that "near earth asteroid" meant it was "nearer than a comet."

"Well, yeah. I calculated it. You can bring back a huge payload to Earth orbit. Rocket fuel. Water."

"You gonna do something with it?" he asked.

He also heard me tell Marland I was going to do something. He was curious, because he wanted to make the fuel elements for a nuclear rocket fuel, and he had spent most of his life making steam generator nuclear reactor fuel. He wanted me to win so he could have fun again, making nuclear reactor fuel.

"Oh, yeah. This'll change everything." I asserted.

John Rice's desk was 10 feet from mine. Talking with him for about an half hour, I told John Rice the whole story, from start to finish. John wanted me to succeed because then he could do what

he like, to formulate all the safety related documents and requirements.

Tom Hill had been at the INEL long enough to know that facilities more than anything else determined where new work would go. Building a new facility to do anything always took many years when the government did it. A year to get the money, a year to get the plans approved, a year to get bids from contractors and a few more years to build it. Then add a year or three if the cost seems to be big, because Congress had a habit of delaying it till a better time. So, whoever had the facilities right now would be ahead of the others.

Tom Hill wanted me to win because he knew the INEL had the only facilities where the steam reactor testing could begin right now. All the other work had gone away and the facilities were practically idle.

John Martinell wanted me to win because he loved space. He had spent a year at DOE headquarters working with the people in the Program Office who would work with NASA to spend the money. John wanted to see something really neat happen for mankind, and occupying another planet fit his dream. John was also in charge of some INEL space work.

When I saw Ted Howell, the one who found it, he told me "I was trying to get better orbit data for the near earth asteroids. I went back into the Mt. Palomar records to see if I could get a previous sighting."

If Howell could find out where the asteroid was in the sky a decade or century earlier, with moderately accurate data, then he could put that into his computer and get a much more accurate fix on where the asteroid was moving.

With an accurate fix, he could predict a lot better where it would be in the near future. He wanted to know if any of the NEA's would hit Earth in the next 100 years. The near earth asteroid "1979 VA" had an orbit that came close to Earth.

"I went back into the (Mt. Palomar) history slides and picked out the slide where 79 VA should have been during 1949, and I saw it."

He motioned how he pulled the slide out of the drawer and then did a double-take.

"I said "whoa." I saw the tail and knew it was a comet."

When I talked to Brian Marsden he said "Yes, it was a comet seen by Wilson and Harrington. I don't know why I missed that."

Marsden felt a little guilty that he had not checked to make sure that the NEA orbits were not something others had already found, named and claimed. Marsden was the Director of the Minor Planet Center, Smithsonian Astrophysics Observatory, Cambridge, Massachusetts.

Marsden had a reputation for knowing the details of every comet ever discovered.

Gene Shoemaker introduced me to Alan Harris. Alan had looked at 1979 VA with a telescope.

"I was looking at it. It was always a strange object," he said.

"You mean you were looking at it, you saw it? What did you see?" I asked.

"Well, no. I was using a photometer. I had trouble with it. I thought I was doing something wrong, or maybe something was wrong with the photometer. I kept getting erratic results, unpredictable," he explained.

"So, what was going on?" I asked.

"Well, as soon as I found out it was a comet, everything became clear. We were looking at parts of the comet's tail, something long and wispy, sometimes taking up the whole field of view, sometimes not," he explained.

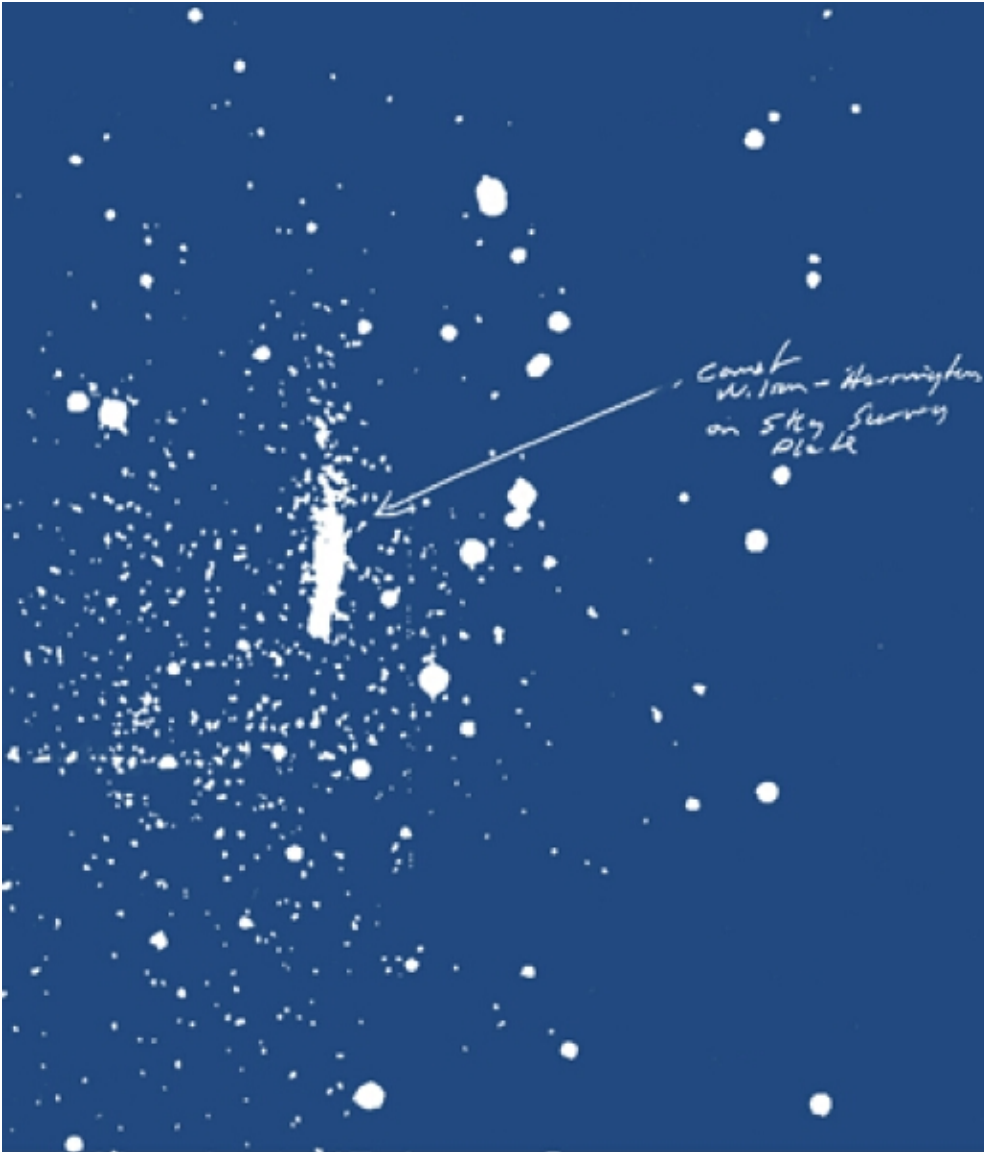
"You were looking at wisps," I mused.

"Are there any more?" I asked.

"Don't know," he said. He didn't much care about using NEAs for anything or about steam rockets, but he was definitely friendly.

Gene Shoemaker faxed a copy of the 1979 VA / Wilson Harrington comet. I showed it to everyone and gave them a story, a story of steam rockets and water and Occupying the Solar System.

Years later I realized: I was stupid. I was calculating how many comets were easy to get to from Earth. All I needed was a gas station to fuel up on the way to another comet. Two steps in stead of one, and the mission would have become simpler. What a shame.



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Near-Earth Comet Hydrocarbon / Rocket Fuel /Resource Candidates

	a	e	i	P	at Earth	V ∞	ΔV rendezvous			ΔV to Capture			
							at comet	Mission ΔV			% over minimum ΔV		
								km/s	lo	med	hi	0	50
neo-comets	A.U.		deg.	yrs		km/s			km/s				
1979 VA #4015	2.64	0.62	2.8	4.3	8.19	0.1	1	3.1	4.64	6.14	3.0	4.50	6.00
P/duToit-Hartley	3.01	0.60	2.9	5.2	8.59	0.6	11	3.9	5.52	7.15	3.3	4.89	6.52
Oljato	2.18	0.71	2.5	3.2	7.65	1.74		4.41	5.74	7.07	2.66	3.99	5.33
P/Tempel-Swift	3.18	0.64	5.4	5.7	8.95	0.5	8	4.0	5.78	7.53	3.5	5.25	7.00
P/Haneda-Campos	3.29	0.67	5.9	6.0	9.12	0.4	4	4.0	5.86	7.67	3.6	5.43	7.24

P/Barnard1	3.07	0.58	5.5	5.4	8.73	0.9	24	4.2	5.92	7.59	3.4	5.03	6.71
P/Blanpain	2.96	0.70	9.1	5.1	9.10	0.6	9	4.2	5.95	7.75	3.6	5.40	7.20
P/Finlay	3.64	0.70	3.7	6.9	9.36	0.3	2	4.1	5.99	7.88	3.8	5.68	7.57
P/Tuttle-Giacobini-Kresak	3.10	0.66	9.2	5.5	9.17	0.5	7	4.2	5.99	7.82	3.6	5.47	7.30
P/Howell	3.15	0.55	4.4	5.6	8.69	1.2	37	4.5	6.18	7.85	3.3	4.99	6.66
P/Schwassmann-Wachmann3	3.06	0.69	11.4	5.3	9.41	0.6	10	4.4	6.31	8.22	3.8	5.72	7.63
P/Hartley2	3.40	0.72	9.3	6.3	9.54	0.5	6	4.4	6.34	8.29	3.9	5.86	7.82
P/Denning	3.80	0.70	5.5	7.4	9.55	0.5	5	4.4	6.34	8.30	3.9	5.87	7.83
P/Wirtanen	3.12	0.65	11.7	5.5	9.42	0.7	12	4.5	6.39	8.31	3.8	5.73	7.64
P/Swift	3.73	0.65	3.0	7.2	9.33	0.8	18	4.5	6.40	8.28	3.8	5.64	7.52
P/Lexell	3.15	0.79	1.6	5.6	9.05	1.1	32	4.7	6.44	8.22	3.6	5.35	7.13
P/Churyumov-Gerasimenko	3.51	0.63	7.1	6.6	9.33	0.9	23	4.6	6.51	8.39	3.8	5.64	7.52
P/Lovas2	3.57	0.59	1.5	6.7	9.07	1.2	35	4.7	6.53	8.32	3.6	5.38	7.17
P/Neujmin2	3.09	0.57	10.6	5.4	9.12	1.2	36	4.8	6.60	8.40	3.6	5.43	7.23
P/Kushida	3.78	0.64	4.2	7.4	9.39	0.9	27	4.7	6.62	8.52	3.8	5.70	7.60
P/Forbes	3.35	0.57	7.2	6.1	9.07	1.3	43	4.8	6.64	8.44	3.6	5.38	7.17
P/Tritton	3.43	0.58	7.0	6.3	9.16	1.2	40	4.9	6.68	8.51	3.6	5.47	7.29
P/Wild2	3.44	0.54	3.2	6.4	8.90	1.5	57	5.0	6.69	8.42	3.5	5.20	6.94
Adonis	1.87	0.76	1.4	2.6	7.13	3.20		5.55	6.73	7.91	2.35	3.53	4.71
P/deVico-Swift	3.41	0.52	3.6	6.3	8.86	1.6	69	5.0	6.77	8.49	3.4	5.16	6.88
P/Kopff	3.47	0.54	4.7	6.5	8.99	1.5	61	5.0	6.80	8.57	3.5	5.29	7.06
P/Clark	3.12	0.50	9.5	5.5	8.90	1.7	75	5.1	6.88	8.61	3.5	5.21	6.94
P/Brooks1	3.09	0.57	12.7	5.4	9.36	1.2	39	5.0	6.88	8.77	3.8	5.67	7.56
P/Tempel1	3.12	0.52	10.6	5.5	9.04	1.5	66	5.1	6.90	8.68	3.6	5.35	7.13
P/duToit-Neujmin-Delporte	3.44	0.50	2.8	6.4	8.82	1.8	80	5.2	6.92	8.62	3.4	5.12	6.82
P/Spacewatch	3.14	0.51	10.0	5.6	8.99	1.6	71	5.2	6.93	8.70	3.5	5.29	7.05
P/Boethin	5.01	0.78	5.8	11.2	10.30	0.4	3	4.8	7.03	9.25	4.4	6.67	8.90
P/Honda-Mrkos-Pajdusakova	3.04	0.82	4.2	5.3	9.07	1.7	74	5.2	7.04	8.83	3.6	5.38	7.17
P/Tempel2	3.11	0.52	12.0	5.5	9.19	1.6	67	5.2	7.07	8.90	3.7	5.50	7.33
P/Biela	3.53	0.76	12.5	6.6	10.02	0.7	16	5.0	7.09	9.21	4.2	6.37	8.49
P/Harrington	3.58	0.56	8.7	6.8	9.37	1.5	59	5.3	7.18	9.08	3.8	5.68	7.58
P/Kohoutek	3.54	0.50	5.9	6.6	9.02	1.9	89	5.5	7.24	9.01	3.6	5.33	7.10
P/Tsuchinshan1	3.54	0.58	10.5	6.6	9.53	1.4	50	5.3	7.24	9.19	3.9	5.85	7.80
P/Denning-Fujikawa	4.33	0.82	8.6	9.0	10.23	0.7	13	5.1	7.27	9.46	4.4	6.60	8.79
P/Giacobini	3.54	0.59	11.4	6.6	9.63	1.3	46	5.3	7.29	9.27	4.0	5.96	7.94
P/Wild4	3.36	0.41	3.7	6.1	8.55	2.5	114	5.7	7.32	8.94	3.2	4.86	6.48
P/Tsuchinshan2	3.60	0.50	6.7	6.8	9.13	1.9	88	5.5	7.35	9.16	3.6	5.44	7.25
P/Schaumasse	4.07	0.70	11.8	8.2	10.23	0.8	19	5.2	7.37	9.56	4.4	6.59	8.79
P/Brooks2	3.62	0.49	5.5	6.9	9.06	2.0	96	5.6	7.37	9.16	3.6	5.36	7.15
P/Faye	3.78	0.58	9.1	7.3	9.58	1.5	56	5.4	7.39	9.36	3.9	5.91	7.88
P/Schorr	3.54	0.47	5.6	6.7	8.95	2.1	102	5.6	7.39	9.14	3.5	5.25	7.00
P/Swift-Gehrels	4.39	0.69	9.3	9.2	10.15	0.9	25	5.2	7.39	9.56	4.3	6.51	8.68
P/Takamizawa	3.74	0.57	9.5	7.2	9.58	1.5	58	5.4	7.40	9.37	3.9	5.90	7.87
P/Shoemaker-Levy7	3.56	0.54	10.3	6.7	9.47	1.7	72	5.5	7.45	9.37	3.9	5.78	7.71
P/Kowal-Mrkos	3.77	0.48	3.0	7.3	9.05	2.1	101	5.7	7.49	9.27	3.6	5.36	7.14
P/Schwassmann-Wachmann2	3.44	0.40	3.8	6.4	8.62	2.6	123	5.9	7.50	9.14	3.3	4.92	6.56
P/Reinmuth2	3.53	0.46	7.0	6.6	9.02	2.2	108	5.7	7.50	9.27	3.5	5.32	7.09
P/Giclas	3.65	0.49	7.3	7.0	9.19	2.0	98	5.7	7.53	9.36	3.7	5.50	7.33
P/Bus	3.49	0.37	2.6	6.5	8.57	2.8	130	6.0	7.64	9.27	3.2	4.87	6.50
P/Reinmuth1	3.76	0.50	8.1	7.3	9.36	2.0	97	5.8	7.70	9.59	3.8	5.67	7.56
P/Shoemaker-Levy2	4.42	0.58	4.6	9.3	9.71	1.7	73	5.7	7.71	9.72	4.0	6.04	8.06
P/Mueller2	3.50	0.41	7.1	6.6	8.87	2.6	124	6.0	7.77	9.49	3.4	5.17	6.90
P/Helfenzrieder	2.66	0.85	7.9	4.3	8.93	2.6	120	6.0	7.79	9.53	3.5	5.23	6.97
P/Shoemaker-Levy4	3.49	0.42	8.5	6.5	8.99	2.5	116	6.0	7.79	9.56	3.5	5.30	7.06
P/Gale	4.95	0.76	11.7	11.0	10.71	0.7	14	5.4	7.80	10.17	4.7	7.12	9.49
P/Harrington-Abell	3.86	0.54	10.2	7.6	9.68	1.8	83	5.8	7.84	9.84	4.0	6.00	8.00
P/Spitaler	3.69	0.42	5.8	7.1	8.99	2.6	119	6.1	7.85	9.62	3.5	5.29	7.06
P/SingerBrewster	3.46	0.41	9.2	6.4	9.01	2.5	118	6.1	7.86	9.64	3.5	5.32	7.09
P/Helin-Roman-Alu2	4.07	0.53	7.4	8.2	9.56	2.0	95	5.9	7.87	9.84	3.9	5.89	7.85
P/McNaught-Hughes	3.56	0.40	7.3	6.7	8.93	2.7	128	6.1	7.88	9.63	3.5	5.23	6.97
P/Russell4	3.51	0.37	6.2	6.6	8.72	2.9	138	6.2	7.90	9.57	3.4	5.03	6.70
P/Metcalf-Brewington	3.92	0.59	13.0	7.8	10.10	1.5	64	5.8	7.98	10.13	4.3	6.45	8.60
P/Neujmin3	4.83	0.59	4.0	10.6	9.90	1.8	79	5.9	8.01	10.09	4.2	6.24	8.32
P/Kowal2	3.44	0.56	15.8	6.4	10.06	1.6	68	5.9	8.01	10.15	4.3	6.41	8.55
P/Jackson-Neujmin	4.14	0.65	14.1	8.4	10.44	1.2	41	5.8	8.05	10.32	4.5	6.82	9.10

P/Shoemaker-Levy6	3.85	0.71	16.9	7.5	10.71	0.9	28	5.7	8.05	10.42	4.7	7.12	9.49
P/Cifreco	3.74	0.54	13.1	7.2	9.90	1.8	82	6.0	8.06	10.14	4.2	6.24	8.32
P/Kojima	3.95	0.39	0.9	7.8	8.97	2.9	135	6.4	8.13	9.88	3.5	5.27	7.03
P/Grigg-Skjellerup	2.96	0.66	21.1	5.1	10.63	1.1	34	5.8	8.14	10.48	4.7	7.03	9.38
P/Perrine-Mrkos	3.56	0.64	17.8	6.7	10.55	1.2	38	5.8	8.16	10.47	4.6	6.95	9.26
P/Lovas1	4.36	0.61	12.2	9.1	10.30	1.5	63	6.0	8.19	10.42	4.4	6.67	8.89
P/Shajn-Schaldach	3.83	0.39	6.1	7.5	9.04	2.9	137	6.4	8.21	9.99	3.6	5.34	7.12
Ceres	2.77	0.08	10.6	4.6	7.33	4.53		7.00	8.23	9.46	2.47	3.70	4.93
P/Bowell-Skiff	6.27	0.69	3.8	15.7	10.54	1.3	45	5.9	8.25	10.56	4.6	6.94	9.25
P/Shoemaker3	6.59	0.73	6.4	16.9	10.78	1.1	33	5.9	8.30	10.69	4.8	7.20	9.59
P/Gehrels2	3.98	0.41	6.7	7.9	9.24	2.8	131	6.5	8.33	10.17	3.7	5.55	7.39
P/Klemola	4.92	0.64	10.9	10.9	10.48	1.5	55	6.1	8.34	10.63	4.6	6.86	9.15
P/Harrington-Wilson	3.43	0.52	16.3	6.4	10.03	2.0	93	6.2	8.35	10.48	4.3	6.38	8.51
P/Arend-Rigaux	3.60	0.60	17.9	6.8	10.53	1.5	60	6.1	8.43	10.74	4.6	6.92	9.23
P/Vaisala1	4.89	0.63	11.6	10.8	10.52	1.5	62	6.1	8.44	10.74	4.6	6.91	9.21
P/d'Arrest	3.44	0.62	19.4	6.4	10.69	1.3	48	6.1	8.45	10.82	4.7	7.10	9.47
P/ComasSola	4.26	0.57	13.0	8.8	10.26	1.8	84	6.3	8.46	10.67	4.4	6.62	8.83
P/Shoemaker-Levy5	4.22	0.53	11.8	8.7	10.04	2.1	100	6.4	8.48	10.61	4.3	6.39	8.53

- **First INEL papers on steam rockets, and the White house 3 times**
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on 1979 VA

Telling About The Water In Space

This was a rocket science meeting, a *nuclear* rocket science meeting.

It was August 17, 1992, and it was a normal, cold summer day in Jackson Hole, Wyoming. Mountains above us, hid the east and west horizons, making Jackson Hole a cold place all the time. The ski slope trails were easy to see because they looked like the mountain had been given a shave. The green grass and the gray rocks looked nice together as a color combination. The ski lift was taking regular people up to sight see. A constant stream of busses were arriving at the Snow King hotel to bring the rocket scientists, *nuclear* rocket scientists.

Down the street a mile or so my motel shared the parking lot with a convenience store that sold 190 proof grain alcohol. Full sized pickup trucks with waist-high, foot wide knobbed tires and 30 year old, thin, mostly clean shaven males in jeans, spotless cowboy boots and an unwrinkled cowboy hat driving them seemed to be as common as pigeons in Cleveland. Humiliating to Americans, tourists speaking Japanese or German dominated the downtown sidewalks leading to stores with high-priced toys and trinkets, like a full sized head of a real Moose. The expensive knife store also sold full power pepper spray, illegal in California, and knives that would be illegal in many countries. Expensive art and jewelry stores seemed to be prospering.

The American Nuclear Society was holding a meeting here, at the Snow King Hotel and convention center. Dr Dave Buden had a large say in having it here. He liked Jackson Hole as much as we did. And it was only about 1 hour and 50 minutes from Idaho Falls, if you went 20 miles per hour over the speed limit on the first 60 mile stretch.

This was a no-mistakes-allowed, rocket science and nuclear reactor meeting. Only nuclear physicists, rocket scientists and known, high grade engineers were allowed here. Every technical paper had to be reviewed by at least one expert to make sure everything was all real and correct.

Mike Jacox and I prepared a technical paper to tell the world how our nuclear energized rocket and electric generator device would enable Space Exploration. We meant exploration by robots, not people. People explorers were NASA business. We were Department of Energy. We were looking for more energy resources for the United States.

Exploration", pages 76 thru 86, Volume I, NTSE-92, Proceedings of the American Nuclear Society Topical Meeting on Nuclear Technologies for Space Exploration, 16-19 August, 1992, Jackson, Wyoming, ISBN 0-89448-174-6, ANS order Number 700177

Mark Sykes, Mike Jacox and I had also prepared a technical paper describing how two magical things happened: 1. we found rocket fuel in space near Earth, on the asteroids and near earth comets, and 2. we found out how to use a steam rocket to develop a space-based infrastructure.

I did not know what "infrastructure" meant.

Zuppero, Anthony C, Michael G. Jacox and Mark Sykes, American Nuclear Society, Regional Jackson Hole Conference, "**Bootstrapping Spacebased Infrastructure with Recently Observed Water Objects in the Space Near Earth,**" Nuclear Technologies for Space Exploration, Jackson Hole Wyoming, 17-21 August 1992, Sponsored by American Nuclear Society, Idaho Section, NTSE-92, Vol III, pp 625 - 634

I never liked the title. It was supposed to say we discovered something that would enable a human Exodus to Space. Instead, it used anti-exciting, sleep-inducing words like "bootstrapping," "Infrastructure" and "Spacebased."

*"Infrastructure?"
What's that mean?
Why do I care about that?
Sounds bureaucratic to me.*

Mark Sykes knew what infrastructure meant. It meant things like roads, bridges, electric power, sewer lines. Without those, nobody lives there or does anything there, wherever "there" refers to. Tom Hill knew what infrastructure meant. "Facilities that already exist and you don't have to build them" he told me. But I thought this was just a lot of social studies stuff.

If I were to have read that title, I knew I would never read the technical paper. I stop for titles that declare in subtle ways that something new and exciting is going on. This title did not, and there was not much I could do.

Three of us together wrote it. I wrote about how the steam rocket would haul huge payloads back to Earth. Sykes wrote how wonderful that would be. Jacox wrote how to get there earlier than 2 decades from now with his rocket. Sykes wrote the title.

That was the plan.

A New Water Rock in Space

Totally unexpectedly, Gene Shoemaker had called just before the meeting with an unexpected discovery of an almost black comet, a water ice object, that almost touched Earth's orbit every 4.2 years.

This could be epochal, we all thought.

So, we changed our story. We included the monumental discovery of the Comet 4015 Wilson Harrington, lately known as Near Earth Asteroid Rock In Space "1979 VA".

We were about 3 months too late to change what had already been printed in the official proceedings. So the permanent record in history didn't have the discovery written of the 1979 VA written into it. It only had some near Earth comets and asteroids listed.

We pestered everyone we could with a picture, a viewgraph, showing that near earth comet. I told everyone I came across of the discovery. That was worth something.

Billion Watts in a Garbage Can

I thought this was supposed to be a conference of no-mistakes rocket scientists. But in the technical session where I would speak, Robert Bussard presented a technical paper on how to make a fusion rocket. He was proposing a nuclear fusion rocket that would generate a billion watts and would use fusion power.

It was OK for this meeting that for the last 20 years no one had been able to make the fusion device he was proposing. If anyone could succeed, it would generate a billion watts in a device the size of a VW bug or large garbage can.

But this rocket seemed crazy. The crazy thing was that he was trying to dump 100 million watts of waste heat in to something the size of a garbage can. It would totally vaporize within one second of when he would turn it on. He must have been a physicist.

No one seemed to notice that his reactor was only 90% efficient. That meant 90% of a billion watts was going out the back of the rocket, pushing it. That would be really wonderful.

All I saw as he was talking was that the remaining 10% was left over. That would be 100 million watts, for making rocket parts vapor.

My mother, who got C's for most grades in high school during the 1930's could figure this one out. Well, maybe not, but this is NOT rocket science.

This was crazy. The conference organizers put me in with him and other outlandish concepts. They must have thought we were quacks.

Tossing Small Planets into Big Planets

Another thing seemed to be crazy.

Dr. Robert Zubrin was the featured lunchtime speaker. He showed how humans could transform Mars into a place like Earth, in less

than a few hundred years. Transforming Mars into another Earth was not so bad an idea, I thought.

Then he showed that to do that he would need to go out past the planet Pluto, grab a small planet that had a lot of ammonia on it, like an asteroid or comet, and send the entire small planet smashing into Mars.

After the spectacular collision in space, the dilute whiffs of ammonia would permeate the Martian atmosphere, and it would start to warm.

He showed a convincing curve on how just a little added ammonia on Mars would cause Martian Global Warming. On Mars, that would be nice, because Mars was typically minus 100 Celsius or Fahrenheit, and the hottest known place on Mars was 37 Fahrenheit.

But when I took out my pocket calculator to figure how big an asteroid he would have to grab, and how much more enormous a rocket it would take to move that asteroid, it was outlandish.

It was like something I would propose.

The whole speech was just entertainment.

Radioactive Dinner Plates

That wasn't all. The lunchtime speaker was an antique collector. He told us how that orange Fiesta ware old fashioned ladies liked was radioactive. That popular orange color came from Uranium compounds in the glaze.

The law said that we could own Fiesta Ware. But if we broke a plate, we could not just throw it away. It then came under the Anti Evil Radioactivity Environmental Protection Laws.

You have to bring your broken plate to the government for proper treatment and disposal.

Wyoming Affair

About the only good thing I can say about the conference was that the night before I had to present my technical paper I got to spend a small slice of the evening at a country western bar in downtown Jackson Hole with June Cutlass, one of Dave Buden's secretaries, and about 10 rocket scientists who were also trying to sit next to her.

June was pretty. She was nice. She was single. She was sharp and smart. I liked her. She smiled at me a lot.

I bought her three, high quality booze drinks, and then we danced country western a few times, which she had never done before. She wanted to learn how, and I was Aspie enough to focus entirely on showing her how to dance Country. Then we talked and talked.

However, there was no cheek-to-cheek dancing, even though I kinda wished for it with crossed fingers behind my back. That would have been too distracting and wishful thinking, and she would not dance cheek to cheek with an old guy.

I left her with the 10 other gawker geeks more her age who were sitting with us, waiting for their turn. I left for my motel room early,

10:30 pm, because I had to be fresh the next day to tell our Monumental Discovery story of Water In Space.

Next day she bragged to me she got to stay up till 3 am, cavorting in public with some of the young rocket scientists.

Bastards. If she and I were not both innocents, I would not be telling.

The evening with June was the only good part of the whole American Nuclear Society meeting. Nobody cared about our water rockets or anything else we did or said.

It was *supposed* to have been the announcement of “How to Start the Exodus into the Solar System.”

World Space Congress

It was the first of September in Washington DC. I always liked Washington DC, especially when it was cool but not cold, warm but not hot. Our conference was in some safe and busy part of the city where most of the buildings looked glassy, and shiny new. The people on the street walked somewhat slowly and dressed like retired government workers. An old stone church with green mossy stones and perfectly manicured grounds was less than a block from the convention center. The church had no parking lot, so I wondered how they managed to get any visitors.

I did not know where I was. I never did learn where I was in Washington. The cab driver always knew.

We were here for the rocket science. This was the World Space Congress meeting, 1992. Originally, I had put together a paper for

the meeting but had decided not to go. It was not such an important meeting, I thought. How would I convince Marland Stanley to pay for an expensive hotel, airplane ticket and meals to Washington, just to talk about space resources?

When Gene called telling us about the comet close to Earth, suddenly the World Space Congress was a good thing. We could tell the world about the discovery.

It was too late for me to get my name and paper into the official proceedings. But, I had an official paper number and an official cover, and I had an official place on the reprint table where people could buy a copy of what we said. I took 150 copies of our paper with me.

IAA-92-0159

**World Space Conference
Institute for Astronautics and Aeronautics
Washington DC
Aug 30 - Sept 2**

Near Earth Object Fuels (neo-fuels): Discovery, Prospecting and Use

**Anthony C. Zuppero
Michael G. Jacox
Idaho National Engineering Laboratory
August 25, 1992**

[[see this at <http://www.neofuel.com/WSC92>]]

I didn't expect I to see very many rocket scientists at this meeting. I did know Dr. Mike Duke of NASA, who was the chairperson for the session where I would tell of the comet and its water and what it would mean.

Dr. Ted Fay and his boss Stan Schneider were there. They surprised me because I thought I would not know anyone there. Stan was a boss at MacDonnell Douglas, at the facility where the Space Station was being put together. I had met Stan before.

They were here looking for money. DOE money. NASA money. DOD money. They were desperate. The Berlin Wall had fallen and it was still down. The Aerospace and the Military Industrial Complex were still bleeding. Almost nobody in Congress wanted to pay for the Space Station. Government money to do anything in space was going away.

Ted Fay had promised me they would find me some ice near Earth, during our first meeting in La Jolla. Ted was very happy to hear they really did find me my ice. He liked that the famous Gene Shoemaker personally told me immediately about 1979 VA and that it was a comet. Ted Fay made the best of the ticket to Washing

DC: he brought Ann, his wife, and Aaron, his son. This was part vacation for them.

His boss, Stan Schneider offered to help me make a good speech. We rehearsed it, over and over, aloud, in my motel room. He timed me to make sure I kept within my limit, and told me where to emphasize what. We practiced.

When I gave the presentation, it went exactly as planned. This time, there were no bureaucrat words like "infrastructure" in the title. I made sure I told the audience that there were two discoveries, and that the discoveries would change everything.

My technical paper clearly told the reader that something monumental had happened:

Discoveries

Active Comet & Enabling Propulsion

Two discoveries came to fruition this year. Astronomers discovered a rocket propellant/fuel object in the space

near Earth. And engineers discovered a simple means to bring the materials back to Earth orbits.

The whole time I talked I saw Mike Duke, the chairperson, smiling. He didn't remember smiling when I later told him he was. But, he seemed to like what we said.

No one cared.

No one came up to ask me about it. No one seemed to get the story, the picture, the message that we found rocket fuel in space, and that we found a way to use it cheaply. What was I doing wrong?

Everyone I personally told the story loved it. They helped me tell it. Even people from MacDonnell Douglass went out of their way to help me win.

Nothing was working.

I had to do something. Anything.

Meeting people, as many people as I could, seemed to be the right thing to do. So, I did.

I always kept a record of who I met, indexed by date:

19920901 WSC92: World Space Congress, 1992, adamson, sandra lee, nss vp auchampaugh, george lanl bicos, andy bodreault, richard, acta astronautica broadhead, william s. brotherton, david f. brown, alan m, bynum, frank miami u cantrell, james n usu balloon mars Clark, ben cohen, edward d. ball collins, john saic schauburg **duke, jackie u of tx cartilage 0 g bad, duke, mike & carrol** edberg, donald, fay, ted, ann, aaron fuhrman, robert aiaa pres garvy, john goulard, jacques hamer, john harris, phil hopkins, mark space cause jochmann, horst, jones, ron, kilmer, charles p landis, jeff lenorovitz, jeffrey m, av. week maryniak, greg, olson, william bill p, ph.d vp mdssc huntsville rappaport, carl. s. reichert, rudi g dornier sadeh, willy schneider, Stan sforza, pasquale m. ph.d. slobodrian, dr. r. j. stephenson, david g gs of canada strine, linda hull tischler, marc valdez, robert velosa iii, alfonso al watson, stewart d, ion eng. wickwar, vincent b usu winisdoerffer, francis, wood, clarence woody ball yeomans, don

We are the Wrong Species

"We humans will be "superman" when we get to live in zero G."

As I started to listen to a special NASA session, that's what I thinking.

That's what I actually believed. I expected that people associated with NASA would be talking about how we would all be able to go to space and live there. That was my vision.

Many NASA rocket scientists were here. I felt I should listen to at least one of them.

Dr. Jackie Duke of University of Texas talked about experiments with growing cartilage in zero G. She described how it did not grow the way it was supposed to. It wasn't working because the cartilage didn't know which way was "up", so it grew every which way.

Dr. Duke was thin, sharp looking, very professionally dressed, alert, assertive, confident, and definitely smart. She was almost intimidating.

Everything she said about our kind of life in zero G seemed to be bad news. I could not believe it. She showed several slides of good cartilage and space grown cartilage. All the space growth was wrong, bad, malformed, mixed up.

After she finished with her rather medical presentation, I went up to her to make sure I got the bad news accurately.

"Did I hear you right?
Cartilage doesn't grow in space?"

"Yes, that's what I see." she replied.

"That means we will never get to space.
we are the wrong species." I concluded out loud.

She was horrified, startled, taken back immediately.

"No! We will evolve." she blurted out, after halting due to the shock I jolted her with, stating we are the wrong species.

I got her card, but was distracted at what she said.

Duke, Jackie Dr. Pauline, 71 792 4161, FX 5258, Asst.
Prof. Dental Sci Inst., U of TX Dental Brch, Health Sci.
Ctr. HSC, PO 20068, Houston TX 77225, cartilage 0
g bad, Hubbard, Verna Histology, WSC92

For the first time, I realized something was wrong. I was perseverating about it.

*bad news.
we need to evolve,
or we can't live there.*

*we are the wrong species
for space.*

I wandered away somewhat lost. Not only did no one care about the discovery of immense quantities of rocket fuel, enough to start an Exodus of Mankind into the Solar System, but we are the wrong species.

There is nothing I can do about me being the wrong species.

Visiting Headquarters

Marland paid my ticket partly using the excuse that I would visit the Department of Energy Headquarters people.

I met the crew of middle level bureaucrats who told us what to do every chance they got. It was their job.

John Warren was our direct "boss." He acted like a classic bureaucrat. He did not reveal any expert knowledge about anything, but he was in charge of our money and of what we did.

Then I met Bob Lange and Wade Carroll who were in charge of related DOE work. They were smarter. They wanted to get things done. But they were not interested in our rockets. That was John Warren's job.

Our "boss" was worthless. So was my trip to "NE 50."

Apparently, so was the trip to the World Space Council.

On the good side, I got to be the first to talk about the discovery of the near earth comets relative to space travel.

On the other hand, absolutely nobody cared, and bureaucrats were in charge.

My very own trip report on this trip is a great example of what people call "spin". It is a classic. It says everything is wonderful, even though we are the wrong species and nobody cared about our monumental discoveries. It follows.

19920901 WSC@NE52 carroll, wade fay, ted helms, ira
houts, mike lanl lange, bob mastal, edward reichert,
rudi g. schneider, Stan warren, john weitzberg,
abraham, ph.d. nus

INTEROFFICE CORRESPONDENCE

Date: September 9, 1992

To: M. L. Stanley, MS 3413

From: A. Zuppero, MS 3413

Subject: WORLD SPACE CONGRESS & RELATED PRESENTATIONS TRIP REPORT

Attached, you will find the trip report for the World Space Congress Presentation and the related contacts and presentations occurring during the week 31 August through 4 September, 1992, at the Convention Center, Washington DC. Attachment 1 is the trip report. Attachment 2 is a copy of the paper presented at the World Space Congress. Attachment 3 is a copy of the Draft paper for the Small Satellite Conference, which was handed out to NE, DOE and SDIO contacts.

If you have any questions, please contact me at 526 5382. Thank you.

acz

Attachment:
As Stated

cc:

Buden, Dave
Jacox, Michael G
Madsen, W. W.
Martinell, Z. John
Olsen, C. S., MS 3413
Olson, Tim
Ramsthaler, Jack
Rice, J. W. Jr., MS 3413
Struthers, R. D., MS 3413
Watts, K. D.
Zuppero, A. C. File
Central File, MS 1651

World Space Congress Meeting
Washington DC
Trip Report
31 August through 4 September 1992

Summary

INEL presented a paper at the World Space Conference describing the recent discovery of rocket fuel sources in the space near Earth. We were invited to publish this work in *Acta Astronautica*, immediately after the presentation. Aviation Week copied two of the viewgraphs and indicated they would cover the topic in the upcoming issue.

We presented concepts for neo-resource prospecting, assay and sample return missions using 200 watt and 20 kW electric nuclear electric propulsion technologies to Wade Carroll, NE-52, to Bob Lange, NE-53 and to Fred Tarantino of SDIO.

We consulted with the Office of Space to ascertain how to best promote DOE interests. Dr. Ed Coomes, Dr. Tom Finn and Bob Waldron all offered suggestions, which focused on close ties with NASA JSC and JPL.

McDonnell Douglas Space Systems Company (MDSSC) representatives accompanied us on most of the visits and provided independent, industrial verification of the validity and practicality of INEL concepts. MDSSC offered to inform legislative and DOE/NASA/DOD/SDIO contacts on the details of the INEL concept.

Ball Aerospace offered to help promote the concept. They have provided small satellites and space object exploration systems for over 2 decades. They have been involved in the neo-resource topic as long as it has been around. They also offered to inform both the legislative branch and DOE/NASA/DOD/SDIO of the details and benefits.

Department of Transportation "Deputy Assistant Directors" were contacted at their booth at the conference, to see if there were any areas of mutual interest.

1. Presented paper at World Space Conference,

Zuppero, Anthony C & Michael G. Jacox, "**Near Earth Object Fuels (neo-fuels): Discovery, Prospecting and Use,**" 43rd Congress of the International Astronautical Federation, 28 August through 5 Sept., 1992, Washington DC, paper # IAA-92-0159.

Dr. Ben Clark, session Co-chairman indicated they gave our paper very high marks. Immediately after the presentation Dr. Richard Boudreault, Chairman of the session, requested that we reformat this talk for immediate publication as an **invited paper in *Acta Astronautica***, where he is the Editor.

Aviation Week: Jeffrey M. Lenorovitz, Senior International Editor, Aviation Week, listened to the presentation, asked questions, took copies of two viewgraphs and indicated he would put the story in the next issue.

William S. (Bill) Broadhead and David F. Brotherton, Legislative Assistants to Idaho Congressman Larry LaRocco, and Shana Dale, Special Staff assigned to Congressman Ron Packard on the House Science, Space and Technology (Authorization) Committee each obtained copies of the paper and had a short conversation with us. Ms. Dale indicated that Cong. Packard would very much like to know of the recent developments. Broadhead and Brotherton recognized this as the same as the front page INEL article in the recent Idaho Falls Post Register.

The National Space Society offered to publish an article on the INEL near-Earth comet resource topic. They publish "Ad Astra," a glossy magazine advocating space. They have an active lobbying team. Sandra Lee Adamson, a Vice President of the society offered to help get political support.

We informed Francis Alhoff, of the EGG Washington Office, before the presentation of expected attention and asked for help. Alhoff was substituting for Len Kojm who was gone for the week. No action was taken.

Mike Duke of NASA Johnson Space Center introduced himself and his wife, Carol, after the talk. He was clearly pleased to be associated with us. (About 2 months ago he circulated a letter indicating that NASA should closely watch these INEL developments.)

2. Briefed Potential Customers

A Zuppero of INEL, Larry Redd of DOE ID and Dr. Ted Fay and Stan Schneider of McDonnell Douglas Space Systems Company (MDSSC), Hunting Beach CA, briefed Wade Carroll, NE-52, Bob Lange, NE-53 and Frank Tarantino of SDI. At the Office of Space, Redd briefed Fenton Carey, and Zuppero and Red briefed Bob Waldron.

Wade Carroll, NE-52 We briefed Carroll in his office. Also present were Mike Houts, John Warren, Abe Weitsberg, Larry Redd (DOE ID), A. Zuppero (INEL), Stan Schneider and Ted Fay (MDSSC). We suggested there could be 20 or more missions using an SP-100. We emphasized the capability of SP-100 class, 20 KW electric vehicles to perform the prospecting, assay and contact missions associated with the neo-fuel concept. Carroll kept emphasizing the 1998 "launch ready" date for a 3 year life, 5 to 20 KW electric, 500 KW thermal system. Wade suggested that we make a presentation to the Newhouse/J Green committee that week. He later called my hotel to say he will not be able to make the presentation this week, and that he will call next week. Carroll received copies of both the World Space Congress paper and of the USU draft.

Bob Lange, NE-53: We briefed Lange in his office before we briefed Carroll. Also present were Mike Houts, Ed Mastal, Steve Bartas, Larry Redd (DOE ID), A. Zuppero (INEL), Stan Schneider and Ted Fay (MDSSC). We suggested there would be a need for up to 50 missions in the low power, <500 watt class. We emphasized the capability of RTG class, 120 to 250 watt electric vehicles to perform flyby and flyby-penetrator prospecting missions associated with the neo-fuel concept. We showed him a picture and some data of the Ball Aerospace "Quicksat" vehicle. Ball indicated that they could fly 4 of them on a Pegasus for about \$10 M each, and 1 on a Delta as a secondary mission for \$10M, complete with launch. We said we would meet with Lange again after the Carroll meeting, but we did not, due to time limitations. Lange suggested that Tarantino of SDI would fund the entire mission and that we should go see him. Lange received copies of both the World Space Congress paper and of the USU draft.

(Maj?) Fred Tarantino, SDIO We briefed Tarantino and Dan Mulder in their Pentagon SDIO office after we briefed NE-52 and NE-53. Also present were Larry Redd (DOE ID), A. Zuppero (INEL), Stan Schneider and Ted Fay (MDSSC). We explained that the concept was first publicly revealed at that very office in about 1989, with Lt. Col. Roger X. Lenard, Dr. Jim Powell and Maj. Gen Ed Coy (USAF Ret), where Powell was authorized to "spend money." Further, their own Chief Astronomer for the Clementine program, Dr. Eugene Shoemaker, gave us the plate of the

newly discovered, very near Earth comet. And, the Clementine targets favor such missions, with Dr. Stu Nozette having tracked the INEL details since about July 1991.

Tarantino volunteered that they could "make something happen" with the concept. He had publicly declared that he was looking for a TOPAZ mission.

Related: Office Of Space Larry Redd, DOE ID, briefed Fenton Carey on the "Unmanned Planetary Study" being funded through Bob Waldron, both of the Office of Space. Fenton redirected the focus of the study away from non-SEI missions, but the new focus is not yet clear. See Larry Redd for details. A conversation with Bob Waldron indicated that we would be able to define a significant work scope to allow us to continue, and that the scope would be changed.

Ed Coomes and Tom Finn (Office of Space) both strongly suggested that we give NASA a way to let them feel like they invented the idea of near Earth object resources. They pointed out that NASA can justifiably state that the DOE knows little or nothing about missions to assay space resources. They asserted that NASA does indeed have the best mission and orbital mechanics analysts, especially the group associated with Carl Sauer at JPL. Furthermore, NASA has the skills to define a credible infrastructure needed to exploit the resources. While the discovery of rocket propellants and fuel ores in the space near Earth may be an energy acquisition program, for the next dozen years it will be dominated by activities where NASA has the required skills. Both Coomes and Finn strongly suggested we exploit existing connections with JSC on this topic.

Further, Coomes suggested that NE-50 take the lead on emphasizing enabling features of nuclear systems in the exploitation of neo-resources. He pointed out that we (INEL and Redd) can emphasize the discovery and its use of solar as well as nuclear technologies. The benefits of nuclear may be obvious, but the DOE does NOT need to volunteer to make that choice. Users can choose the least expensive, fastest option.

NASA Lewis: Dr. Stan Borowski and I had supper and discussed SEI and related topics. Stan strongly suggested that their own John Riehl and Kurt Hack are mission experts with as much stature are the Carl Sauer crowd at JPL. His emphasis was on the ability to model accurately the orbital maneuvers associated with medium and low thrust propulsion of the kind we expect when using nuclear electric or low thrust nuclear thermal systems.

3. Briefed Potential Industrial and Commercial Partners

Ed Cohen of **Ball Aerospace**, Boulder Colorado, was briefed on the meetings with DOE, NASA, Office of Space and SDI. He offered to help lobby Congress, DOE, NASA, SDI and anyone else that might be of help. He saw value for Ball in several phases of the concept. Early work would use Ball "Quicksat" technologies. His estimates of a Quicksat carrying 50 Kg payload is about \$11 M per vehicle, \$13M for a launch vehicle, and up to 4 can be put on a Pegasus. Later, Ball could deploy penetrators, similar to the ones they made for the CRAF-Cassini mission.

John M Gravey, Manager of Space & Planetary Science & Technology, **MDSSC**, offered to help get funding for neo-resources work. He suggested we contact the program manager of NEAR, a near Earth asteroid, small satellite program. The contact is: Coughlin, Tom 301 953 5012, APL.

Department of Transportation: Deputy Assistant Directors Zuppero briefed Carl S. Rappaport, Deputy Assistant Director, Commercial Space Transportation, and Linda Hull Strine, Deputy Assistant Director, Program Affairs, Office of Commercial Space Transportation. Both said they "work for the Secretary," presumably the Secretary of Transportation. They had a booth at the World Space Conference. They said their role was, by law, to "regulate, facilitate and promote" commercial space, which included a space transportation system. My objective was to explore ways we might work together and benefit each other's goals. They seemed interested, but clearly needed to verify what I told them. They expect us to follow up.

WSC action items

Call Cathy Z, return of 2 sept 2 pm
Tom Geherls book meeting
Farquahr
Call: Coughlin, Tom 301 953 5012, APL, Pgm Mgr NEAR, de Garvy
Kojm: inform
Johnn Riehl & Kurt Hack: LeRC are mission experts
Inform Dave Weaver
National space Society article?
SPACE article?
call Powell again
DOT follow up
LaRocco ofc: follow up
Buden's mars on space resources paper
Sforza, Pasquale M: what was I supposed to do with him?
Acta Astronautica
Dave Byers LeRC ion steam engines

Ted Fay: what & where should he be next Wed to tell them?

tony tunes list

Joshua's Rocket Beats Space Dangers

The poison rain of space, the weightlessness and the long journey in a confined space ship drive Joshua to use a fast space ship. Jo Snowbrains uses a chemical rocket and suffers from radiation poisoning, brittle bone disease, and has a diminished immune system. And he goes nuts in space, while Joshua has been at his destination several months already.

"Took a Snowbrains to figure that one out."

"Jo Snowbrains"

- **First INEL papers on steam rockets, and the White house
3 times**

white house 3 times

TBD

1992 Autumn

The White House, 3 times.

with Larry Redd, Tarantino and Beason

The discovery of a source of water at 4600 m/s delta V, "close" on what used to be labeled asteroid but was really a small, dark, near-earth comet, drove us to do something. It was what we were waiting for.

White House,

Washington DC

OEOB, Old Executive Office Building

Vice President Quayle's office, wandering in there,
him not there, getting caught.

What is your address here?

"White House"

no, what is the Fed Ex address?

they have to get it exact for Fed Ex.

If this is the White House, then it will say.

She wrote it on the stationary.

I looked out the window to see the real white house,
the one with the bedrooms.

She wrote:

"Executive Office of the President"

In the cafeteria:

"can I have a receipt?"

"Humpf?"

The heavy lady draped over the cash register seat gave me a funny look.. I could see in her eyes and hear in her noise response:

"You are in the White House. If you are allowed to be in here, you are not so poor you need a receipt for \$3.50 for your coffee and dough nut."

All I just wanted was something that said "White House" and had a date on it. A souvenir.

called back to INEL from 5th floor pay phones.

A curiously smart fellow pushing a waist high paper waste bin said

"you don't need to put money in there."

I was impressed that the guy was so intelligent.
Even the wastebasket guy is top of the line.

called just to be sure they understood I was there.
Larry Red was with me.

girl was calling someone, obviously a relationship thing.

tarantino:

"meet us in white house tomorrow.
where are you?"

me: I don't know. in wash dc somewhere.
I never knew where I was. That was the cab driver's job.

Tarantino, Major Fred, @ sdio/bmdo 703 693 1801, @ OEOB OSTP for Natl. Security Affairs Division, secy JoAnn: Ward 202 395 4823, FAX 202 395 1572, @ Home 703 503 8834, sdio/bmdo Topaz 9/3/92, 572 Old Executive Office Bldg, Wash DC 20506 mulder, wordon, beason 10/8/92

National Space Council: Rm 423, OEOB, Wash DC, 20500, Col. Dr. Peter Warden, White House:10/31/90

OEOB = Old Executive Office Building: see White House, Tarantino, Beason, Harrison

Worden, Col. Simon P, USAF, 719 554 9768 sworden@spacecom.af.mil at General Wardvs office [719 567 5000; USAF 50-th Space Wing Commander 719 380 3010, secy Summerwood-scott 719 380 3287; FAX 719 380 3496; wordensp@fafb.af.mil, USAF Space Command, Director for Studies and Analysis; Space Warfare Center, Studies and Analysis, 730 Irwin Ave., Falcon AFB, CO 80912-7300; secy Morales, Jackie 703 693 1801, FX 703 693 1701, USAF, Deputy for Technology, Ballistic Missile Defense Office, BMDO/DT, Pentagon Rm 1E148, Wash DC 20301-7100, Strategic Defense Initiative Org.] FED EX: sdio/bmdo/DT, Pentagon Rm 1E148, Wash DC 20301-7100, Space 92, OLD: 202 395 6175, White House @National Space Council.] de dr. John Lewis; Obal, Mike; Harrison, Steve; SpcPwrSym92 10/22/92; garver, lori; beason, doug; 940907; fleeter, rick aerosastro; spacecast 2020; hunter, max; tarantino, fred; OGraham, Danny; nozette, stu; Nikolich, Mitch; reddy, frank; mcraay & tedrow; 960603space96

Andrews, Dr. Arlan, Sr. P.E., 202 395 3637, FX 202 395 3719, sandia Mgr Adv. Mfg, de beason 3/5/93 White House OSTP

Harrison, Steve, 202 395 6175, FX 202 395 4155, @ beeper 202 424 4007 type 7 digit # & room to call, National Space Council, White House, de Lange, 10/07/92

White House: National Space Council = Worden, Harrison; Office of Science & Technology Policy = Beason, Tarantino

Beason, J. Douglas, Lt. Col. Ph.D., secy 719 472 4195, FAX -4255, Dir. Of Faculty Research, US AF Academy, Mail code DFE, CO Spgs CO 80840, [@ofc 719 472 4345, @secy nellie 719 472 3510, 719 472 3510, FAX 719 472 2947, BeasonJD%DFP%USAFA@dfmail4.usafa.af.mil Phys Dept, 202 395 3840, secy -5130, FAX 202 395 3719, Rm 436, ne (OSTP) Office of Science & Technology Policy, Physical Sciences, Executive Office of the President, Wash DC 20500,] Itcol usaf de tarantino waldron andrews, dr. arlan, 3/5/93 930805 940210 940226&; 940906 worden; 950314;

OSTP @Coleman, Donna 202 395 3840, secy -5130, FAX 202 395 3719, http://www.whitehouse.gov/white_house/eop/ostp, Rm 436, Office of Science & Technology Policy, Physical Sciences, Executive Office of the President, Wash DC 20500 andrews, dr. arlan, sr. p.e. beason, doug bonometti, robert j. coleman, donna secy gibbons, dr. jack kingston, margo tarantino, fred JOHNS, SKIP ?@ASST DIR FOR TECHN & SPACE DalBello

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**Trip Report:
Briefings at White House, DOE, SDIO,
NASA and Department of Commerce,
6 through 8 October, 1992**

A Zuppero

December 3, 2009, 12/3/2009 2:37:52 PM

1. What were the tactical objectives this trip addressed?

1. Seek and obtain funding and programmatic support for "Fuel From Space Discovery," which is the INEL vision of the Resource Option of the NASA Space Exploration Initiative (SEI).
2. Obtain NASA data needed to perform on the Office of Space contract.

2. What was the plan to meet these objectives?

1. Accommodate National Space Council request to meet with Office of Management & Budget (OMB) on economic factors reviewing INEL economics calculations of space resource discovery.
2. Show OMB the INEL calculations indicating "between 20 and 40 kW electric NEP" has great value.
3. Suggest "Fact Finding Study," a ~200 K effort.
4. Meet with NASA Advisory Council board member for strategic planning and his offer to take INEL concept to Aaron Cohen (Assistant Administrator of NASA).
5. Brief those other agency players who would win if we do or who are necessary for us to win:
 - NASA Code SL
 - DOE NE
 - Office of Space
 - DOE DP Labs,
 - NASA Code X
 - DOE ER
 - Dept. of Transportation (DOT)
 - Dept. of Commerce

3. What actually happened?

Contacts That Broke Down:

OMB, NASA Examiner, to have been set up by Steve Harrison, canceled at last minute.
DOE NE connections thwarted by Space Council need to leave OMB and NSC meetings "on demand."
SDIO meeting to discuss support for Fact Finding Study.
NASA Code X in Griffin's office: Diana Hoyt called in sick.
DOT: Carl Rappaport --both his and our schedule didn't allow meeting.
DOE ER connection opportunity did not arise.

Dr. Steve Harrison, National Space Council, White House
(202 395 6175, FAX 202 395 4155)

He had asked us to be prepared to brief the NASA Examiner at OMB on the economic look we did. Bob Lange (DOE NE-53) suggested we talk with both Harrison and Tarantino. Larry Redd (DOE Idaho) and I presented the near Earth comet discovery. We sketched the near term, medium and long term Vision of use, and our economic analysis. Harrison cautioned that we should get industry to substantiate our assumptions of a market for 10,000 tonne units of propellant in space. To help us, he suggested we see Dr. Scott Pace (Assistant to the Director, Office of Space Commerce, in the Office of the Deputy Secretary, US. Dept. of Commerce).

Harrison said we should perform a short study outlining the conditions under which space resources would be profitable or otherwise irresistible. He suggested it would cost under \$50K (but volunteered no source of funding). This would better prepare us for an OMB meeting. The OMB contacts indicated we should come back after the new year.

We proposed that near term we would return rocket fuels or propellants to Earth orbits for commercial use, for example, in orbital transfer vehicles (OTVs) to ferry TV, data, weather and navigation satellites from LEO to GEO. Medium term we would use the massive (10,000 to 50,000 tonne) amounts of propellants to transport strategic materials to Earth surface from very close NEOs (near-Earth Objects). We suggested this would provide the market for the 10,000 tonne units and would permit resource transportation back to Earth itself at prices less than mining on Earth.

Our long term use would be to provide the 50,000 tonne units of construction material required for space power beaming systems, to provide energy for Earth. We suggested this was a DOE ER responsibility, and would be enabled by DOE DP space nuclear power and propulsion.

Dr. Fred Tarantino, Office of Science & Technology Policy, Executive Office of the President, White House, and assistant to Col. Pete Worden, SDIO
(at OSTP: 202 395 4823; at SDIO: 703 693 1801) .

Fred asked us to meet with them at SDIO after the OMB meeting. When that meeting failed he asked that we meet with Dr. Don Beason, at the Office of Science & Technology Policy (OSTP), in the white house. Fred was most interested in our findings that of order 40 KW electric would enable landing on the first half dozen known very near earth comets and on tens of percent of the suspected resource bearing NEOs.

Tarantino demonstrated a commitment to bring the resource option to the forefront. He repeated "we will make something happen here" again. And the SDIO Technology Deputy he supports (Pete Worden) would provide the first hardware to exploit the near Earth comet discovery.

Larry and I had planned to present Col Pete Worden, and Tarantino SDIO with a plan for a Fact Finding Study, to be performed in part by a Workshop / Conference. I provided the WBS and outline of the study to Fred in a package of information, but time and circumstances prevented presentation of the proposal.

Even though these missions (NEO-resource, NEO fuel) are not in the SDIO charter, both the Clementine and the TOPAZ hardware and missions completely complement the NASA science mission needs and are currently being performed in concert with NASA Code SL. (Dr. Richard Vorder Bruegge, contractor to Dr. Carl Pilcher of Code SL is the NASA representative on the Clementine program.)

Dr. J. Douglas Beason, Office of Science & Technology Policy, Executive Office of the President, White House
(202 395 3840, FAX 202 395 3719)

Beason commented that he liked the 5 minute sketch of the near Earth comet discovery and the INEL implementation because it had plenty of Vision and yet had an practical aspect. He asserted that the commercial use was the practical part. He asked what we wanted from the DOE. I answered "Funding for the Fact Finding Study. And the supporters will look good because we already know the answer." Tarantino repeated "we will make something happen here" after the Beason meeting.

Tarantino had asked me to come back to the White House on Thursday, 9:15 AM, for a 10 minute briefing in his office with Beason. He introduced me as having a concept that they would come back to after the current rush, and wanted Beason to connect the concept with the face. Beason was preparing for a 10 AM meeting. I presented near Earth comet discovery, the near, medium and far term uses, and the plan to assay the find.

Larry Redd was unable to make the meeting because he was waiting for me at the Pentagon, where we had planned to spend time with Tarantino, Nozette and others at SDIO. Tarantino completed the connection and called me at the last minute as I was leaving for the Pentagon.

Dr. Everett Beckner, DOE DP-2, Forrestal Bldg
(202 586 2179, FAX -5670)

Everett heard of concept during recent NASA/DOE exercise and entertained more complete briefing. Larry Redd and I explained the near Earth comet discovery of August 14, 1992; the implications for customers, especially commercial and military; and a plan to verify and assay the newly discovered resources.

Beckner seemed to appreciate that the DP labs (SNL, LANL, LLNL) have been providing key technologies for very closely related NASA and SDIO similar missions. He reminded us that space nuclear systems were the purvey of DOE NE. We showed how the DP Labs would probably spend the first dollars in the next half a dozen years of exploration, and never infringe on the NE nuclear space charter. We suggested that in spending the first sensor and satellite dollars, DP would be creating a market for space nuclear power and propulsion.

Dr. Fenton Carey, DOE, Office of Space, Forrestal Bldg
(202 586 7092)

Larry Redd briefed Fenton on his activities, with myself and Bob Waldron supporting. Larry informed Fenton that we received a welcome reception at NASA Code SL when we asked for their help in determining the least common denominator for space nuclear power and propulsion needs for the NASA deep space and science missions. Fenton seemed pleased and approved of our effort. He did assert that we should become familiar with and support [non-nuclear] mini-satellite missions, such as the 100-200 kg, 6 year fast mission to Pluto that uses no nuclear propulsion.

Larry also mentioned the intense activity and interest generated by the 1.5 month old discovery of a near earth comet. I described in 3 minutes what had happened since we briefed this concept to Fenton last February 1992. Fenton seemed to appreciate that the recent revelation with a picture of the comet posing as a space rock made the difference, and may take the concept from futuristic to potentially valuable. His response positive and supportive, compared to neutral last February.

Fenton made us aware of the uncertainty associated with the elections. He encouraged exploring NASA science mission opportunities.

Dr. Scott Pace, Assistant to the Director, Office of Space Commerce, US. Dept. of Commerce, Office of the Deputy Secretary
(202 482 6125)

Larry Redd and I visited Scott to discuss how we might make a credible case that abundant space resources would find a commercial market. Scott and I had talked previously, at Harrison's suggestion, about the INEL resource option.

Pace asserted that if Fenton asks, his Office and its Director, Mr. Frelk, would be happy to do whatever is necessary to support DOE.

Pace suggested that we explore how commercial satellites such as COMSAT and related industries might benefit. He said we should have the Government only be an anchor tenant, along with defense and Lunar/Mars. He cautioned that our assumption that launch cost and hardware cost are directly related has been proposed but is still controversial. He points out that the hardware cost is of order 5 times the launch cost, so that lowering launch costs might not affect total costs as much as we hope.

He suggested that we contact industry leaders (CEO's of such places as Loral, Hughes, GE) and have them send letters of interest stating what they would do with the resources if they were available. He reminded us that refueling satellites is NOT good because satellite electronics are about 2 generations obsolete by the time they are launched. Removal of the old satellite is more valuable. He suggested 4 uses for space propellants, such as 1. cheaper launch, 2. enabling new missions, 3. an OTV upper stage and 4. space clean up (SIREN). The OTV could provide small satellite dispersal, and upper stage OTV.

We should make a schedule chart of the transition from the government creating an infrastructure to industry paying its way. Recall the national highway system and the Autobahn, both created for military transport, and the transition of both to commerce, he said.

He strongly suggested we bring a team to petition the government to exploit the near Earth comet discovery. Team would include more than one representative from industry, DOE, DoC, NASA and other parties.

His parting summary suggestion is that we show a story of who in the industry/government/defense consortium would perform the next steps.

Dr. Don Beattie, NASA Advisory Council and private consultant with ENDOSAT and the Colorado School of Mines
(301 460 6187).

Beattie, Larry Redd and I discussed strategies over lunch to bring NASA into the mainstream. Dr. Don Shoemaker (USGS and NASA Advisory Council member) convinced Beattie that the INEL application of the near Earth comet discovery deserved immediate action. Shoemaker suggested he take me to the Goldin (NASA Director) and Beattie offered to take us to Aaron Cohen.

Don strongly suggested that we quantify the demand for kilo-tons of NEO-fuel, or at least for as much fuel as is needed to reduce the cost to something attractively below that of Earth launches.

He said our main objective is to get NASA and DOE to put it into their 94 budget, which is coming up.

He told us he contacted Noel Hinnens (sp?) of Martin Marietta and told them to contact us. He said that Martin Marietta and INEL should together brief Griffin.

He indicated that some industrial entity should contact Senator Barbara A. Mikulski (D-Maryland) to point out the role of Goddard in the exploitation of the near Earth comet discovery. He believes Mikulski is the type who would see the value of the discovery to the country.

We should get the National Academy of Sciences to perform a study that shows the high value and practical applicability of the water sources near Earth.

He strongly suggested that we do everything we can to help NASA take the torch.

We agreed that I will contact Gene Shoemaker when he gets back 12 Oct to orchestrate the next moves.

Dr. Stu Nozette, Deputy Program Manager Clementine, SDIO, Pentagon,
(703 6931801)

Stu pointed out that the Clementine mission and program has Carl Sagan and Bill Clinton support. He says Democrats like it and Liberals support unmanned missions.

Stu asserted that he has been a fan of Near Earth Asteroids for the last 10 years. He very much likes the near Earth comet discovery and understands its implications. He and I have presented papers at several NEO/ NEA meetings. He is part of the "club."

He asserted that his (Clementine) technology is limited by the STAR kick motor. His hardware could return samples to Earth from trivially close NEOs, he points out. We all know that his hardware can access nearly all trivially close NEOs, and with a cost & schedule NASA currently can not beat.

Dr. Richard Vorder Bruegge, NASA Code SL contractor with Dr. Carl Pilcher, and Staff scientist, Space Science Operations, SAIC Virginia Ave

(202 479 0750, FAX -0856)

We asked Vorder Bruegge for help. We explained the DOE is trying to find out what are the best few propulsion and power systems to focus on. To do this we need to know the entire spectrum of NASA missions, science included. Further, NASA mission definitions might be favorably changed if we could provide NASA with new or otherwise unfamiliar nuclear power and propulsion elements

Larry Redd and I listened to Vorder Bruegge explain the entire panorama of unmanned science missions under consideration by Dr. Carl Pilcher, NASA Code SL, for whom he works. He left us with a copy of the viewgraphs he used. [Available from Zuppero, call 208 526 5382] Missions spanned range from near-Earth Object science missions to Pluto flyby.

He strongly suggested we attend the NASA Discovery Workshop this 16-18 November, at San Juan Capistrano, California. The entire set of Code SL planned and proposed science missions will be described and on display there. We would much better position to find uses for nuclear power and propulsion by being at that meeting.

We suggested that some of the new RTG and DIPS systems could provide NEP performance approaching that of a reactor (~50 kg/kW) while weighing 1/10 as much. Vorder Bruegge was not aware of the Thulium isotope heat source and its potential performance. This would enable a new class of affordable, mini-satellite missions to deep space. Vorder Bruegge described a multi-stage mission to Pluto that would use a mini-satellite and travel there in about half a dozen years.

We suggested that the availability of 20 KW electric power provided new degrees of freedom. We explained, for example, that a 20 KW vacuum tube communication system would provide a signal so strong that graduate students could receive it using small, commercial sized satellite dishes. Further, the tube can operate with a red-hot (800 C) plate, permitting relatively low mass heat rejection management. The 4-th power, Stephan-Boltzman radiation law strongly favors the red hot plate and sharply contrasts the low temperature (100 C) solid state transmitter systems. This would greatly reduce mission support costs, which can be of order 30% of the total mission cost.

We avoided a sensitivity by not discussing the near Earth comet discovery at any length with Vorder Bruegge, even though the first missions would all be science missions of the kind they have funded in the past.

We also met Vorder Bruegge's boss, Dr John K Soldner, Division Manager, Solar System Exploration Support Division. (202 479 0750). Larry Redd had worked with him in Houston.

What are the action Items and next steps?

- Get back to SDIO for help in searching for funding for the Fact Finding Study.
- Contact Dr. Gene Shoemaker for a conference call to orchestrate next moves.
- Brief Griffin's office on the near Earth comet discovery.
- Get satellite makers from industry to suggest how they would use the space resources if available.
- Perform a short study of the economics for OMB/ NSC.
- Quantify market for ~kilotonnes neofuel.
- Get Industry / Government / University team to present near Earth comet discovery to NASA and DOE for 94 funding.

- Go to San Juan Capistrano for Discovery Mission meeting.
- Provide more data on uses of DOE sensors and active, contact probing devices.

TBD

"Don't Trust Them," each said of the other

- 1992.10.07 DOE NE 50: Al Newhouse: Briefed Fuels From Space Fact Finding, achieved agreement to find, but no promise, of funding support
- 1992.10.07 SDIO Technology: Col. Pete Worden, Briefed Fuels From Space Fact Finding, achieved funding support, and to match DOE
- 1992.10.07 White House: National Space Council, Dr. Steve Harrison, Wednesday, 7 Oct 1992, at 4-th floor of Old Executive Office Building, on Discovery of Fuels From Space and the basis and results of the Economic Study.
- 1992.10.08 White House: Office of Science & Technology Policy, Dr. Don Beason, Dr. Fred Tarantino, Thursday, 8 Oct 1992, at Rm 547 of Old Executive Office Building, on Discovery of Fuels From Space. Briefed a Vision, a practical use, and wanted the start of the Fact Finding Study.
- 1992.10.20 NP-TIM-92 Nuc. Prop. Tech Ixg Mtg, Plumbrook Oct 20-23, 1992 blecker, col. gene bhattacharyya, sam borowski, Stan breen, jeff Clark, john dahl, wayne defillipo, felix dobranich, dean, evans, dallas friedlander, alan frisbee, bob gilland, jim hill, tom hooper, bickford juhaz, al kaltenstein, bonnie kesaree, malati ludewig, hans marissa miller, tom noble, chuck, pelaccio, dennis powell, jim ramsthaler, jack roy, don ryder, bill sawyer, buzz schmidt, dr. eldon shoenberg, kurt todoso, mike, trucello, vince warren, john zubrin, bob
- 1992.11.00 lanl NOV92 berzins, don braithwaite, karl casperson, don cobb, don donila edwards, brad feldman, bill fellow hecker, sigfried holden, danknox, stephen o forte laros, john g myers, c. weston priedhorsky, bill cygnus x1 seldon, bob simon, daniel simon, daniel thompson, buck william verzino, bill

Fall 1992, spring 1993

DOE and DOD Pay for a Workshop

DOD pays first, and does right thing

Worden at Star Wars, DOD that morning deep in the Pentagon says

"dont trust those DOE NE guys"

Dave Buden laughs.

Newhouse at DOE NE that afternoon says

"don't trust those Star Wars DOD guys"

They both said

"don't tell the other guy, but,

we will pay when the other guy finks out."

"when" not "IF" they were both confident the other guy would drop out.

neither dropped out.

- **Discovery Program Workshop Nov 1992 San Juan Capistrano**

Space Gas Stations Everywhere

It's right in front of us, and we miss it. The gas tanks in space were right in front of me, but I let all that noise get in the way. It is maddening. We do it all the time, complicate things, ignore the simplest possible path to where we want to go.

How can you learn from my mistakes?

How can I communicate my frustration that I could have led us out, to inhabit the Solar System, 15 years ago?

My space gas stations were swarming around Earth's orbit the whole time. They were soft, like sun-baked dog poo, not hard, like a sidewalk. They were so close to us we could get to them easier than landing on the moon. I had tables of their orbits, so I could have easily figured it. The space gas stations had enough water to fuel a hundred thousand trips to Mars or 10,000 trips to Jupiter and Saturn. They could fuel the start of an Exodus.

That's all we need to know. The rest is noise. We could stop the story right here and start exploiting neospace.

It took me 17 years to see it, *after* I got my Medicare Card.

At San Jan Capistrano, California, a favorite and convenient place, 11 November 1992, NASA was holding a "Discovery Program Workshop". NASA got some money to send tiny robot space ships to explore the solar system. They wanted to spread the money a little. Dan Goldin, head of NASA, showed up. Gene Shoemaker showed up. A whole crew of valuable and useful people, all related in some way to the recent discoveries about our own inner solar system, showed up, with proposals. I knew a good fraction of them.

This is a very short story.

NASA would send low cost robots to explore what they called "deep space." Deep space to me always meant deep in the Galaxy, or the next Galaxy, but not nearby, here. To NASA, it meant anything past the GPS and TV satellites.

That was really good news to me. NASA could easily choose to hunt for space water objects, any kind, like moons of Mars, or near earth asteroids, or near earth comets. It seemed nearly everyone wanted to explore the NEA'S.

Any NEA had such low gravity that one could land on it. That really makes a big difference. Your tiny spacecraft would not crash into the NEA. It would always crash on the moon, or Mars, or Venus, or any planet or moon in the solar system, unless you spent a lot of money on a powerful braking rocket.

The DOE and the DOD had both just pledged money to my team to have a meeting on NEA water and the space gas stations, and we needed competent speakers. I was recruiting.

Gene Shoemaker and I were sitting at a hamburger bar and Gene told me that 40 % of the near earth objects were a form of water-soaked minerals. He said they were almost like regular, plain, Texas clay.

"I let the word out that I would travel to see them as soon as they fell," Gene told me.

"Somebody in Texas saw one land and I got there within about a week after it fell."

"If you wait more than a few weeks, it looks like dirt, clay."

"The reason you never see them is that they are so soft, they either break apart when they hit the atmosphere, or they disintegrate into dirt after a month or two."

"About 40% of the NEA's are hydrated mineral clays."

That was all I needed to know, and didn't know it.

We did not need to explore a comet. If we picked a convenient NEA, we would have a 40 percent chance of hitting clay dirt, hydrated mineral water, enough to fuel the largest water tank bladder anyone would imagine.

That's way better chances than oil drilling in Texas. The oil well drillers only had a 5% chance.

We would not need space sledge hammers to bust the asteroid sidewalks into pieces. We could stick pieces in our nuclear garbage can heaters. The stuff was so soft we could use scoops, instead. Like baked mud. Like crispy, crunchy desert dirt.

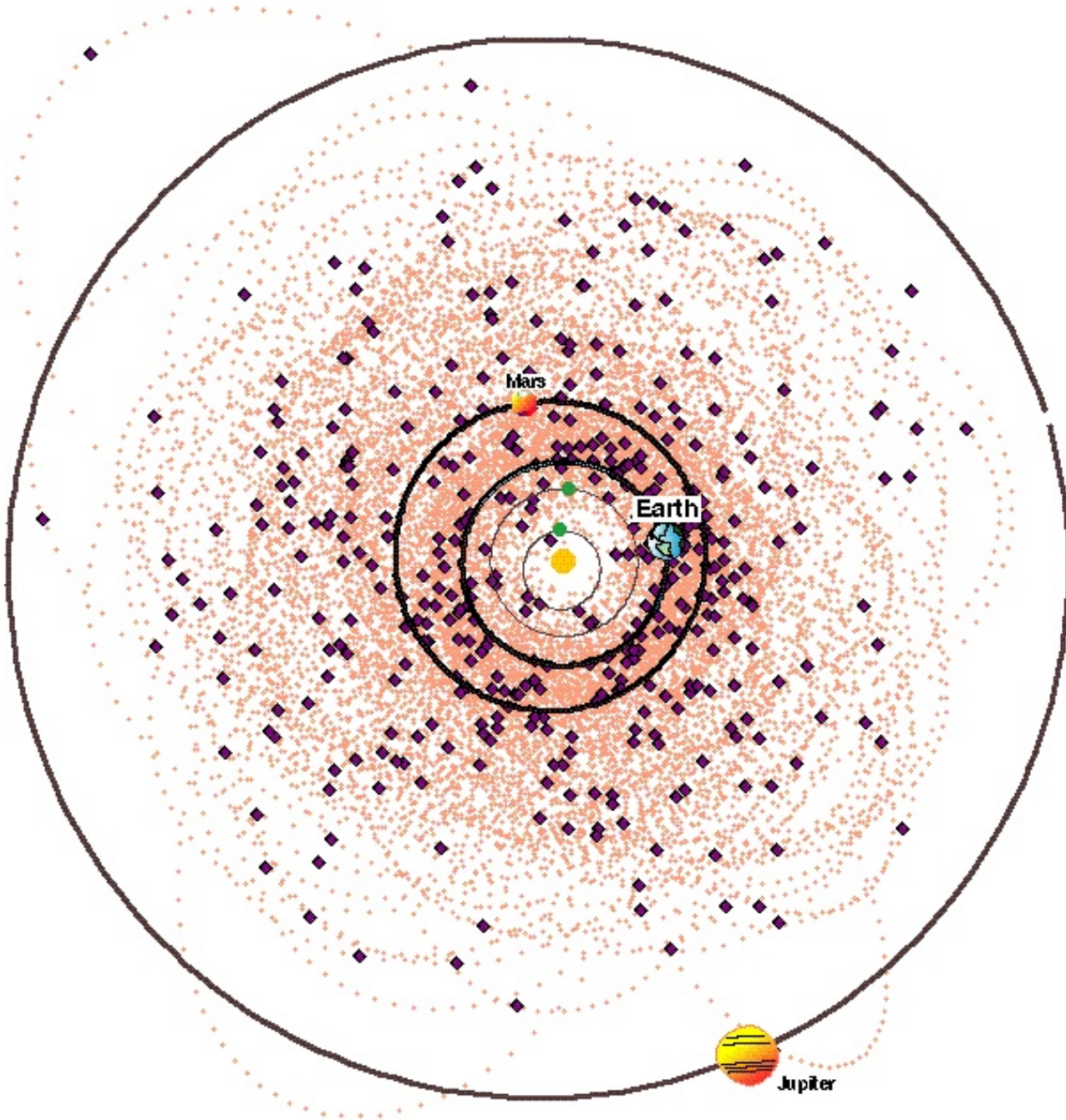
We would only need to heat the NEA dirt to cookie oven hot, not to melting lava hot. We could do this with a nuclear heater the size of a large garbage can, literally.

We could use the water directly in a rocket, no electricity required, no electrolysis, no cryogenic complications, nothing, just water in a steam rockets.

The payloads would be huge, literally like that of a complete submarine.

And most convenient, Earth lived in a swarm of them. At the time we did not plot the orbits. But we would plot them soon enough. I

should have known.



nea_43

Swarm of Near Earth Asteroids, NEA's, in orbits relatively near Earth. Dark diamonds are the asteroids on a particular day during 1996. The dotted points are the orbit points, plotted with equal time between each point. The intensity of the fog of points in some little regions is proportional to the chance of finding an NEA in the region. Most NEA's are "tiny", like 100 Megatons. The picture is probably deceiving. There seem to be more of them near Earth because it is easier to see them and find them when they are near Earth.

A Bad Thing I learned was that my scheme to bring back massive resources from space was doomed. I would generate huge, horrible pollution.

Pollution?

When a hyper speed thing, meteor, Anthony's Cargo from neospace, near earth asteroid, enters the Earth's atmosphere, it comes in so fast that it burns the air. It makes the nitrogen in the air combine with the oxygen. It makes smog. NOx. Nitrogen Oxide.

If Anthony's Cargo would bring back enough oil shale from the Oil Shale near earth comets to fuel the Earth's oil needs, about 1 cubic mile per year, I would generate huge smog.

A Stupid Bureaucrat thing I heard was Dan Golden, head of NASA, talking to the young rocket scientists up front.

Goldin told them they should take risks and not be so conservative. He wanted them to make more risky proposals in their space projects.

How crazy can he be? These kids, younger rocket scientists, had bills to pay and mortgages to service. Risky projects meant you would be out of a job most of the time, because "risk" means most of the time it doesn't work.

It is irrelevant that some of the time, 1%, you get rewarded beyond your dreams. "Risk" means 99% of the time you are broke.

The head of NASA was asking them to volunteer to be broke.

All the rest of the meeting was noise. Important noise. People told me things of value. I met people of value. I recruited speakers. Noise.

You could Google

"Discovery Program Workshop" Capistrano and find out the official version of the meeting. You could email me for my version. It was all noise.

921115 DPW92 Discovery Program Workshop at San Juan Capistrano, 15-20 Nov 1992 a'hearn, mike arnold, dr. james belton, dr. michael j. s burke, jim carle, glenn cheng, andrew f, Clark, ben coombs, dr. cassandra cruz, mauel l. dickinson, tammy dudenhoefer, james, e duke, mike eckstrom, dick edwards, bradd edwards, bradley c., ph. d. elphic, rick farquhar, dr. robert w (bob) fay, dr. ted, freitag, joseph jr. garvey, john goldin, dan harris, dr. alan klusendorf, roy e., lapins, uldis e., dr lillie, dr. charles f. lofgren, gary e, ph.d. morrison, david morton, oliver the economist brittain mulholland, j. derrel pod france nash, doug host neugebauer, marcia neukum, prof. gerhard germany pilcher, carl reedy, bob reinert, dr. richard p schneider, Stan, shoemaker, eugene, nears stuart, alan sykes, mark vorder bruegge, richard wdowiak, prof. birmingham ala willoughby, asteroid alweissmann, paul pathfinder soccer

- **Hazard meeting with Carl Sagan**

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Story Line

Nothing can compare to a scary story for attracting a crowd. The NASA team tried to create a scare story meeting to drum up public sentiment for near Earth asteroid astronomy and space missions.

I expected nothing. Only to meet Gene Shoemaker again and talk about the comet. I never checked the roster to see who would be there, except to note that Carl Sagan and Edward Teller were scheduled to have an argument about how or whether to knock killer asteroids out of the way.

I came away excited. The contacts I met were important people, and they received me well. I was hyped.

I was also looking for attendees for the workshop we were holding in 3 months.

And, I learned some astounding things about nature.

- *"Survival of the Lucky," a new paradigm to replace "Survival of the Fittest."*
- *"The atmosphere seems to be alive. It seems to heal."*

Three different people told Carl Sagan he had to hear my story.

John Pike, a king of the anti-whatevers, liked what I had.

Edward Teller himself said he would go anywhere with me.

I was hyped.

I never expected such a reception.

I left there certain we could energize the world for an Exodus To Space, to occupy the solar system.

tedesci, bill loaned me his car while I stayed in the far away hotel. I didn't rent one.

drobyshevski, dr. ted, his English got better. I bought him a few good drinks. we talked.

jay melosh told an audience how he would fry rocks with a big mirror and cause an asteroid to move. I wondered how in the hell he would do that and asked a technical question at the meeting. If the sun could see the rock (get focused on to the rock with a mirror), the rock vapor could see the mirror. the rock vapor would cloud the mirror.

Stu Nozette introduced me to his wife to be. During his talk he told the whole audience that he did clementine for \$1 M less than the limit of \$100 M.

everyone was here. It seemed I had met everyone.

Hazards of Asteroids and Comets Jan 4-9, 1993, Tucson Arizona

Hazards of Asteroids and Comets

◆ *World Famous Carl Sagan to Fight World Famous Edward Teller*

Nothing can compare to a scary story for attracting a crowd. That's what NASA thought when they tried to create a scare-story meeting to drum up public sentiment for near Earth asteroid astronomy and space missions.

I expected nothing. Only to meet Gene Shoemaker again and talk about the near Earth comet he told me about. I never checked the roster to see who would be there, except to note that Carl Sagan and Edward Teller were scheduled to have a public argument about whether or not to knock killer asteroids out of the way.

This was the 4 January 1993, Tucson Arizona, on the University campus. The landscaping was that kind of barren sand, red sand in

some places, brown tan sand in others, with dark lava rock in between. Carefully planted, stunning branching armed cactus, probably stolen from the real desert, were surrounded by a few blue-green leafed century plants and yucca plants. Red lava gravel and black lava gravel filled in 3 foot wide spaces where green grass would have been on any other campus. And everything in between was like the Arizona desert.

John Pike's Camel cigarette, the kind with no filter, was so, so inviting, so luring. I had seen him and knew he was someone I needed to stalk, to track, to find a way to meet. Pike knew a lot about space and about nuclear propulsion in space. CNN would ask him for his opinion, often. I knew what he looked like

because I had seen him on CNN after I had talked on the phone to Steve Aftergood, one of the people on his staff.

Pike was an "anti", someone who was "anti" things others wanted to do, like what my boss wanted to do.

I had watched Pike quietly go out the double exit doors near the far rear of the auditorium. Someone was at the speaker's podium droning on about some detail that was less important than John Pike. Instead of listening to a bunch of scientists talking on and on about some wonderfully interesting point, which I knew I could extract anytime I wanted, later, using the people and telephone network, I chose to talk to Pike.

So I went out the same door. Only one door later I was outside the building, under a cozy little protected area. Clouds were obscuring the afternoon sun. Pike had just lit up that Camel cigarette and was leaning up against the one foot diameter concrete pillar. Just the smell made me want one. I almost asked him for one.

"Hi. You're John Pike, aren't you?" I asked. It was a clumsy but disarmingly honest way to introduce myself.

"Yeah. Hi," he replied, acting friendly, smiling, and then looking off towards the other buildings.

Anyone here was part of the in-crowd. He would easily be friendly.

"I talked with Steve Aftergood about steam rockets," I said, hoping to jar his memory about me and what I was doing, and in a slightly clumsy way kept adding to my sentence, "nuclear heated steam rockets, to go to Mars, and the periodic comets. One of the asteroids was really a comet."

Everything just came blurring out of my mouth. In my mind it was a complete picture. But I wasn't listening to myself. I was watching his face and his reactions.

"Yeah. I heard about that. Steve told me. Pretty clever." he replied, with strong non-verbal facial expressions and voice inflections clearly asking me to talk with him.

His remark suggested he knew what I wanted do. And it appeared he was already "not against." My anxiety level dropped and my excitement level rose by the same amount.

"Well, we found the water," I said, trying to communicate that something fundamental happened to change things for the better.

I was here to negotiate with John Pike, to find a way to let me have my steam rocket in deep space.

What would I have to do to get John Pike to say "yes, I will not oppose that."

What would my "that" have to be?

I liked the Federation of Atomic Scientists, with whom he was a leader and strongly aligned. I had already worked with one of his cohorts, Steve Aftergood and found out that they didn't like anyone running a nuclear rocket in our atmosphere. I agreed with that completely.

If it would help, I would become a member of the Federation at the slightest push and give up a little freedom.

What did they think about nuclear reactors in space? What were their issues? The two of us could formulate a space travel plan that would be politically tenable. I knew they had to allow something. It would be the human in us all, looking for another Earth to occupy.

Mars was another Earth; we just knew it. We could all be totally opposed to everything nuclear. But, Mars was another Earth. If it took a nuclear rocket and a nuclear reactor to exist on Mars, we would all do it. It was the Life Form in us, insisting on growing.

The Vision was inside all of us. I needed to find out how to coax it out of him, and the Federation of American Scientists, the "anti" guys.

"I would use water, not liquid hydrogen or oxygen. I get a huge payload when I do that. I get the water off the comets, the Jupiter family comets," I explained.

"You mean you use the ice on the comets?" he asked.

"Yeah. The reactor melts the ice. I put the water in my tank." I replied.

"Then you make liquid hydrogen and liquid oxygen, the rocket fuel? Where do you do that?" he asked.

"No way. I use a steam rocket to bring the water, ice, back to Earth orbit."

"So, you don't have the electrolysis machinery out there," he stated.

"Right."

"So where do you have it?" he asked.

He was trying to trick me. He knew the space polluters would have one of those things somewhere, and that there would always be a monstrosity large nuclear electric generator lurking near it, and the whole thing would probably be orbiting in some sloppy dangerous place in a low earth orbit.

"I don't need it. That's why it's so exciting. It's so simple." I replied.

"So you just ship water around. Where do you drop off the water?"

"In Earth orbit. In orbit around Earth," I motioned wildly with my hands.

My left hand was "Earth." My right hand was moving towards Earth, pretending to be the rocket ship coming back from a comet.

I knew I had to say it some time. I had to turn on the nuclear reactor near Earth. Without this I was dead. There was no other way. No other way would work. I tried them all. The only thing that worked was turning on the nuclear reactor as close to Earth as I could get away with.

He could see that my rocket ship, my right hand, with my index finger pointing towards him, with the tip of my index finger, my fingernail, being the rocket from outer space, loaded with water ice, was headed right for my left hand made into a fist, which was Earth.

I moved it real fast, hoping he would not dwell on it.

My rocket ship came in from outer space and then got caught in a nice, clean elliptical orbit that swung two feet above and then swung around below my left hand fist.

"I do a propulsive capture." I stated.

He was supposed to understand that we turned on my nuclear rocket turned just as it was coming in from deep space and moving as fast as meteors crashing from the outer asteroid belt.

"I would come back from space, do a thrust at just outside the debris belt, at 1.3 earth radii, and capture into a high elliptic orbit, with apogee past the moon."

I didn't know what he was going to say. He might have said "you can't use your nuclear reactor anywhere near Earth."

"Then I drop off the ice, and go back to get more." I said.

Then he finally asked the key question:

"How long would you stay in orbit around Earth? A year? 2 years?"

"One turn." I replied.

"You mean you wouldn't stay very long at all? In orbit around Earth?"

"No. Hell no, of course not, you wanna get back there as fast as you can," I blurted, rushing my words, excited.

I didn't know why he would care. It was an orbital mechanics thing. But I told him anyway.

What I meant to say was "you want to minimize the trip time, so you would like to leave immediately and get back to the comet for another load. More loads means more money, profit."

But I didn't say it.

In my mind I said: "If you can pay off your loan with one payload, then the second payload is pure profit. The more payloads you can get in a given time, the richer you are. The last thing you want to do is dilly dally in orbit around Earth."

But I didn't say any of that.

I was about to go on an on, and then on and on some more, like some people say I do too often, about how the profit is directly related to how many payloads per year you can bring back from out there in deep space.

Within one puff on that non-filter Camel cigarette, like the one I wanted him to give me, he realized what I wanted to do he said, "Oh, yeah. You just want to keep it in deep space."

"Well, yeah." I replied, so intelligently.

He kept looking off towards some buildings, as if he were waiting for someone. He was paying attention to me, but he acted like he was here for more than a cigarette, like he was waiting for someone.

"So, you don't stay in Earth orbit at all?" he turned back to me, distracted.

"Well, no, not really." I replied.

I didn't know what he wanted me to say. But he was smiling.

"That's pretty good." he said.

I finally got it. The "bad guys" want to leave an operating nuclear reactor in orbit around Earth, for as long as they can get away with.

"How long is your reactor on?" he asked.

"About a day" I replied.

"Not true," I thought, a millisecond after I said it, "I better tell him now, or he will come back later and get me."

"I would turn it on out there by the comet when I leave it. I might run it at half power for a few days. Then it would coast for a year or 3," I clarified, making sure I didn't hide anything from him that I myself would want to know, given that we were both rebel environmentalist types.

"You mean the reactor is off most of the time? What kind of reactor is this?" he asked.

"It's like the reactors in a nuclear submarine, with 110 sailors inside. Makes steam." I replied.

He was expecting me to use a nuclear rocket like the one at Jackass Flats, that spewed radioactivity across the Nevada Test Site back during the late 1960's. We both knew that that

radioactivity from one of the Rover program rocket tests was apparently detected up in north Idaho.

[[I have a picture of the flaming fire squirting up out of the ground and into the sky of that Rover test.]]



\ lepage3.jpg



\ Rover-FIRE-ets1.gif

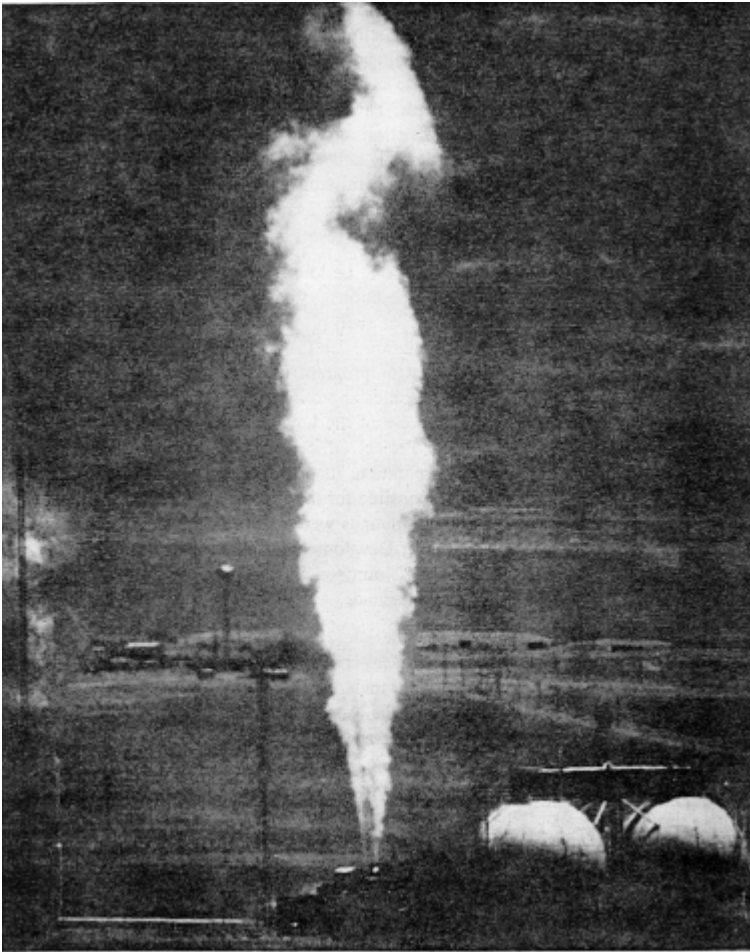


Figure 9 Nuclear rocket test at Jackass Flats, Nevada's Nuclear Rocket Development Station, 26 June 1968.

\ Rover-Nerva-test-Flames.gif

\ Howe-roadrunner ROVER pic

"So it's not like the Rover test at Jackass Flats?" he said, somewhat chuckling.

"No, there ain't no way I would put up with that kind of rocket." I asserted.

That's for sure. Just because I liked nuclear rockets for deep space did not mean I was crazy.

"I like my car. But I don't run the exhaust through my living room." I exclaimed.

He understood all the missing words. I did not even have to help him.

The missing words were that we would have to test the rocket before we would fly it. We would have to test it somewhere. The rocket would have an exhaust. The exhaust would probably have some radioactivity in it when the test failed. All tests fail at some time or another. They better fail. If we don't push them till they fail, we don't know how far we can push it. When it fails, we better plug

up every leak and catch every molecule of exhaust and not let it get into our air.

That was what Marland Stanley and Tom Hill were working so hard to demonstrate for NASA and the world: that our reactor dome in Idaho could hold all the garbage from a failed test of a full scale nuclear rocket.

John Pike and I were visualizing that picture of the flaming nuclear rocket exhaust they vented directly into the atmosphere during the 1960's.

He really did know details. He knew them well. I wanted to impress upon him that if you dilly dallied around Earth, you would be wasting precious time. You needed to be going back to space as fast as you could.

He was worried people would keep a nuclear reactor in orbit around Earth, all the time building up fission products and becoming more and more of an accident waiting to happen.

"I'm hauling a payload that is 100 times the mass of the Shuttle." I proudly boasted.

He laughed.

"I could haul 500 people at a time."

He was all smiles.

"I like that." he said, grinning at me.

I would have negotiated backwards just to get him to let me use the steam rocket in deep space. I would have let him force me to use a chemical rocket to cause the capture at Earth. The "capture" was the capture of the space tanker from deep space to a "captured" orbit around Earth.

Forcing me to use a chemical rocket would horribly punish the whole concept. It would drive up the cost of space travel so much that it would be completely non-competitive with anything, completely unaffordable by any taxpayers. It would kill the viability. I would agree to it to give me time. When all would appear to be lost, I would show how the nuclear reactor version of the original Vision would save the day.

Only primitive forms of human, those extremist, vegetarian, artist, soybean eating, communist environmentalists who failed arithmetic would insist on that chemical rocket.

But John Pike and I were not one of them. We were an advanced form of environmentalist human. We were able to figure. Pike

knew my rocket was as clean as one could get and still let our Life Form expand and Occupy Space.

I knew, but I suspected that he did not know that the cost was what was mostly wrong with the chemical rocket, the one that would use liquid hydrogen and oxygen fuels. The chemical rocket would cost way too much.

I was really stimulated by how much Pike knew, and about the really key questions he was asking. He asked me all the right questions. This was really exciting.

Then he saw the guy he was waiting for walking towards us, rather far enough away that I could not recognize who it was.

"Hey Carl, you gotta hear this story." he told Carl Sagan, as he introduced me to him. Pike was really smiling.

I didn't figure out till later in the meeting that Pike was grilling me, like a journalist trying to nail the bad guy. He was trying to find where I was going to try to be sneaky and slip in a flying nuclear garbage pit right into the space just above the air we breathe. Because Pike was so damn reasonable, he was surprised. I thought he really liked the story.

Here all this time I thought we were having a really meaty discussion.

Nuclear Rocket Dumped Radiation on Los Angeles Residents in 1965 Test

By Melissa Healy
Los Angeles Times
WASHINGTON

A federal agency's test of a nuclear-powered rocket in 1965 produced a radioactive cloud that drifted over Los Angeles before dissipating over the Pacific Ocean, according to a lawmaker who charged Wednesday that the area's 6 million residents were used as human guinea pigs in the experiment.

Citing documents released by the Energy Department in recent weeks, Rep. Ed Markey (D-Mass.) said the radioactive cloud of nuclear material was the result of an "intentional accident" designed to monitor the effects of a malfunction aboard the rocket.

While radioactivity levels were extremely low and unlikely to have caused illnesses, Markey said "an intentional reactor accident releasing a radioactive cloud should not be considered prudent public policy."

The incident is the latest disclosed as a result of an Energy Department effort to expose government testing programs in which humans may have been exposed to radiation without their knowledge or informed consent. A panel of scientists and ethicists commissioned by Energy Secretary Hazel O'Leary is investigating a range of radiation experiments involving humans between 1945 and the late 1970s. The panel also is expected to recommend compensation and medical follow-up for victims.

In a letter sent to O'Leary Wednesday, Markey urged the secretary to refer the rocket test to the investigating panel for consideration as a human experiment. If the panel accepts the experiment as an episode of human experimentation, Los Angeles residents who can demonstrate they were affected by the test could be eligible for some compensation. More likely, however, area residents would be subject to efforts to trace the long-term health effects of the test.

"The history of the Atomic Energy Commission's nuclear-powered rocket program is already one of unrestrained radioactive hubris," Markey wrote in a letter to O'Leary.

The test was conducted by the Atomic Energy Commission, a predecessor of the Energy Department, with the assistance of the U.S. Public Health Service and a private contractor.

At 10:58 a.m. PST on Jan. 12, 1965, scientists conducted what they called a "controlled excursion."

The rocket took off from Jackass Flats at the Nevada Test Site and burned off part of its radioactive core in a spectacle that scientists said "resembled a Roman candle." Prevailing winds pushed the resulting cloud of radioactive debris Southwest from the test site, over Death Valley, and then onward over "the Los Angeles area," according to the documents. Aircraft stopped tracking the cloud when it drifted over the Pacific Ocean.

Public Health officials taking routine air samples from Barstow, San Bernardino, Los Angeles and San Diego observed "increased radioactivity" on the two days following the test, according to a 1968 report prepared by the Los Alamos National Laboratory.

In fact, levels of radiation released in the experiment were lower than scientists had predicted they would be, the Los Alamos report observed. At 15 miles from the test site, the maximum level of whole-body radiation exposure was measured at 5.7 millirad. That is well below current standards set by the Environmental Protection Agency for the exposure of the general public from commercial atomic power operations. Those standards dictate that over one year, a member of the general public should not be exposed to more than 25 millirad whole-body radiation.

Experts said that if individuals were exposed to 5.7 millirad at 15 miles from the test site, those in Los Angeles, some 200 miles away, would have had significantly lighter exposures. It is thus doubtful, said one aide to Markey, that the test caused measurable health effects among residents of the Los Angeles area.

But Markey and O'Leary have argued that even if exposure levels do not themselves prompt concern, the emerging picture of early radiation testing raises serious questions about the ethical standards observed by the federal government enforced in its experimental programs.

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People with Stars Named After Them

Carolyn Shoemaker

People who have stars in the sky named after them are special. Their names stay in the sky forever. They are like the gods. The ancient Greek gods were stars in the sky.

During the technical sessions I noticed that Gene and Carolyn Shoemaker were sitting way up in the back, almost the highest seats in the auditorium, farthest from all the din and noise, far from most of the audience, almost alone. I went up there and commented how they were all alone.

"Do you have celestial objects in the sky named after you?" I asked Carolyn Shoemaker.

"Well, yes," she replied, realizing both from what Gene said and from my question that I was a rocket scientist, not an astronomer. Carolyn was a soft spoken person and she didn't volunteer great pontifications or try to do politics or tell fancy stories.

Gene started bragging how they both looked for comets the old way, with film, and how tedious it was. His words and descriptions of the tedium melted into the background as I realized I was talking to two people whose names are immortalized in the sky. Both of them discovered not one but many celestial objects.

"I wonder how many other people here are immortal like that?" I asked, not realizing that the question came out of nowhere and probably puzzled them both. I looked at them both and tried to clarify, and somewhat stuttered, stumbling over my words,

"you have celestial objects named after you. Your name is immortalized. Almost nobody in the world gets that. And you live to talk about it."

I sat with Carolyn for a while after Gene left with someone, politicking. It was quality time with a celestial celebrity.

Sagan and Teller To Fight

Carl Sagan was supposed to be there to fight Dr. Edward Teller about using atomic bombs in space to knock the killer asteroids out of the way. They were supposed to have a big argument. That was supposed to be the highlight of the meeting. Sagan was supposed to say "no nukes." And Teller was supposed to say "Gigaton bombs."

Instead, they both pretty much agreed that we would do whatever it took to save 5 Billion people from a horrible death, and they both agreed we would use the safest possible way we could all think of to do it.

They were supposed to fight. But, they were just too reasonable. What else would we expect from scientists in front of their peers?

After the supposed fight, everyone stood around and talked in the lecture hall. Gene Shoemaker told Sagan as I stood next to both of them that Sagan should listen to my story. Gene introduced me to Sagan.

When we moved to one of the rooms outside the lecture hall, I asked Carl Sagan if he had 2 minutes so I could tell him my story. But I guess I talked too much.

When I was finished telling him my steam rocket story, Carl Sagan's only comment was "that was a long two minutes."

He never asked anything about it.

But that was ok. There were people here with celestial objects named after them, and I just met a two more.

Brian Marsden

It was dusk, almost dark, and we were waiting for a group to gather. We were milling around at the designated meeting point for someone to give us a tour of really neat, almost the only one of its kind, telescope-maker works. People I didn't know were starting to appear, all waiting and knowing each other. Most didn't know me.

What I really wanted from these guys was where in space I could find water. The orbits of the water objects in space were the most important thing to find out about. Without the orbit data, nobody could do anything. One could not see the objects without the data. One could not verify who saw it first or find out if someone saw it earlier. One could not plan missions. One could not figure the economics, because the orbit data told us how long it would take for a round trip.

I spotted a younger lady standing around waiting, obviously part of the astronomer crowd and, as a way to meet her, asked her "do you have celestial objects named after you?"

I figured that this would be a good line to start a conversation with her. I didn't know any of the half dozen people standing there, so,

given a choice, pick the beautiful lady first. For about 1/4 of a second, I fantasized that this rather pleasant lady, neatly dressed in what appeared to be jeans and astronomer blouse, might talk to me, maybe walk the tour with me.

"You mean did I discover any comets?" she asked.

"Yeah. What do you do?" I asked.

"I work at Palomar," she replied. She startled me because she looked so young, so much unlike Dr. Eleanor Helin and the other Ph.D. ladies of the Jet Propulsion Lab at California Institute of Technology. She looked more like a 30 years younger version of Carolyn Shoemaker, who was also plainly dressed that day.

"You mean you discovered celestial objects?" I asked, again, still totally surprised.

"Could you sign my notebook?" I asked.

Not only did she sign, but she gave me her address.

"Wow," I said, after she signed it. "People who have celestial objects named after them are special." I said. She looked so young to be that famous, I thought.

Mueller, Jean 1993a, PO Box 200, Palomar Observatory, Palomar Mtn, CA 92060

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Ed:Guy M Hurst, 16,Westminster Close, Kempshott Rise, Basingstoke,
Hants, RG22 4PP,England. Telephone/FAX(0256)471074 Int:+44256471074
TELEX: 9312111261 Answerback: TA G          TELECOM GOLD: 10074:MIK2885
GMH at UK.AC.RUTHERFORD.STARLINK.ASTROPHYSICS  STARLINK: RLSAC::GMH
GMH at UK.AC.CAM.ASTRONOMY.STARLINK          STARLINK: CAVAD::GMH
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COMET MUELLER (1993a)

Jean Mueller reports her discovery of a comet on a plate taken during the course of the second Palomar Sky Survey with the 1.2-m Oschin Schmidt Telescope, and provides the following positions from trails. The object is condensed with a prominent coma and a faint tail to the south.

	1993 UT	R.A. (2000)	Decl.	m1
Jan.	2.40833	9 46 45.34	+47 02 27.8	15.5
	2.45347	9 46 42.62	+47 03 05.2	
	3.52708	9 45 28.25	+47 20 23.7	
	3.54792	9 45 27.11	+47 20 37.7	

IAUC 5687

Most of the people standing around didn't know me. So I asked the next person close to me, "Do you know about the comet Wilson Harrington?" And after a predictable blank stare, "1979 VA ?" "No. But I bet Brian Marsden does."

The young guy next to him said "Marsden knows every object up there," and they both laughed.

They meant near earth asteroids and comets, not all the stars.

"I bet you a dollar he knows all about it." said one to the other.

"I'll pay a dollar," I said, interjecting into their private joke about Marsden. They all laughed, but no one took the dollar I was holding. I just wanted to know where the space water was.

I introduced myself, and David Levy told me that Marsden knew every near earth object and comet by name.

"You know the Shoemakers?" I asked. He looked at me rather obliquely, as if I was supposed to know something about him that I didn't. "They have celestial objects named after them."

One of the others then informed me, with Levy standing there, that "Levy here is also an editor of Sky and Telescope."

Levy ignored the introduction and said "I have objects named after me."

He was a bit competitive, as if other guys like Shoemaker weren't the only ones who discovered comets and asteroids.

"You do? Would you sign my notebook?"

He looked at me even more strangely.

Levy had discovered several near earth objects, so I asked him to sign my notebook. Every time I met someone who had a celestial object named after them, I begged them, tricked them, asked them or forced them to sign my notebook.

I pulled out my raggedy home-made notebook. I had cut Xerox paper exactly in halves, punched 3 holes in the pages and connected them with 35 cent rings from a book store. I made the cover from some green plastic I had cut. I opened it up and handed it to him.

Extending a pen to him I asked if he would write the name of one. He didn't seem to understand that I wanted his autograph. It was a bit unusual, I finally realized, since we were just people at a technical meeting, and no one that I could remember ever asked anyone for their autograph, except me. It didn't stop me though.

"I have 17 objects named after me." he asserted. His mannerism were clearly boasting a bit in front of the other guys, as if to say "I find as many important objects as the Shoemakers."

"What's the name of one of them," I asked, as I copied it into the notebook, and handed to him again.

He signed his name, and as he did so I asked if he would write the name of a few others, in his own hand in my book. He did. He wrote a few, and filled the page their names with his rather larger handwriting script.

Levy, David, home: 602 762 5638, 602 621 4200; old: 602 621 4073, FAX 602 621 4933, dhlevy@lpl.ariz.edu, Lunar and Planetary Lab, Univ of Ariz., Tucson AZ 85721, Mueller, 17 objects named after him; smith, james; Lebofsky, Dr. Larry; 2/1/95; scotti, jim; larsen, steve; Aguire, Edwin; Sky and Telescope; Emmy 1997 3 minutes to impact (w/ zuppero)

"You think Marsden will know the orbit of 79 VA?" one of the others asked Levy, as the other one laughed.

Then all 3 of them chuckled, "yeah."

"Wanna bet a dollar?" the other asked.

But everyone was betting that Marsden would know, and nobody would bet he didn't know.

Then the King of Data walked up.

"Speak of the devil. Here he comes," said the other. They laughed. I was missing something.

Dr. Brian Marsden was the keeper of all the data. A shorter fellow, somewhat heavier than me, and very pleasant, and his mannerisms reminded me a bit of a British way, I thought. I could be completely mistaken, because he was from back east, and they talk different there.

Marsden was the director of the Minor Planet Center at the Smithsonian Astrophysics Observatory at Cambridge, Massachusetts.

Then we asked him. "Do you know about Comet Wilson Harrington?"

He stopped for a moment.

"Oh?"

"They bet a dollar you would know the orbital elements" I told him.

"And 1979 VA, that they are the same one."

He thought for another moment.

Sure enough, Marsden said "Oh, yes. I wonder how I overlooked that."

Apparently, he recalled the orbital elements for each, in his head, and compared them and realized they were duplicate entries for the same thing.

He knew that 1979 VA and Comet Wilson Harrington were the same. He was apologizing for not cross-checking the comet orbit table with the near Earth asteroid table, to find the objects that were the same in both tables.

Somebody won the dollar, I guess, and they all laughed. They laughed, and I could never figure the private joke they were laughing about.

However, I got the signatures of David Levy, with 17 celestial objects named after him, and Jean Mueller, from the Palomar Observatory, who had celestial objects named after her, and I had talked with Carolyn Shoemaker, who had several named after her and Gene, and she said "4446" was hers.

I was looking for water, and found people with celestial objects named after them instead.

I kept searching. Water was my main mission.

As we were walking by a huge, 8 meter across telescope mirror blank, in the process of being carved and shaped, Dr. Chris

Chyba told me that nearly all the carbonaceous chondrites were hydrated minerals. He said the objects were likely rubble piles, not hard rocks. He confirmed that the comets really did consist of "kerogen, like dirty oil shale." I thought Chyba would know. He was at the Harvard Smithsonian Center for Astrophysics and wrote several papers on the topic.

He also had an office in the White House, at the Old Executive Office Building, with the National Security Council.

The only data point I got was what Chyba said:

"... nearly all the carbonaceous chondrites were hydrated ..."

and that

"... the comets were made of kerogen, like oil shale ..."

“I'll go anywhere with you...” said the World Famous guy

The sun was shining in the mid morning. We were taking a break. We were standing outside the building on the east side of the north facing door. It was somewhat warm, something like 60 degrees. I had my Pentagon Suit on and so did Dr. Edward Teller. For some reason, he was just standing there, alone in the sunlight near a concrete pillar holding up a building, and without a crowd of people around him, pestering him.

I started talking with him about steam rockets and how they would perform, and he seemed to agree. He was not objecting as he was prone to do. His mind was quick enough to spot weak science and he would let you know immediately and with certainty, and with a Hungarian accent to add to the credibility of the cut. One had to be somewhat careful and not say stupid or flawed things to him.

Since he was the Famous Dr. Edward Teller, he could get important people to let him into their offices. Only a very few people could do that.

So I asked.

"Would you go with me to see Dan Goldin?"

Goldin was the head of NASA. The plan would be to talk with the head of NASA so he could find a way join forces with DOE, and we could all Occupy the Solar System.

Edward Teller replied almost immediately, without thinking much about it,

"I will go with you anywhere to see them."

Then, just after he said it, he paused. He paused long enough that I wondered what the heck he was going to make me do. I could tell he was going to put some condition on the transaction. I hoped I would be able to uphold my end of the bargain.

"You must first make sure,"

he said, as he made sure he paused again, as if to say that an old and wise man like himself gets to talk slowly, deliberately, with authority and decision, and maybe needs to catch his breath and take time to formulate precise dictates,

"that they
want to see
me."

I didn't know what to say or how to react. The important old fart played a joke on me.

He knew that he was controversial. People wrote books about him and about what he told Ronald Reagan about an X-ray laser weapon. Some say he snookered Reagan and even made a sucker out of him.

The Famous, The Infamous Dr. Edward Teller reportedly told President Ronald Regan that the Livermore Lab that Teller founded could make an x-ray photon torpedo phasor weapon that would be energized by an atomic bomb and would vaporize the enemy ICBM in one pop.

"Wow, what a weapon" I thought when I first heard this. "How the hell would they aim the thing?" I wondered, about 10 milliseconds later.

The laser didn't work, of course.

Teller knew, some people would not want to see him, hated him, would throw stones at his house. And he was just not taking himself so seriously. He thought what he said was somewhat funny, and he used it as a good line.

But he did tell me and he seemed to mean it: "I will go with you anywhere..." He could get me into anywhere.

I did not expect this at all.

Survival Of The Lucky

It was now lunch time of the second day. Jan Smit, Peter Sheehan and I were walking to lunch in the mid-winter noonday sun of the southwestern desert. Wispy high clouds whitened the otherwise blue sky. Smit had just taken an hour to tell the audience about the temperature of the Earth for the first few thousand years after the Chixilub meteor crash. He had explained how he looked at the micro-life forms to estimate the temperature. Different forms lived at different temperatures in those days, just like they do now.

"The Earth's atmosphere seems to be like skin, alive." said one of the two as we walked to lunch on the campus.

"What do you mean?" I asked.

"Well, the atmosphere seems to heal. It gets these attacks from monstrous, erupting volcanoes, from space, whatever, and then it heals." One of the two continued.

I was so fascinated with what they said that I did not know who was talking. I was just hearing, listening, staring, at the sky, and then at the sidewalk, entranced by the concept of the entire atmosphere of a planet being the skin of a living animal, that the Earth might be a whole animal. A giant animal, not just its parts like us.

Mars itself could be an animal, with the dirt and surface of Mars being like a skin, conserving the water for the cells of its body. The cells would be the deep underground plants and maybe animals in the volume ocean under the Martian surface. I was going to ask them how plausible that would be, and they volunteered the starting point, a living skin called the atmosphere of the Earth.

After all, this whole meeting was all about 10,000 Megaton bombs hitting earth, wiping out the ozone and most of the species on the planet, and they were saying they believe it happened 150 times during fossil history, not once or twice to dinosaurs.

"The atmospheric skin seems to regulate itself so that the Earth's temperature stabilizes so life can live."

"It's like skin to a carbon based life form" he said.

Instantly the whole concept came together, in less time than it took to say "Wow," that our Life Form is a single Being, composed of trillions of persons, including each and every plant, animal and microbe on Earth, some being just microbes, others being smart enough to walk and talk and go to the moon. Like a picture of the Earth as a living thing, with One, not many, just One living being, with lots of selves, and a skin that covers the whole Earth. All in a flash.

"So who survives?" I asked.

"It's kind of a revolution, not survival of the fittest."

"Yeah, It's Survival Of The Arbitrary." I pontificated. Back in the early 70's Anthony Pasalacqua shocked me with this "survival of the arbitrary" concept, and it seemed to fit. I never forgot that. I even supported it with some math models. Now they were saying they had data.

"Yeah, you know it's survival of the lucky, not the fittest." Peter Sheehan volunteered, because he saw my eyes light up, and my voice give away the excitement of learning something profound about our Life Form. He was initiating one of Jan Smit's favorite conversations.

Jan Smit had just told the whole auditorium about how he dug in the dirt all over the world, wherever he could find a K-T boundary. The K-T boundary is exactly the layer of rock or dirt that dates to when the meteor hit and wiped out the dinosaurs, 65 million years ago. He could determine what temperature the earth was after the impact. He picked out dead microbes, spores, plants and animals in what had been the muck of the ocean back then. He found out what they were, what kind of plant or algae. He found some kinds that could only live in hot water, and others that could only live in the cold. He was looking at the real data.

"The old ones don't want to believe it. You just have to wait till they go away." said one of them.

"All kinds of animals are waiting to take over, just given the chance." said the other.

They kept talking one then the other, rapid fire.

"The fittest are all of them."

"All the different species who survive the rigors of living with all the others."

"Given resources, any of them could be at the top."

"The marsupials in Australia took over the niches that the mice took over on this continent."

"Whoever is there to fill the niche, does so. The Lucky are the ones who get to be there."

"Everything jumps forward when a catastrophe hits. It's like catastrophe spurs progress."

"When you look at the fossil record you see sudden bursts of forward evolution."

They suggested that the evidence was getting stronger and stronger that the bursts of Nature's progress coincided with the great catastrophes.

"I got into trouble with my wife," said Jan Smit.

"I was mumbling about how all kinds of great advances happened during the Second World War. My wife, a sociologist, got mad, like I was in favor of war. I wasn't. I was just noticing how microwaves and penicillin, airplanes, radio, cars, science, all kinds of things happened when the war came."

"I saw it in the fossils."

"When the great catastrophe's occurred, the establishment went away. Whole huge classes of resources became available, untapped. Whoever was there got the whole thing."

This was stunning.

The Aristocracy gets thrown out. All the rules of the rich that keep them rich, vanish. The rich who got richer got removed. The rich were the dinosaurs who dominated. Monopolies get smashed. The Status Quo is eliminated. The Balance of Nature is no balance at all. It is the Deep Rut of Stagnation.

Catastrophe smashes stagnation.

Just like Iben Browning said, "The ultimate decay of a culture is civilization."

What a trip.

TBD

The rest is noise, but was interesting to me.

Gene Shoemaker and his wife Carolyn invited me to have supper with his Chinese visitors.

I sat with them and tried to understand the Chinese scientists. They were so timid. We knew they were very careful and studious scientists.

I noticed that Gene had a really ragged calculator. I could not imagine how he could carry that ragged thing around.

Jia Xian Zhang had a celestial object named after him, 4760 Jia Xiang Wang

Then Gene drove us all to his motel room so he could get something.

As we were getting out of the car in the rain pouring down hard he told me somewhat jokingly, "there's your comet water."

The oceans were probably brought to Earth by the rain of comets when the earth was formed.

Shoemaker, Dr. Gene 2074 RIP 18 July 97 & 4446 Carolyn, @Ginny Kuiper 520 556 -7012, FX 520 556 7014, secy 520 556 7181, Gshoemaker@iflag2.wr.usgs.gov and "ASTROG::GSHOEMAKER"@IFLAG2.WR.USGS.GOV worked 970210; Yolanda -7000 -7011 -7012, Home 520 774 4350, @palomar 18 inch: 619 742 2115, Address: 2255 North Gemini Dr., Flagstaff AZ 86001, {old area code 602 US Geological Survey, P/shoemaker-Levy-9, old prefix: 527, gene @mit: 617 253 1946, secy -9317, usgs astrogeology, 18" schmidt

@ palomar, flagstaff, } yolanda, ginny, marsden, bowell harmon, frank harris, dr. alan sagan, carl beattie, dr. don zhang, 4760 jia xiang wang, sichao, 940906 farquhar, dr. robert w (bob); nozette; Kuan, Pui; 960603space96 harrison schmitt; 960620 ?home sicki; 960624 -->farquhar; 961013reply; 970210 coauthor yes;

Wang, Sichao, Tel: (025) ;64 42 05, Cable: 4793, Telex 34144 PMONJ CN, FAX 25 301459, Assoc Prof, Purple Mountain Obs, Academia Sinica, 2 Beijing Xi Rd, Nanjing, P.R. China, w/ shoemakers HAZ93

Zhang, 4760 Jia Xiang tel: 432817 432700, HOME TEL: 713823, TELEX 34144 pomnj cn, Prof, Director, Planetary Lab of Purple Mountain, Observatory Academia Sinica, Purple Mountain Observatory, Nanjing, P. R. China, Wang, Sichao shoemakers HAZ93

19930104 HAZ93 Hazards of Asteroids and Comets Jan 4-9, 1993, Tucson Arizona, Gehrels ahrens, thomas bowell, ed britt, dan canavan, gregg chapman, Clark cheng, andy chyba, christofer davis, don drobyshevski, dr. ted gehrels, dr. tom greenberg, richard harris, dr. alan helin, glo hills, jack howell, dr. ellen jacobs, cliff jones, tom lawrence, jeff lebofsky, larry levy, david maise, george marsden, brian melosh, jay morrison, david mueller, jean nemchinov, dr. ivan nozette, dr. stu ostro, dr. steve pike, john rather, john remo, john russell, dr. dale a rustan, lt. col. pete ryan, dr. eileen sagan, carl sheehan, peter shoemaker, carolyn shoemaker, dr. eugene sichao, wang smit, jan solem, johndale spalding, dick sykes, mark tagliaferri, ed tedesci, bill teller, edward toon, o. brian venetoklis, dr. peter weissmann, paul west, steve willoughby, allan worden, col. pete yeomans, dr. don zhang, jia xiang

Workshop at LSL

LSL Workshop

Story Line

This part of the story is where I struggled. I could see clearly how we could make space ships to occupy the inner solar system. From Venus to Jupiter, maybe to Saturn. But I could not get the engine of money to turn. No matter what I did, the engine would sputter. The starter worked. The fuel was there. everything was in order. The engine would sputter and die. No matter what I did.

It seemed that every 6 months or so, I would learn something new that just added to my Vision, that would add in a key way, that would make my steam rockets even better. Outrageous new things.

And so it went.

This time, the outrageous thing was the existence of comets masquerading as near earth asteroids, coming by earth every 3 to 6 years, full of ice and hydrocarbons, and, of all things, as if a gift of the extreme intelligences permeating the universe who are our grandparents, amines, the nitrogen compounds necessary for life. That was, another new thing that could change everything we learned during 1992.

That meant there were way stations for us to stop at, and to mine or extract valuable things from, to exploit, to use, to marvel at, to explore. These were "The near Earth comets."

The near earth comets weren't just distant asteroids, mostly with almost accessible orbits. some came by earth's orbit

It was the end of March, 1993. Landing at the Lafayette, Louisiana airport, I completely prepared myself for a punishing and very uncomfortable weather change. I anticipated that the heat and humidity would be extreme and uncomfortable. Waiting out in the front of the airport for Prof. John Matese, I noticed a smooth skinned, somewhat brown complexion woman who appeared to be a student. I waited for the blast of heat and the withering humidity.

"Probably classic Cajun. I never met a real Cajun lady," I thought. I expected and hoped to see someone like her, totally different in build and stature from the blond, Swedish and Norwegian descendants of Idaho.

"It's not as hot as I expected here. I expected the humidity would be a killer," I said, as a way start to talk to her. She was friendly to me, a stranger, and she quickly replied "Oh, it's pretty hot and humid today. And hazy, too."

"See, Cajun's are the friendliest people of all," I thought. And all the rest of our one minute of small talk conversation didn't register.

Her comment made me realize that my anticipation and expectation of extreme discomfort made the real discomfort feel a lot less than imagined. The act of expecting much worse had completely changed my perception of the actual weather. I only felt a little

so closely that the line used to draw the orbit was wider than the miss distance. The computer drawing lines touched and crossed. It was only that both Earth and the comets were almost like invisible points that they miss, most of the time.

Everything was in place. The King of Comets, Gene Shoemaker, was watching out for me and told me as soon as he found a comet we could access. He had also worked out the rendezvous equation, so that we could both figure out what orbital maneuvers it would take to get there and back. He called me as soon as he learned of it. Immediately.

And the story was convincing enough that my bosses and their slow-minded bureaucratic bosses in Washington DC all agreed to give me money to make the Vision come true. They wanted the Vision to come true. The excitement reached into the fast-minded bosses of the Bureaucrats, the ones (Newhouse), whose only constraint was politics.

We got the money for a "workshop," which would let us bring together the smartest and the best and make a statement for the world. I was thoroughly excited. My bosses were excited. The scientists were excited.

We were here to make the statement, to start a new era in for humankind.

After all that commotion, we did not know how to make something of it. And nothing did.

warm and humid, not a lot warm, and not punished. I had just left Idaho and the Idaho Winter. Winter was still raging away because this was only March 1993. Winter would not end till May. I expected the contrast to be unbearable, but it was not unbearable at all. "How strange," I thought, "that now I like the cold." Hot should have been punishment once I had acclimated to cold.

She put out her cigarette. I realized again that my anticipation that the people would be exceptionally friendly made it come true. Back in Idaho or San Diego, the cigarette-lady combination would turn me completely off.

The only reason we were here in Louisiana was that the University of Southwestern Louisiana at Lafayette had the ear of their Senator. Senator, J. Bennett Johnston controlled a huge fraction of the money allocated to the Department of Energy. We knew how to snuggle up to residents of important states with powerful senators. And Professors Pat Whitman and John Matese were the only ones we could find in the whole state of Louisiana that both knew anything about near Earth objects and were also doing something with them. So we picked Pat and John.

Dr. Ted Fay had told us about them first. Ted was from Louisiana and vouched for their technical competence. A joke in

Washington about such choices went "they were the only ones who could read. That's why we picked them." But, these guys were good, in spite of living in a state of good-old-boy sheriffs and drive-in bars. Just after checking in to the hotel, I personally and deliberately walked past a drive through bar that served full-potency mixed drinks that people could drink in their car as they drove away.

Both the United States Department of Defense (DOD) and the Department of Energy (DOE) had given us money for a Workshop. They wanted us to win. Each had told us, off to the side, that "when" the other agency would renege on the money, they would fill in, but don't tell the other agency that.

We had convinced both DOD and DOE that we could change the way humans accessed space. Part of the strategy was to include politics, like working with the University of Southwestern Louisiana.

"We're on a mission now. We're going to get the voice of experts to say that there is water in space, and we can use it to Occupy The Solar System." I mumbled to myself, as I walked across a parking lot finished with thick green plants taller than me, blooming flowers, and lush green, greener than San Diego.

In my hands as I walked was the transcript of what David Morrison told Congress about the dangers of the near-earth asteroids. He actually did get money from the government.

We got money from two big agencies of the government, and we were holding the workshop on the:

Space Energy Resource Discovery & Utilization Initiative

Dan Greenwood, Dr. Robert Zubrin and I arrived a day and a half early. So we had a free Sunday afternoon.

It was a wonderfully sunny Sunday afternoon. Trees and grass were green. Flowers were blooming. The weather was wonderful, clear. Dan offered to drive if we would go with him to a Civil War Battleground Park. He found out that the people would be dressed up in costumes to show visitors how it was during those "recent" times. After that, Dan suggested we go to a bazaar type of bake-sale, booths, Cajun Food fund raiser put on by the local Catholics supporting some kind of girls preparatory school. Both places were in the out-back, so to speak, away from the cities, 40 miles into the countryside. Zubrin and I could not resist. This was too authentic to miss.

At the Civil War park, we parked on a mildly wet grass field and followed groups of 3 or 5 people, walking into the woods, up and down a few gentle hills surrounded by trees in a rather thin forest, along a half mile path where rebels and union forces more than a century ago sneaked up on each other and shot at each other. A few

of them faked some ambushes to scare the visitors. In the open field the people in costumes had set up tents depicting the war zone hospitals and central command.

During the entire time we walked in the park Zubrin and I kept contrasting life in southern Louisiana, which nearly no one outside of here knew about, against life as we knew it in the DOD / DOE / NASA / Washington DC circles, which only perhaps several million people were part of (the military-industrial complex, including universities with their government funding).

We both kept thinking and talking of humans in space, humans occupying the solar system, about vast riches on comets and asteroids, planets and huge ice moons. Humans whose space-trucks were powered by nuclear rockets. Walking on Mars. Space travel. And we were surrounded by 1860 relics. People who were still living in that era, or trying to. People who had no way of forming concepts or mind-pictures about anything other than the warm humid air, the trees, working in the oil patch, alligators in the swamps, the bayou, babies, cigarettes, families. This was a huge mind-contrast.

The most impressive part to me was the medical tent where severed hands and legs were laid out on the table, complete with realistic blood. All the other stuff was just play acting from a Civil War History book. But the cut off hands and legs, that stuck.

The soldiers must have really believed in their cause to be willing to suffer excruciating torture with no pain killers when some so-called doctor would hack their shattered leg or arm off with what looked like a plain old saw. No anti-biotic. No morphine. Flies everywhere. Punishing humidity. Maimed and bleeding soldiers waiting on palates to be tortured one more time by the saw-doctor before they almost certainly died slowly and painfully from infection.

That was when I found out that Zubrin, the Famous Rocket Scientist, actually had an undergraduate degree in History and taught school before working at Martin Marietta as a Mars Nazi. (He holds Masters degrees in Aeronautics and Astronautics, and a doctorate in Nuclear Engineering.) Zubrin was inventing ways to go to Mars cheaply. Everything he thought about, everything he did, every waking moment was focused on The Humans Occupation of Mars.

Everything I thought about was space transport, for the Human Occupation of the Solar system. Every time I looked up into the sky, I could see the dark, invisible comets passing close to Earth, and my steam rocket space ships docking, melting permafrost, separating water vapor, condensing it into pure water, filling the football-field sized bladder tanks, and my steam rockets pushing 10,000 ton, submarine sized space ships full of Occupiers from Earth to the moons of Saturn, the moons of Jupiter, a few hundred dark, close comets, a few thousand platinum-rich, water rich near Earth asteroids.

As we were talking about women, a topic that always seemed to come up when a fertile reminder would inevitably walk by, Zubrin revealed a bit of his personal life. He told me he met his wife and then chose her because, among other more complimentary things, she was "not screwed up and into meta-physics, like most ladies one meets."

"You mean most ladies are?" I asked, in one more vain and pointless attempt to understand the incomprehensible way that females think.

"The vast majority I met were. It's like a disease," he replied.

I only met a few into metaphysics, and one was a friend Terri and I both liked a lot and was not screwed up any more than me or most of my other friends. I felt lucky. Terri was not into metaphysics and was not screwed up and I did not have to go find a new lady among the mob of incomprehensibles.

After that Civil War-contrasting-space experience, we went on to the Catholic Bazaar.

The Academy of the Sacred Heart, 1821 Academy Rd., Grand Coteau, Louisiana, was having the spring fund raiser. Booths with games. Home cooked food. Boudin (booo daahh, they insisted). This was a Catholic girls school. Its inviting, brick main building looked like something out of the past, which it really was. It was the second-oldest educational institution west of the Mississippi. Continuous operation since 1821. Since Louisiana was probably the only really catholic church state, like Utah is a church state for Latter Day Saints (Mormons), it was appropriate that it was the only U.S. site of a miracle recognized by the Catholic Church. One could visit the Shrine of St. John Berchmans. It had some nice, manicured trees around it.

We wandered around the grounds, soaking in the local culture. This was as local as one could get. I liked the bake sale. Chocolate chip cookies. Chocolate brownies. Zubrin and I both liked the book sale.

Dick and Ellen Winchell taught Zubrin and I to eat a Boudin (rice and meat sausage). It was pretty good. Very good in fact. I had to eat two.

*Winchell, Richard M Dick & Ellen 10 kids & de
Upstate NY, H318 984 8251, Ofc 318 233
9337, 318 981 0119, PO 30418, Lafayette
LA 70593-0418, R.M. Winchell Co
Contractor, Bacque, Conge at Grand
Couteau, Academy of Sacred Heart, Boudin
(Boo Danh), USL9303*

"We escaped upstate New York," they said, both of them volunteering when I asked them if they liked it here, and how did they like the weather.

"You found work here?" I asked, because that always puzzled me. What would people do here in the nowhere's land to make a living?

"We have 10 children. I'm a contractor." he said.

"We love it here. Never move back." she said, and both of them just smiled and laughed and bragged about the Boudin and the lifestyle and the warmth. I understood that part, because upstate New York could get as chilly as Idaho, with its dampness and snow.

Again, we had dropped into a different time zone. Zubrin, Dan Greenwood and I were in the modern days, we thought, with people in space, colonies on Mars, massive space mining operations, massive payloads moving between human pockets deep inside ten-mile-across asteroids, solar power collectors on the moon beaming microwave electricity cleanly to reflectors in orbit around Earth, and then down to Earth, electrifying the world of 20 billion people.

"My goal is to be Mayor of the Moon," Dan Greenwood added, "What do you think of that?"

The Contrast was sharp. These people were in Louisiana, at a Catholic girls school, with mothers baking tasty things for visitors to eat so they could support the school. 40 miles from the nearest city. The Civil War was still fresh on their minds. Crayfish and the oil business brought money. Buy a mixed drink and drive off.

Pat Whitman and John Matese took me and a few others personally to a crayfish eating feast that evening. On the way, we passed some swamps with strange net cage things. "That's a crayfish farm," I was told. I wondered what they fed them. Did they feed them corn? Rotten things?

Within 20 minutes, big cauldrons of crayfish appeared in front of us, carried by different family members of the stark but immaculately clean restaurant. It was the only restaurant within miles of crayfish ponds and fields and farmhouses. Picnic tables inside the white-painted cinder block building permitted whole groups to share huge bowls of red mini-lobsters.

Crayfish are min-lobsters about the length of half a human finger and about half as thick. They taste like lobster, but they are so small it takes a handful to make a bite.

"Suck Head, Pinch Tails." they said, laughing and joking about their motto. They instructed me to suck out the head contents, ignore the chest contents and then pinch the tail to squeeze out the little white thing analogous to the lobster tail. They knew their motto had some risqué side tones to it. This was during a time about 4 or 5 years before oral sex in the White House went public.

The only scary thing about the whole deal was that there were real crocodiles in the swamps that could really eat me. At least that was what they told me. The more I asked, the more tales they told me about it.

The Louisiana Cajun music band played on queue. Loud. Very Loud. When I asked them to lower the volume, the old guy who looked like the band was his said "ok," but I could not hear him say it, and he didn't lower the volume at all. They were here to welcome the outsiders, and that was that. The Cajun music must be played loud.

I finally met Cookie Bacque, our conference organizer. I had talked with her on the phone many times before the meeting. She introduced me to the President and a few officials of the university. She told me quietly that Carl Bauer was an oil man who used to be very wealthy before the oil crash. She wouldn't say if he was just only plenty wealthy now. "Some people lost everything," she said.

Carl was a very pleasant person. He talked me into becoming an ABC of the university -- Alumnus By Choice -- and even got me to give them money. Carl was their government relations coordinator.

Friendly types. They put on a wonderful Cajun party for us. "Us" meant a crowd of near earth asteroid people, mixed in with a hefty dose of nuclear rocket people, a few Visionaries, and the Curious.

Cookie Bacque took us to her home and showed us the Mardi Gras costume she had made for her 16 year old daughter Emily and how much of a big deal it was there. Her home was so cozy and warm, and different from California homes of the same wealth level. Her home fit the stereotype of the Cajun heritage, Louisiana Catholic, not-poor version of a suburbanite one might find in suburban San Diego. The big difference between a San Diego suburbanite home and Cookie's home was that the Louisiana version seemed to have substance and an old South sophistication, some real heritage.

We were here to hold the meeting, not to eat Cajun food or to walk around the Civil War parks. Professor Mark Sykes had insisted that a "workshop" was a great idea and would make all our dreams come true. All I had to do was get the money to pay for their travel expenses for all the invited experts. Which I did.

We were here to start the Occupation of the Solar System, to start the Exodus.

First, we would drive rockets to where we would get water in space. We explained how wonderful that was, how it permitted us to haul huge payloads; how we could haul 10,000 tons at a time, and how we did not need to split the water into hydrogen and oxygen gas first, and how we did not need to compress and freeze the gasses into liquid oxygen and liquid hydrogen, and how we

could haul the water in bladders that would weigh a hundred times less than the tanks to hold liquid oxygen and liquid hydrogen.

We told them how all that water would let us occupy the inner solar system.

"Tell us how to make this vision come true." we commanded.

When our morning mandates were complete, 50 experts broke up into 5 or 6 workshop groups and tried to figure it all out. We were sequestered in a nice hotel with a main conference room big enough to hold a few hundred people. The dozen little conference rooms each had felt boards and felt pen easels. The chairs were comfortable. The rooms were air-conditioned. The telephones were far enough away from us that we could not be annoyed by constant callers.

Jim Powell's group figured how they would make the rocket engines, the actual nuclear rockets.

Rick Binzel's group characterized the near earth asteroid swarm.

Marland Stanley and his group showed how we would make electricity for the operations in space.

Clear Profit

Our workshop group was supposed to show how humans could make a clear profit.

Don Summer's words echoed in my head "The conquest of space is going nowhere until there is a clear profit." I made sure I was assigned to that group. That's the key.

"I figured a way to drop the transport cost to dollars, not 10 thousand dollars, not 1000 dollars, but dollars," I mumbled to myself, smiling at my discovery. This workshop group would identify a few things that could each make a clear profit, and we would all win.

"The near earth asteroids have 10 times more platinum than the best platinum ore on Earth," I asserted.

Zubrin immediately retorted that getting anything from space that we could get from Earth would almost certainly not work.

"The iron meteors aren't worth anything. That's a lot of iron, but we have plenty of it here." His raspy voice, reserved for asserting facts in technical meetings, went on. "You think a 1000 tons is a lot of iron? That's how much they load on 10 railroad cars. That's nothing."

I was talking platinum, not iron. He wanted to talk iron. That was ok. And, he was right. I had never figured that one. Everyone, including myself, just assumed that a huge chunk of stainless

steel would be worth a lot. A chunk of stainless steel the size of a football field ought to be worth something.

"They can make that stuff here on earth for less than a dollar a pound. I think they are getting \$150 a ton for scrap iron. That's If you bring back a million tons, that's only \$2 Billion dollars. You can't even buy very many rockets for \$2 Billion." Zubrin added. He figured fast, in a flash. Pretty good for a history major.

"How are you going to stop that chunk of iron?" Dan Greenwood asked.

Greenwood caught on quick. For the last two years, half of the people at this meeting exposed us to "the hazards of near earth asteroids and comets." That 5 megaton chunk of stainless steel hurling towards Earth from a slowly passing asteroid would hit earth with about 50 megatons of atomic bomb equivalent energy no matter how much we slowed it down. It would blow a half kilometer crater in the Antarctic ice, no matter where it would hit.

"What do you do with a million tons of stainless steel?" Blacic asked. He was thinking "how do I chop off a chunk?" He knew that his rock melter would never melt stainless steel.

I didn't know. How would you chop off some of that million ton chunk of high quality, hi strength steel? Dynamite would not work so well. Oh well.

Then I figured how much money we could bring in if we shipped a 1000 tons of platinum back to earth every year. At \$350 per ounce, platinum would be worth about 10 million per ton. So, 1000 tons would be worth \$10 Billion.

"A thousand ton chunk of platinum would be worth about \$10 Billion dollars" I stated, smartly.

"See?" I thought, "that's a lot of money."

"See, it isn't worth very much," retorted Zubrin, in a flash. "The whole world output of platinum isn't half that much. You've just tripled the supply. The commodity price will crash. You won't get \$2 Billion for it. With only \$2 Billion, you won't be able to pay for the rockets to get there."

He was right again. None of us knew how to make a space program with workers on it that would cost as little as \$2 Billion. Anyone knew it took at least \$10 Billion. Most of us privately knew that NASA would need to have about \$200 Billion to send 20 people to Mars.

The world annual production of the entire Platinum Group metals was only about 300 tons per year.

Nothing seemed to work. Nothing showed a clear profit.

How about oil from comets? We all knew that there was more oil, shale oil, kerogen, that we would ever want on those comets.

I had calculated that the near earth comets and the Kuiper belt comets had enough oil shale on them that it would put a layer of goo around the Earth, like an extra layer of ocean. There was enough oil out there to be a threat, not a promise.

"A couple years ago I figured I could drop the price of space transport to less than \$3 per pound." I offered to the group.

Zubrin, immediately, fast: "What's gasoline cost? \$1 per gallon? Gasoline weighs about 5 pounds per gallon, that's 20 cents a pound, delivered to your corner gas station." Bang. He shot me again. His raspy voice reserved for technical meetings echoed in my head. "It's like bringing water to an ocean." he rasped.

Zubrin must have gone through this over and over. He could not find anything worth anything out there.

"That stuff is only worth something to those already out there," he asserted.

The people in space needed the iron and oil shale. The people on Earth had plenty of shale, oil shale. The entire east coast, in a band stretching about 200 miles inland, as long as the entire east coast, and about 1000 feet thick at the surface, is a low grade oil shale. He was right again.

Not many people knew that the entire east coast, from the Atlantic ocean to about Cleveland, and for about 1000 feet thick, was oil shale. I had figured that out during the 1973 oil crisis, for Sandia Labs. The east coast oil shale would last the United States for about 15,000 years. The main reason we didn't use it was that oil was only \$35 a barrel, and the oil from shale would cost about \$100. The next main reason was that we would have to dig up beautiful houses and road to get at the shale.

Greg Maryniak wanted to change the world, too. He had been part of the first solar power from space exercise, long ago, during the late 1960's and early 1970's. He was a young lawyer then, just out of graduate school.

Dan Greenwood and Dave Criswell were here to push solar power from space, and this time from the Moon in space. They were part of the third wave. The second wave failed during the early 1980's.

This time, Criswell and his cronies put the solar collectors on the moon, in their minds. They surrounded the earth with little mirrors, 10 mile across mirrors made of wire mesh, to reflect the microwave electricity down to the ground. The moon would aim the electric beam at a mirror. The 100 or 300 km long transmitting antennae on the moon would focus the microwave electricity beam at the little mirrors, constantly repointing the beam. A little mirror would be turning just the right way, all the time, and keep the beam of electricity focused right on the antenna farm on the ground. The antenna on the ground would convert the beam into DC electricity and power a city or water desalter.

A dime at arm's length. I tried to imagine how big a 10 mile across "little mirror" would be. A dime is about a millimeter thick. A dime at arms length is about 1 mm at about 600 mm length, my arm's length. The mirror would be about at 600 mile orbits. So, the mirrors would be like the width of a dime edgewise at arms length. Not the dime at arm's length, but the dime turned with its thin edge toward my eye. Visible, but small. I put my dime back in my pocket.

They needed space operations to make this Vision come true. That was why Greenwood, the Mayor of the Moon, and his buddy Criswell were here. I could bring station-keeping fuel, water, to their program. That was always an issue: How would they turn the mirrors? Wouldn't they need some rocket fuel or propellant? I brought water propellant in huge quantities.

Dr. Jim Blacic, from Los Alamos National Lab, was following along and trying to come up with something of value.

"How about metals like cobalt or nickel?" he asked. Then he answered his own questions.

Blacic summarized, "The only things that are out there are water ice, hydrocarbons like an oil shale, some precious metals, and a few, billion ton chunks of high nickel stainless steel asteroids. And none of those things work. The big planets have unlimited amounts of hydrogen, helium and methane, but we can't get at that stuff."

Blacic and his buddy Dr. Vaniman wrote a book on what to do with the moon. Blacic had invented a way to melt moon dirt and make a kind of rock-melter drill. He would melt his way deep into the moon with a hot poker, instead of drilling or blasting. What came out of Blacic's rock melter drill was something that looked like glass wool. It was the hole in the moon he was after. The glass wool was exhaust to his device.

Vaniman and Blacic knew that plain old moon dust had 1% high quality, low carbon stainless steel flakes. Blacic knew very well what the objects in space were made of. The stainless steel flake on the moon was already refined. It was embedded in the micro glass rock of the moon dust. It could be separated with a magnet. But not even all the stainless steel on the moon was worth much.

Blacic finally cast the deciding vote:
"The only thing from space that has any value is photons."

"But doing things in space is expensive," I complained, trying to get the solar power from space guys to show their numbers.

Zubrin agreed, "Anything you do on Earth is a 1000 times more expensive in space."

But the solar power guys had their most recent numbers and were ready to defend them till they choked. Everything else we figured would cost far more than what the guys on Earth would charge for the same thing. There didn't seem to be any choice. Solar electric power seemed to be the default winner.

"Instead of \$3 per pound, I have to bring space oil back for less than a dime a pound," I thought, looking at my calculator as the solar power guys kept droning on and on, and finding ways to make their idea better and better.

At the end of the workshop, politics, logic and a raspy voiced Zubrin all converged. Blacic, Maryniak, Greenwood, and Criswell all said "solar electricity from space, beamed down to Earth." Zubrin said "nothing else will work."

I agreed with Zubrin. The logic of all our arguments was just too clear. I came there to find out how to make a clear profit from space. I could easily put holes in the lunar solar electric power beam proposal. So I had to agree with Zubrin, with one extra detail. I left out the space electricity. My conclusion:

"Nothing from space makes money, yet."

At least it was a very nice day, and the evening was planned out for us by Cookie Bacque.

No Shows Knew

The no-shows must have known ahead of time that nothing in deep space would make money yet. The space around Earth was booming. Communication satellites carrying MTV and CNN to dishes everywhere were fueling a revolution. The weather satellites were making weather actually somewhat predictable over times spans of days, which was remarkable. GPS satellites were actually becoming useful. But nothing related to the human occupation of space was going anywhere. The only things that were making money were little satellites that either looked back at earth or relayed TV or communications.

Gene Shoemaker would not come. He called me from the telescope at Mt. Palomar about the second day of the workshop. I picked up the phone on the table in front of the main conference room doors, where a human was taking messages and phone calls for us, and making sure people were happy here at the University of Southwestern Louisiana. In a normal technical conference, that person would be carefully checking each and every person's badge to make sure they paid their fee before they would be allowed in. A few people were milling around.

"Tony, I really can't come. I really have to be here. When we recalculated the comet's orbit, it's going to collide with Jupiter. We I couldn't believe it. The first pass came close, and the second pass is going to collide. This is so exciting. It looks like a string of pearls."

He and David Levy had found another comet and named it Shoemaker-Levy 9.

"You could wait a 1000 years to see one of these. It's a real collision like could happen to Earth." he continued, excited.

John Pike chose not to go either. He had some good reason, but he still did not go. "I have a meeting in Canada that I promised I would attend, long ago. I go there as one of their featured attendees."

"Can you cancel out for a day?" I asked.

"That's a lot of travel," he replied. He was probably right.

Dr. Stu Nozette, a power figure working for Col. Pete Worden, could not make it. He had "important business at the pentagon." Col. Pete Worden asked me "Will Senator J. Bennett Johnston be there?"

It was the only thing that counted. Will the key person actually leave Washington DC and be there?

"No. He said he would, but he will use a speaker phone connected to the auditorium instead. Some kind of important meeting came up."

Col. Worden asked the right question.

Nobody was able to come up with anything really good.

Jim Powell headed a group who would make the nuclear powered steam rocket. They laid out a 15 year plan to get steam rockets going and transporting things through the solar system.

"15 years," I thought, "is way too long. No one will buy that." I wanted something that only took 5 years.

The Washing DC political rule of thumb was any project should show something in less time than the term of the Senator supporting it.

At the end of the last day, a long day, sneaked out the basement door of the hotel, out the back and smoked a single camel cigarette, the real cigarette, the one with no filter. The cigarette was so intoxicating that I got lost. It multiplied my emotional exhaustion. I did not realize that there was no way back in. It was a security measure. I was so stoned from the cigarette, and from the tiredness of the long day, that I could hardly find my way in the dark around the back of the hotel and into the front of the building.

The next morning, when everyone either left or was leaving, Greg Maryniak and I sat in a breakfast diner, watching the river boats and the flowing river water. We talked about how we could change the world. He told me how the solar power satellite concept was ahead of its time, back in the old days, the late 1960's. We talked about how we could change the world, this time around.

Gregg told me that Visionaries have a hard job, and concluded "But I am tired. I have to make a living. I'm glad you are doing it."

1993.03.29 USL9303 29-31 march 1993 university of southwestern louisiana space energy resource discovery & utilization initiative workshop aldrin, buzz bacque, cookie & donnie barlow, nancy usl/lpi bauer, carl & mary jane usl bayoumi, magdy usl binzel, dr. rick blacic, dr. jim, bleeker, col. gary bloomfield, harvey blumberg, duane, usl dean sci bowell, ted brown, stanley doe chu, henry usl comp sci coombs, cass, pod associates criswell, dave davis #3638 don denton, wayne dinkins, sue dixon, dr. frank dort, wakefield dunham, david apl efe, kemal usl fay, jr. fraering, phil gervais, mike channel 10 cbs grechko, georgi cis cosmonaut greenwood, dan haloulakos, dr. bill mdssc hasenstein, dr. karl & cosi hennessy, corey pod hoglan ede, littlegreen, curt (ne steve dunn) & katherine inman, jim b&w johnston, j. bennett jones, tom kuswa, dr. glenn landry, steve leonard, ray lewis, dr. john maryniak, gregg matese, john usl mcadams, jim schauburg saic mcfadden #3066, dr. lucy ann mondt, jacknock, kerry jpl oubre, troy channel 3 katc abc pace, dr. scott patton, john peterson, jerry ge powell, dr. james bnl prialnick, dina tel aviv reinert, rich ball aero robinson, rae. d., roy, ed cajun humorist, rutger, lyle doe ne52 schade, chris osc seetharaman, guna usl sharp, bill shoji, jim rocketdyne stanley, marland inel stetson, doug nasa cose sl/b steward, bob usl wetlands ctr sykes, dr. mark steward obs taylor, tom global outpost trahan, rodney, channel 10 valavanis, kimon usl vilas, faith? warren, john doe ne52 weissman, paul, jpl whitman, pat usl whitmire, dan usl wilcox, brian williams, brian usu tanks winchell, richard m dick & ellen zavadowski, richard zubrin, dr. robert zuppero, anthony inel

Bauer, Carl & Mary Jane @secy Nina Bienvenu Becky & Carol 318 482 6775, and 318 482 5811, FAX 318 482 5102, H 318 988 0898, @WASH DC 202-488-7500 room 619, @WASH DC voice 202-737-2200 room 942, FAX 202 347 5886, Research Office, Coordinator, Govt Relations, ADDR: USL Box 43610, Layette LA 70504-3610, FED EX: 104 University Circle, Ste 340, Lafayette LA 70503, USL ABC (alum by choice); 200 East University Ave., Morton Hall, Rm 304, Research Center, LSU 3 degrees, landry, steve whitman, pat hayes, cong. jim breaux, sen john silagy, eric w johnston cordell, julie & doyle, john @ hayes breaux, john broussard, John E usl9303; 940907

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doug sullivan, kathryn @DOC rather, john smith,
bill tate, glenn shepanek, mark & ellen rettig, walt
werner, jim

930524 JBJ9305 meeting and gladhandings 24-25 May
1993 bauer, carl craig, larry gougisha, michael
hawks, susan hudson, lara johnson, nils johnston,
senator j bennett jones, proctor kemphorn, dirk
martinell, john moore, thomas rather, john
shepanek, mark & ellen smith, bill smith, maggie
stetson, doug sullivan, kathryn tate, glenn
whitman, dr. pat wittmeyer, jane zuppero, dr.
anthony

Louisiana 1993

March 1993 University of Southwestern Louisiana
Shoemaker was just finding the string of pearls
then smashed into Jupiter,
and no one cared.

Blacic says "the only thing worth bringing back is photons."
nothing in space is worth it.
it all costs too much compared to doing the same thing on
earth.
too much means orders of magnitude to much.
100,000 times too muchy

\$100 K per pound must come down to \$0.1 per pound. I
could bring it down to about \$5 per lbs. but there is another
factor of 100 to go. I knew it.

~~Criswell was happy with the answer that photons were the
only thing, because he wanted lunar solar electric power for
the world.~~ Criswell was in charge of that meeting.

and the schedule: it was way too long.
Jim Powell and his group find that the schedule to just get
something at all is 15 years. Too long. way too long.

the moral of the story:

too expensive, too long a wait, nothing worth it.

The great Senator J Bennett Johnston, was supposed to show up. Instead,
he just showed up on a telephone, a speaker phone. The important people
came there to talk with J. Bennet Johnston. He had his hands around the
Department of Energy money.

J Bennet Johnston, Senator

"!hydrocarbons!" when I showed him a picture of comet halley. really
got his attention. Senator Barbara Boxer's call terminated our big
meeting
he offered a "hearing" on the subject.

long table, everyone sat around. I was to his right. he was at head of table.
John Martinell from INEL DOE to make sure we didnt'say things that
were illegal or that would get us fired.

we blew it again. we didn't follow through and get hour hearing in
Congress.

archaea bacter, deep down, chemisynthetic, not photosynthetic,
means life everywhere.

930524 JBJ9305 24 May 1993 johnston, senator J. bennett
gougisha, michael moore, thomas whitman, pat bauer,
carl, martinell, john hudson, lara jones, proctor

- **solitary space confinement**

Solitary Space Confinement tbd

solitary space confinement

Iowa State, featured evening speaker,
questions, answers,

"you ruined my fantasy about space," said a thin male, regular kind
of person, possibly graduate student, but looked like a 25 year old
Junior or Senior.

I was taking questions as fast as they could send them. They asked
everything. I answered with bytes.
then a younger fellow walked up smiling and said

"I thought space was the ultimate freedom.
You ruined my fantasy. You showed how it was captivity."

that's real. space has no space. It is like the vast freedom you get
in a boat in the ocean. lots of place to roam. but only your boat to
live in. same as space.

19940204 MCSDC94 Mid Continent Space Development
Conference, 515 292 2619, FAX 294 8216, PO box 2465, Ames IA
50010, Early, Brenda K, ldr, Bell, Steve, Co leader Ramsey,
Jeanette Pgm Chair Iowa State Iowa space society, National
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bell, steve sr. aero co chair calkins, tad de usu cormier,
len ssto bus early, brenda k conf chair "set the hook"
fisk, kimberlee pres iowa space soc flatau, dr allison calkins
prof garver, lori exec dir. ad astra gaubatz, bill dc-x
gunger, jon grad stud will call hale, joe nasa human factors
hartsock, dana huset, ben conf video kozak, john
lowther, scott paleont meyer, austin aero driver mittan,
tom will call me speak muncy, james osterberg, inger w/
swartze ramsey, jeanette ruchs, karmen "fox"
sanders, prof wallace seversike, prof leverne & carol
shostak, seth smith, shirley & jerry nss chicago snow, joel
swan, dr patricia vice provost isu sees gibbons swartze,
bernard group chair tiala, sylvia teacher ref shoemaker/ostro
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15nov94 & ltrs Ramsey, Jeanette (515) 292-2619; Gonzalez,
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gaubatz, dr. william mcDonnell-douglas, delta clipper; hughes,
mr. frank johnson sfc, chief of spaceflight training div.
(astronaut training); huset, ben; kessler mr. thomas
international space enterprises; lauer, charles j. u. mich., near
term real estate business park in orbit; lowther, scott & parents;
miller, jason; moorman, cory; potter, dr. seth new york
university, solar power satellites; schele, tony; sears, john;
shaland, ms. irene nasa lewis, international cooperation and ssf;
shostak, dr. seth seti institute, the search for extra-terrestrial
intelligence; smith, shirley & jerry; stringfellow, steve q's all
nite; tedro, matt; tiala, sylvia; seversike, laverne; riley, roger
ch 5 woi tv; vaughan, dr. arther jet propulsion laboratory, hubble
space telescope; wright, dr. bruce boeing, space station; zubrin,
dr. robert martin-marietta, colonizing mars; zuppero, dr. anthony
idaho national energy lab, h2o and mercury's poles;

19960223 MCSDC96 23-24 Feb 96
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McElroy, Christopher D; President of MCSDC96; Osterberg,
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Swartze, Bernard; Tiala, Sylvia; Webb, David C; Zubrin, Dr.
Robert

Nancy's Ice Ship

Ice Ship Nancy

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It was the winter of 1993, Idaho Falls, Idaho. Our secret, Department of Energy Sigma 3, Q-Clearance office complex with no windows had that characteristic orange pink glow of the special, low heat output lights. The air was sterile but constantly circulated and maintained at a constant temperature, regardless of what the bitter Idaho winter blizzard was doing outside. This was the Idaho National Engineering Laboratory of the Department of Energy, and we were almost designated by Washington DC headquarters to be the test site in charge of the testing of the nuclear rocket engines to take the NASA people to Mars.

In the main area, our office spaces were delineated by chin high portable walls. Dick Struthres, Mike Jacox, Chuck Olson, an office with piles of mover boxes full of stuff, John Rice, Brenda Monson, Tom Hill and I had office spaces here. Marland Stanley's office had a door because he was the Boss. Next to it was an office with a door and the secret safes. Behind John Rice's office was a secret conference room that would hold 10, with a door.

I had claimed an old, single seat lounge chair for my office so visitors could at least sit. The office cubicle was so small and cramped that the chair was squeezed into such small space no one could sit there and talk.

Everything in our complex was crude and tasteless, just like all of Idaho Falls, which also had no taste. A typical engineer would come to work here at the INEL because of the hunting and fishing, not because of the work. And the weather was so cold that all the carpets and furniture wore out and got dirty because of all the heavy boots and heavy clothes everyone had to wear. Feet tore carpets and abraded steel foot rails with scratching, stone laden mud. It made our office complex space look like it had not been maintained since 1970.

Dr. Lee Plansky kept pestering us to let him be part of the space work Marland Stanley and our group was doing. Marland did everything he could to avoid Plansky. Plansky would telephone us, because he could not get past the security locks and into the secret room, and he would go on and on incessantly about the philosophy of some space topic, like the human value of sending rockets to asteroids. He would get some of the facts mixed up, like all of us, but definitely got all the priorities mixed up. He was not in the loop, so no one told him the priorities.

Plansky was someone you would want around for his 10% good ideas, but would want to chase away for his 90% poorly thought out ones.

If we would see him socially, because we did not run away fast enough, he would pull out a European-looking, roll-your-own cigarette tobacco pouch and roll a messy, spit soaked, tobacco-leaking cigarette and light it. Lit and burning tobacco shreds would drip and fall glowing to the floor. His voice would then gurgle obnoxiously as he babbled. I like him.

I am making fun of him, but don't you make fun of him. You want him around. His European Scientist culture is different from ours. So we make fun of him. But, we need him and his culture to be here, adding.

Plansky made sure we knew he was an exile from The War, having escaped or migrated out of Austria, and that socialism would be a really good way to run technology.

"We should tax all the new technologies and pay those people who are put out of work by them." he asserted, in a deep, tobacco-gurgled voice.

I didn't run away fast enough when he tried to start that conversation. I faked that I had to run to a meeting and that I was already late. I never heard the rest of the story. There were some parts of the European Scientist Culture that I just could not live with, and Socialism was one of them.

You ought to meet Plansky. You would like him.

He did one very good thing during the 8 years I knew him. He introduced us to Nancy Linarez-Royces. She was working in nuclear safety and reliability somewhere in the bowels of the technical buildings. And she wanted to get a Ph.D. no matter what. Plansky had created a "syllabus" for a course on space with the University of Idaho and talked her into getting a Ph.D. in some kind of rocket science. He convinced me to co-teach the course, and got me an "Adjunct Professor" position at the University of Idaho.

We were now Nancy's thesis advisors, and "Professors."

Nancy could think and figure, and she needed something that would bring her a Ph.D. related to space. Maybe fame, too, but she wanted the Ph.D. first. Everything she did aimed at it.

A good first step would be to pick a topic, write a paper on it and publish it. I was looking for a co-author for the topic.

"Lets analyze making a space ship out of ice," I asked her.

She tried not to act too surprised. It was rather strange.

"When I was back in San Diego, before I came here, I discovered that a space ship made of ice would not fly apart if it were spun just barely enough to make a synthetic gravity. The ice is just barely strong enough. We should do a little study and write a paper on ways to make space ships out of the whole class of materials we can find in space."

She did not know what I was talking about. In my mind I told her everything she needed to know. However, the blank look on her face told me I better start from the beginning. So we did.

"We are trying to make big space ships cheaply," I started. I really meant "inexpensively," not "cheap."

"We have to have gravity, or we die. We can't live the zero gravity of space. Our bones loose calcium. Our immune system fails. We become a basket case."

"Buzz Aldrin, the second guy to walk on the moon, told me " "If we make two cages, tie a 100 meter cable between them and spin them out there in space, the people in the cages will get thrown against the cage as it spins." "

I spun my right hand like I was holding a string with a stone tied to the end of it and spinning it like a child does, just before he lets it go to make it fly through the air.

"If they did not have any windows, they would have a hard time figuring out that they were spinning. This is Buzz Aldrin's concept."

She now seemed to understand a little, probably because I also took a sheet of paper and drew it.



"The only telltale symptom they get is that their head is moving at a slightly different speed from their stomach."

I pointed with the pencil to the guy's feet, and then to his head, and then to the center of the spinning thing.

"Their head is closer to the center of the spin. The stomach is farther."

"So what does that do?" she asked.

"They throw up. They would get permanently sea sick, in space," I replied, trying to be graphic about it.

"So then it doesn't work," she asserted bluntly. This meant she really did follow what I was saying.

"No. It works, you just have to make the string long enough," I replied.

"So why doesn't NASA do this?" she asked.

"The string has to be too long, and the cages become too heavy."

"Why are the cages too heavy?" she asked.

"Because you have to shield the people from the intense radiation from space."

"So where does the radiation come from?" she asked, "your nuclear reactors?" She knew that our group's mandate was to operate full scale nuclear reactors in space, both to make electricity and to run the rocket engines.

"Nope. Space. Space is radioactive. Cosmic rays. The Galactic Cosmic Radiation."

"What about the nuclear reactors?" she asked. She was, after all, earning a living in some kind of nuclear safety / reliability area related to nuclear reactors.

"Oh, we shield the reactors." I used the same line Buden used on me. I set her up and she fell for it. But she didn't seem to be too much impressed.

"How bad is it?" she asked, referring to the radiation from space.

"About 45 rads per year," I answered.

She looked at me with a calculated, thinking stare. Immediately I knew she knew I did not work in the radiation field. The scientists had long ago changed the name of the unit of measure for radiation, and I never caught up.

"I don't know how many milli-Sieverts that is. I'm old." I quickly said, showing that at least I knew that they changed the name from "rads" to Sieverts.

Cosmic rays hit the surface of the earth and give humans in Cleveland or New York about 0.06 in a year. In Denver it is more like 0.3 per year because they are mile up. The air is thinner at higher altitude. The air shields the Galactic Cosmic Radiation. There is less air between them and space. So they get more cosmic rays.

"We have to shield it and bring it down to 5." I said. She knew what all the numbers meant.

"5 per year is what the old Atomic Energy Commission back in the 1960's would let radiation workers get. If they get that much today, it's an incident. But, astronauts can live with 5." I said.

"How bad is 45?" she asked, wondering just how dangerous it would be to just ignore the radiation. After all, NASA was planning to send people into space for 2 or 3 years, to Mars, and NASA didn't talk about shields.

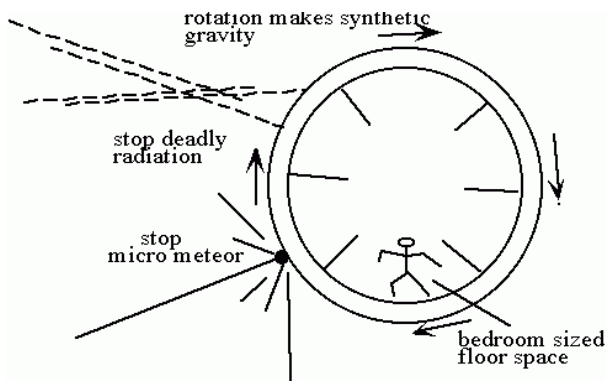
"I think 45 means you get a 1% chance of a deadly cancer for each unshielded year in space."

"So, what do you have to do to shield it?" she asked.

"Use 3 feet of water," I replied.

"Ok. Is that why you use ice?" she asked.

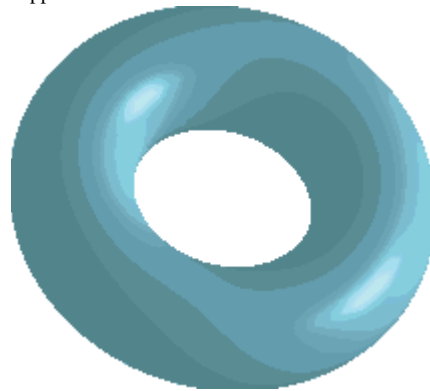
It wasn't exactly clear where I was going. But in my mind it was all clear. I was making a ship that provided everything we would need to live ok in space. I had a synthetic gravity so we would not get sick. I made it big enough so we would not go crazy penned up in the small space for a year. I made it thick enough so the deadly radiation would not kill us. And I even armored it so that small meteors would not puncture our living space and let out our air. But that was only a picture in my mind at this point.



"Well, no. The radiation part just told me how thick it has to be. I use ice because I already have the water out there, in space, and the bag bladder to hold water doesn't seem to weigh that much."

Her facial expressions indicated she was not quite following.

"What I really want to do is make
a big round torus,
an inner tube,
like a car tire,



100 meters across,
as big as a football field."

I used my arms to make a big wheel.

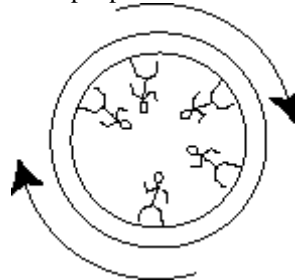
Then it hit me like a flash. A much better way to describe it was to use the room we were in.

"See this room, those walls,"
I pointed to the walls in our office complex.

"This whole thing is rotating, slowly."
as I stretched out my arms and pointed to the walls, slowly turned, rigid, 180 degrees. It was symbolic for the whole room rotating.

I walked over to the wall, put my fingers against the wall and let "my fingers do the walking", like that old TV commercial for using the Yellow Pages.

"The people would be walking on the wall, like that."



She started to laugh. John Rice laughed. He was watching Nancy carefully, because he noticed just like I did that she was thin, younger than either of our wives, smart, and good looking. Of course, John was just carefully listening to my story. His office was 4 feet behind mine and against another wall.

She now understood what we were trying to do. So did John Rice. So did Chuck Olson, whose desk was next to mine, against another wall. They all decided to take a break and listen to my story. My office was in the middle of the office spaces. I was the new guy.

"When you wander up to an asteroid or comet, you can just take as much stuff as you want of that old asteroid. You use it to make your space ship. If you're near a comet, you have lots of water,

so you can make the space ship out of ice. If you're next to an asteroid, you can make the walls out of brick. Make brick rock out of the asteroid dust. That's what I'm trying to do."

"Oh." she said.

I guessed it was clear.

"If we just launch a balloon, a bladder and a mold, something that looks like the final spaceship when it is inflated, we can inject the walls with the stuff, and get a space ship."

"The important thing is that we don't have to put together." I explained, jumping ahead with my thoughts again and assuming everyone would completely follow my logic.

John Rice walked closer to my desk and joined in.

"What are you trying to do?" he asked.

It was somewhat hard to describe, even though it was very simple.

"I want to inject water into the walls," I said.

"OK," John nodded.

"or brick mud, or cement mud, or liquid lava. When it hardens I got a space ship." I added.

"Oh," John Rice said, and with his face he said he understood, so it didn't need any more explanation.

"You just have to wait for it to freeze or harden up, right?" he said.

"Right. The easy way to get the right shape is to use an inner tube inside of an inner tube. You fill the space between them with water."

Their faces showed they understood the first part, where water turns to ice and cement mud hardens into cement, but they didn't see how I was doing next.

"A smaller balloon inside of a bigger balloon." I said, trying to pick a better mind-picture.

"Imagine you inflate the inside balloon with air or some gas. Then you inflate the outside balloon with water."

That should have been clear.

It wasn't, apparently. First I told them I was spinning a room, then I told them the room was like an automobile tire, and now I had balloons, spheres. They were trying to imagine who to spin a sphere and have balloons inside of balloons. It was all very confusing.

"OK, I want a doughnut-shaped bagel,
as big across as a football field,
with the outside nice and crusty

with the insides eaten away by ants and cockroaches.

What's left after you eat the inside is the crusty shell.
Now you have a crusty bagel shell.

You got an hollow space inside the bagel shell.

Now coat the inside of the bagel shell with plastic.
Coat the outside of the bagel shell with a plastic.

See? You just coated the walls with plastic.

the inside plastic is a tube.
The outside plastic is a tube.
They are almost the same size. Only the crust is between them.

You still got an empty space
inside the inside bagel shell."

I waited for a second, to let them realize what was going on. They were supposed to see that the people replaced the soft part of the bagel, and the crust of the bagel was covered up completely with plastic. I could not tell if that's what they were thinking, but I kept on talking.

"That's where the people are. Inside the bagel shell. After we made the bagel shell space ship they filled the inside with their stuff.

Remember, this bagel doughnut is as big across as a football field.

And the real one isn't made of doughnut dough.
It's made of water ice, or cement, or ceramic, or brick.

Now cut a little hole in one of the plastic covers.
Squirt water inside where the bagel crust is,
not where the people are, but in between,
where the crust is.
Make the crust wet and mushy,
and wash all that stuff out the little hole.
Now you have two empty plastic bags where the doughnut shell was.

Inside the inside plastic bag is empty, where the bagel dough used to be.
The space between these two bags is where the bagel crust was."

"OK?" I asked.

"OK," Chuck Olson said, smirking a little and clearly trying to humor me, so I would continue the story.

"All I want to do is launch the plastic bags."

"OK," Tom Hill said, smiling, almost laughing in my face. This was getting to be a party.

I continued:

"First I inflate the inside bag, where the people will be, with air.
The outside bag is loose around the inside, inflated bag.
It's like a loose skin around the inflated bag.

Now, squirt whatever we can find already in space into the little hole,
into the skin.
That's the space between the two bags.
It's the wall of the space ship.
When it hardens, we got a doughnut space ship,
and all we launched was the plastic bag."

I was waving my arms and describing it like a good Italian physicist.

"It's a huge automobile tire, one or two football fields across."



We put the people inside.
When the tire spins, the people get thrown against the inside wall.
They think it's gravity.

"How fast are these guys spinning? Aren't they gonna get tumbled, like the inside of a clothes dryer?" interjected Chuck Olson. He was always rather quick and rather practical.

I could see people tumbling inside the clothes dryer, with that frantic look on their faces, their wide open bulging eyes going by the little round window as they tumbled.

"No, no, that's not how it is. It rotates slowly. Like in that movie, 2001. About 20 seconds per turn. They're thrown against the wall. They don't tumble.

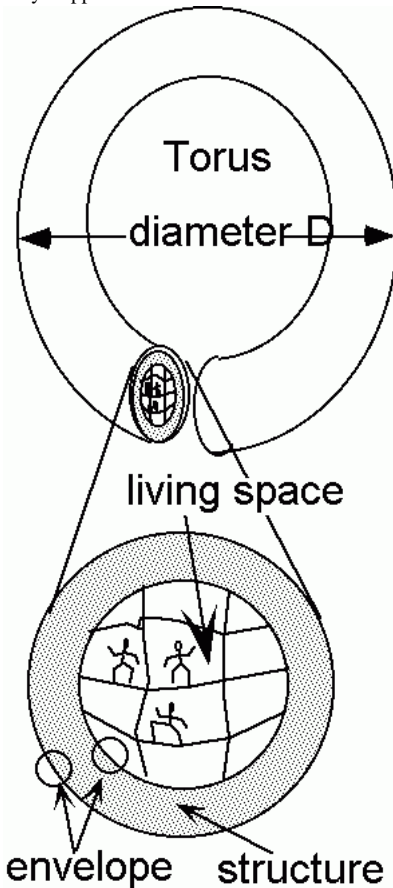
"So, how much does the bag weigh?" Tom Hill asked. He was practical, too.

"20 tons. Depends on the ship. It would fit in the shuttle payload bay," I replied.

"Aye. All right," Tom Hill exclaimed, somewhat clapping, "that's pretty good," and he smiled, grinned, along with everyone else.

I guessed they all must have understood because they dispersed without asking too many questions.

In my mind it was clear.



\ Fig-2-torus.gif

It took a while for them to see, a few weeks, but the details were easy to work out, and the concept was trivial. Everyone liked it.

It really wasn't that hard to do.

The Doughnut Space Ships

We started work on the concept. Nancy and I had to make sure we picked materials that had enough strength. We did not want the ship to fly apart when we spun it.

"Can you just imagine if a meteor hit it?" I started, with Nancy.

"What do you mean?"

"If a meteor hits it and cracks it open."

"Everybody will die," she said, surprised.

"No, I mean body parts, silently floating through space."

I opened my eyes as wide open as I could and stared. I stretched out my arms, opened my mouth wide open gasping for air, and slowly rotated as if floating through the black of space.

"Foaming blood freeze drying as it pours out of their mouth, into the vacuum of space," I continued, making a motion with my right hand by my mouth like blood-red foam was pouring out.

"Stomach trying to come out your face. Eye veins bursting."

"Stop!" she demanded.

"What-you-think-such-bad-things-for?" she said in her strong Venezuelan accent that sometimes came out when she got upset.

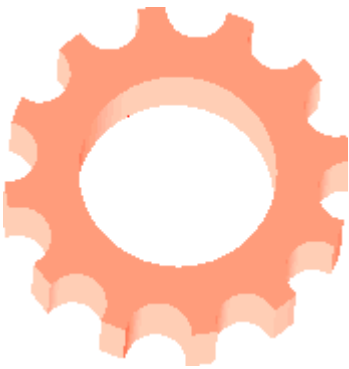
Nancy's part was to go find tensile strengths for things like steel foils, brick, cement and ice. She had to go find how strong various kinds of plastic bag would be. We also considered using thin steel foil as the bagel doughnut wrapper.

With a steel foil as the doughnut wrapper, we could squirt liquid lava into it and have a ceramic space ship when it cooled off. I wondered if brick or lava ever developed cracks when it cooled.

"You think there'd be cracks in the brick? When we spin it, the thing would split in three?" I asked.

"I don't wanna hear it. Don't talk about it." she commanded, starting to reveal a female-type displeasure that could turn into a loud voice and unpleasantness if I didn't just shut up.

I used my computer to draw what I thought a brick space ship would look like. When I was all done, it looked more like a gear than a tire. But, we could make it any reasonable shape we wished. I thought that maybe individual sections, the gear parts, would be nice, individual quarters, with some privacy.



Brick Space Ship

All I had to do was figure how much each of the pieces would weigh. I analyzed various kinds of doughnuts. I looked at thin doughnuts, more like the tire of a racing bicycle. I used thick doughnuts, like a real doughnut. I used really thick doughnuts, shaped more like those really flat, wide tires that racing cars use.

The thick doughnuts are unstable and could eventually rotate the wrong way, end over end. The thin, racing bicycle tire didn't hold enough people. The bagel tire turned out to be the best shape.

We considered cement as the filler, to make a cement space ship. Mix Moon dust and water and you get cement. Presumably,

asteroid dust and water would also make cement. Some asteroids are made of clay. So we considered wet clay as the filler, to make a brick space ship. I would fire the bricks with a mirror in space, focusing the sun on it.

Or almost dry clay dust, heated with sunlight, to make a ceramic space ship. I thought if we melted the dirt, like Jim Blacic did with moon dirt, we could make a lava space ship. When it cooled, we would have a lava rock space ship. We would need that steel metal foil wrapper for the lava space ship.

Before I ever started, I knew the simplest idea would work. A few years earlier in San Diego while I was at the Village of the Damned, looking for a job, I had already calculated that ice was strong enough to make the kind of ship I needed.

The Bag

The whole Idea was to find a way to make the bag with low enough weight. The plastic bags into which we would squirt water or mud or lava. If the bag did not weigh too much, the idea would be good. If the bag was too heavy, the whole Idea would be kaput.

I felt a bit of suspense. Until one actually does the calculation, one just does not know. The first time I did it was with a hand calculator. I only estimated the answer. This time it was a full blown spreadsheet model.

Will the bags weigh almost as much as the ship? Will the bags be so heavy that they weigh more than the Shuttle? Everything rested on the weight of the bags.

I used a spreadsheet to figure, and I double checked the relations. And to my surprise, nearly every combination of every ship I tried gave a bag that weighed less than the Shuttle.

Not every combination of space ship worked out. When the ship got bigger than a few football fields, the ship would fly apart when I would try to spin it fast enough to make gravity. That was because the big ship became way too heavy. (It scaled as the cube of dimension.) When the ship got smaller than a football field, I would risk having permanently seasick people in the space ship, throwing up all over and making a real stench.

So, the only space ships that seemed to work were those with masses between something like 8,000 tons and 100,000 tons. It was just a fortunate coincidence that between 1 and 3 nuclear heated steam rocket engines could push those sized space ships to Mars.

These space ships would hold between 20 and a few thousand people. This was very much like submarines, just like Dave Nickerson said back at Electric Boat.

We only tried to make space ships that a steam rocket could send to Mars and that was not too heavy and that would not fly apart. For all those space ships, the bag was not so heavy.

The bag typically turned out to weigh less than the Shuttle Payload. The bag for a bigger ship would weight like the shuttle itself.

What a relief.

The People

The important part was the part where we put people into the space ship.

"How much space should we give each person?" I asked Nancy.

"Well, ju can't have them go crazy in thee small spaces," she said, with a bit of Venezuelan inflection in the words.

"How about 4 people in a 2000 square foot house? That's like 100 cubic meters per person," I offered.

Nancy didn't know anything about how much space astronauts were allotted. All I knew was that they were way too cramped. One time I looked inside a space capsule on display in the Smithsonian Aerospace Museum in Washington DC. It was really cramped. I would never go into space under those conditions. It looked like a cramped two seater car, with old fashioned electronics from head to toe, elbow to elbow, and no bathroom. I would be horribly claustrophobic. I was told, confidentially and off to the side, they pooped in their pants.

So, I chose to put 4 people in a house almost as big as the first house Terri and I ever owned. That would be how much space each person would get, 1 / 4 of the house. That turned out to be about 100 cubic meters. It was also the size of the largest hotel room in Idaho Falls. I had measured one. It also turned out to be the inside volume of the entire space Shuttle. That meant that I was giving each astronaut as much room as the entire space shuttle.

It seemed like a lot at first, compared to NASA standards. On the other hand, the Ice-tro-nauts would be stuck in there for a couple of years.

When I used 1/4 of a house per person, we discovered that a moderate sized ship, as big across as a football field, would hold one or two hundred people. When we calculated how much mass the ship would take, it came out about equal to the payload that a steam rocket could deliver to Mars, given comet water as the propellant, something like 10,000 to 20,000 tons.

Then I recalled my visit to the General Dynamics Electric Boat Division in Groton Connecticut. I had learned how the United States Navy put one or two hundred people on a submarine. The number of people was no accident. They chose the people for their skill mix.

I also remembered that the displacement of a submarine was something like 10,000 tons. That meant that for about 100 sailors on a submarine, each would get about 100 cubic meters. My ship would give astronauts about the same volume as sailors on a submarine. I found the submarines comfortable. But, I was never

on one for more than a few hours. So, I was no expert, but that's what they get, 100 cubic meters.

The most captivating space ship was the simplest one: the one made of ice. So we made that one the baseline space ship.

When we were all done we wrote a story telling what we did and prepared to publish it.

That's when we knew we had a good story. Both the space ship and the number of people were just right. The launched bags to make the ship would not weigh too much. The ship would not fly apart when we spun it fast enough to throw the people against the outside wall, fooling their bodies into feeling "gravity." The ships walls would shield against the deadly Galactic Cosmic Radiation.

The Technical Meeting

I was well prepared. I got to go to the meeting. But no one had any money for space topics, so Nancy Linarez-Royces did not get to go. The meeting, named SPACE94, was held in Albuquerque New Mexico, 26 February through 6 March, 1994.

The room held about 30 people. Random chairs were facing a viewgraph overhead projector and the screen behind it. We were assigned a technical session where graduate students and a few professors presented all kinds of structural topics related to space. What they said and showed was interesting. One of the respected elders of the field, Dr. Willy Sadeh, was in the audience. Most of the graduate students presenting papers were his students.

And the bad news was that nobody cared. I expected Prof. Dr. Willy Sadeh to tell us we had a great, stunning idea. But no. He was pushing what his students did. He shrugged it off. If it didn't bring him or his students any money, he wasn't interested.

No one cared. No one seemed to notice.

1994 Published Ice Ship with Linarez

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weaver, dave nasa john son willoughby, alan analex
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& carol SNLA Hi CONSEQ campos, angela snla cooper,
arlin snla cox, david LANL CORE COMP STRAT
PLAN bastian, rich hartford, jr, allen lanl martinell,
john swanson, basil EVE #2 sanchez, felix & clorinda
& bryanna gabaldon, rich (X&debbie bird of paradise)
zuppero, jennifer

SPACE94 Actions Items:

“get the right, important people educated.”
USU abstracts due 2 may 94
send neo data to steven brody, nasa, under pilcher’s group for adv code
sx
send DOE NE-52 document to:
cassandra coombs
david criswell
send hubert davis data on neo space for clementine links
journalist and public are wrong audience for getting money foley

Foley, Theresa 505 982 7867, FAX 505 986 9911, 703 658
8411, Sr. Ed. Space News , PO 9913, SANTA FE NM
87504, Bruce asst, garver, lori 22FEB94 space94
interview

dave weaver said says to preface each talk with why we go to space

It was always fun to go to these meetings. I would always meet wanna-
bee's. These were the people who "wanna be" space travellers.

19940226& SPACE94 26feb-6 mar94 space94 zuppero, anthony
(1-800-space94 (772-2394)) artis, don blair, brad brazell, james
shaker up brody, steven nasa nederlands coombs, cassandra uofhi
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clementine dow, stacy foley, teresa galloway, dr. rodney gorin,
barney fairchild robots graham, rex abq jrnlst hart, peter hey, nigel
snla pubs hollinger, james s hopkins, joe boeing jenkins, lyle
johnson, stewart conf head lauer, charles perigrine leo bus. park lin,
zhu yi little, samuel love, judy planetary society abq mahadevan,
sankaran, martin, bob ch13 news maryniak, gregg futron mendel,
wendel monaghan, daniel koat ch 7 abc nash, thom l inel robots
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foundation spoke up @weaver schiftbauer, bill william, bumines "10"
schwartz, milton architect seboldt, wolfgang taylor, julie asce lady
taylor, tom weaver, dave nasa johnson willoughby, alan analex

AF Academy and Dr. Prof. Lt. Col. Beason

Scene name time: US Air Force Academy, 1994

Scene: talking to the students

Expected: students and the usaf academy would be interested

Unexpected result:

- only one student took it seriously
- "**Have a Nice Life**" he says

Color: the vanilla smell of the ponderosa trees, timelessness, the mountains in the background

His reaction: he retired from the white house tour to be a us af teacher

My reaction:

- nobody cares

What I decide to do next: try to change my career. Maybe make miniature electric generators, with the solid oxide people.

The late afternoon flight from Albuquerque to Colorado Springs was quick. The snow-capped rocky mountains did not look that steep from the airplane window. We passed over snow white peaks, spots of grey dirt above the tree line, and forests fanning out and down the hills. I thought I could see individual ponderosa trees. We must not have been that far above the mountains. I had to run and rush to catch the airplane for my speaking engagement at the United States Air Force Academy. I was ready to speak to their physics and aerospace class. They wanted me to tell them about the steam rocket and comet water ice. I was so glad I made the plane. Missing it would mean I would miss the chance to speak to the Future of the United States Air Force.

Bill Teague's mild manners, his smirking smile and poking, dry humor never seemed to change. Bill was a mild mannered aerospace engineering boss. It often happened that someone I knew would be living at somewhere I was going. It was not really an accident, because I would go to places that had big, aerospace activities, and that is where my colleagues often worked.

Bill Teague had hired in at Sandia about the same time as I did. Twenty five years earlier, his wife Carol had the body of a hot model and the demeanor one would expect of the wife of a rich southern gentleman. Terri, my wife, became a model, getting paid to show off clothes and lingerie. Teague loved 4 wheel drives and so did I. Our families went on several desert and mountain day trips together in New Mexico. We found all kinds of petrified wood, because it is everywhere in New Mexico, and many ways to get stuck farther into nowhere than any 2 wheel drive could get to with a tow cable.

Bill and Carol settled in Colorado Springs. Carol was looking slightly older now, but still looked and acted very dignified. She ran races up the mountain, to Pike's peak and back, for exercise. It kept her thin, and damaged her back and bones.

When I called to see if we could meet for supper Bill said "Antonio, how ya doin?" He always called me by the nickname he had

assigned me February 1970. When I asked for a rendezvous time he said "Sure. I'll give you about an hour to take a shower, relax, play with yourself a little bit in the motel." He stopped talking, and waited for my predictable shocked response. He chuckled.

His hair was getting whiter. Carol looked a little bit older, and so did I, and so did Bill, compared to 1970. But we didn't too much notice. They both seemed to get a chuckle out of my stories and my schemes. Bill reminded me that I always had some kind of scheme. Carol reminded me that my language still had those explicit words I used to use in Albuquerque, words that were not quite proper. She accepted it, and commented like a proper lady, with only a little disapproval and an acceptance that "that's the way you men are."

I remarked that the winter didn't seem too be too severe here, in February. Neither of them seemed to mind the weather much.

As we were talking about work, I made a comment about a way to lace secret objects with invisible tracers. When a bad guy would steal the secret object, he would accidentally, and by our design, rub the scratch and sniff. He would not know that he released the secret tracer. Then, we would use insects whose sex pheromone receptors detect the secret tracer. Bill said his group had worked on one of those.

He surprised me. I told him I had actually proposed that non-secretly to a secret agency. I never realized they took my suggestion. I didn't ask if it worked, because it might have been classified and that would put him on the spot. The concept was so obvious that any engineers would come up with the idea. It was common to discover that other people would think of obvious solutions and try them.

As I drove to the Academy the next day, I realized they seemed to have placed it in what seemed to be an isolated, many miles across park at the base of the mountains that featured Pike's Peak. I

smelled the characteristic vanilla scent of the ponderosa trees. The scent reminded me of the high country around Los Alamos. I could see the forest floor in the foothill forest leading up the mountains. It was clear, not jammed with weeds, brambles, poison oak or scrub trees, but clear, just dirt on forest floor, where one could go for a peaceful hike and take any path in any direction. The setting they chose for this Air Force Academy made me think "timeless." I looked up at the sharp-edged, Rocky Mountains rising silently, motionless to the west. The trees even looked timeless.

Walking across the main campus of the Air Force Academy, it became obvious that this was very much an academic institution, like a college of engineering, only this was the College of Air Forces. Instead of busts and stone heads of old literary heroes or instead of weird art like any normal campus that caters to the weird, left wing, fanatic, outrageous, impractical, no, this campus had a few, real jet airplanes parked between classroom buildings. Stunning inspirations. Far superior to statues or abstract art designed to make me think clunky thoughts. These were modern jets, still brightly painted. They made me think race-car-in-the-sky, 15,000 horsepower turbine jet engine, thunder-in-the-chest-as-they-pass thoughts. Boy thoughts. As I entered the courtyard, every direction I looked I saw an inspiration sculpture, a real and brightly colored jet airplane just parked, ready for somebody to just climb in.

Perhaps they really did just park them here, somewhat ready for use. Many professors here were actually U.S. Air Force officers who actually did fly fighters or bombers. Many times USAF pilots had bragged to me how they had just flown a jet to visit somewhere.

I walked inside what I looked like a typical, drab college building with typical, somewhat motley dressed, engineering and science students milling around. But I saw no long hairs. Everyone seemed to be clean cut. I expected that. These were students who already had a job, an Air Force job. They were being trained to lead.

Lt. Colonel U.S. Air Force, Professor Doctor Doug Beason had an office that was just as much in a corner as his office in the White House. It wasn't bad. It just wasn't plush and ostentatious. It was dignified. Spartan. He did retain some of the dignity of the former position. He was now "Director of Faculty Research" and was located in the Physics Department. His former address had been

Office of Science & Technology Policy,
Physical Sciences,
Executive Office of the President,
Wash DC 20500

His boss had been the Science Advisor to the President.

The classroom was also Spartan, and drab. About 20 physics students marched in, listened to me tell about how we would use comet water in a nuclear heated steam rocket, and left when the bell rang. One student took a sharp interest, and another hung around watching.

Usually, when I would be a featured evening speaker, people hung around and asked so many questions I would not get a chance to eat. But this was the second time in two days where nobody cared.

As I left the Academy I began to realize how far out my universe was. The airplanes in the courtyard were real. The students passing them every day could touch the wings, kick the tires, see the cockpit chair just a little out of an arm's reach. Each time they passed the plane they could feel the roar of the engines and the acceleration throwing them against the headrest as they shot into the sky, in their minds.

All I brought was a story about the dark of space, a job as a coal miner on a lonely comet, silent, alone for years of travel through nothing. And my payoff payload was just a big bag of water.

Then I remembered again what the 30 year old NASA fellow said at the rocket science party at my house when the DOE - NASA rocket scientists had a meeting at our INEL site in Idaho. We were drinking cold beer from a real beer tap at my home. I held a free-food and beer party. I asked him why NASA was not paying any attention to the discovery of comet resources.

"If you're a kid, you don't say 'I'm going to go to an asteroid or comet. You say 'I'm going to Mars.'" he asserted.

He was candid. NASA and the U.S. Air Force were selling excitement.

I was selling a tar-dust coated ice ball and lonely, 4 year trips in a porta potty jail called a space ship.

After I got back to the INEL, I talked on the phone with Lyle Rutger of the Department of Energy. "DOE NE 53" was their code. He was the NE 53 bureaucrat in charge of the money I got for our Workshop. Congress had just taken away all his money for making nuclear rocket engines to go to Mars, and the NE 53 people had to go find something else to do. He could not give us any money because Congress shut off the program. Clinton was in charge now.

"I don't know where you can take it from here. Do you have any prospects?" he asked, sounding quite bored.

"I'm still working on it," I replied, assuring him I did not give up.

He was completely uninterested in helping tell Congress or anyone else that we had discovered rocket fuel in space or that we had discovered a way to take 500 people to Mars. He just did not care.

"Well, have a nice life," he said with a slight laugh, clearly mocking me, as we hung up.

Somewhat insulted, I quietly hung up.

My office was a humiliating cubicle in a bullpen. I had no privacy. Chin-high portable partitions separated us. The entrance to my space was open to the aisle. The only feature I could claim was that my boss, the head of business development had his office down the aisle, in a corner room with a door and two walls of windows.

Trying not to become depressed, my emotions kept saying "Rutger is right. It is about time to quit this topic. I should find other work."

Congress really did shut off the money to make nuclear rocket to Mars. Now I was trapped here in Idaho. I started to think about making miniature electric generators using those solid oxide fuel cells that a ceramics expert named Dr. Paul Lessing told us about when we were planning rocket engines.

Maybe Beason would know how to proceed. When I first visited him he was working in the White House. I called Beason at the Air Force Academy and talked about where I could take the steam rocket and comet water scheme. He didn't know. He seemed to be un-interested, just like the students.

"A comet is too far away," he said. "Even the near earth asteroids are too far away." The nonverbal part of the communication, which he delivered using the pauses between his words and inflections of his voice, said "this is fantasy."

"Well," he said with a little laugh almost inflected with the same insult Lyle Rutger used as he was about to hang up, "have a nice life."

This career is a mirage.

Beason, J. Douglas, Lt. Col. Ph.D.,
secy 719 472 4195, FAX -4255,
Dir. Of Faculty Research,
US AF Academy,
Mail code DFE,
CO Spgs CO 80840,

(OSTP) Office of Science & Technology Policy,
Physical Sciences,
Executive Office of the President,
Wash DC 20500

- **Clementine discovers Ice**
- **S4 CH 040-betcha-Cb-.doc**

Clementine discovers ice

It was May of 1994. The more significant bad news was now starting to dominate and disintegrate my Vision: President Clinton was making sure that the word “nuclear” meant “to be terminated,” and that anything related to “space” was the wrong social program and its money to be used elsewhere. So, “space nuclear” was a double anathema, double cursed, completely no no. The INEL was nuclear and I was space.

My desk things were packed in three-times recycled cardboard moving boxes and were stacked in the cubicle for the move. Our fate was staring us in the face. There seemed to be no escape. Two of us working as a loose team on nuclear garbage disposal checked out our new office booths. My self image felt like hoof-punched mud, soaked with urine, in a feed lot, as I walked around the drab pen in the middle of the windowless part of a one story rented building located on a non-maintained, almost unpaved side road 2 miles away from anyone important.

It looked like the person before me who left the cubicle that would be mine had just pulled whatever things were attached to the wall right off. Screw holes and an 8 inch piece of hanging, torn wall cloth remained. A slightly warped and twisted, brown painted metal computer table had the tell-tale marks of being bent and kicked repeatedly. At first I imagined an Idaho macho elk hunter using his boots. Then I pictured the kind of engineer who would work on nuclear garbage disposal and who was born and raised in Idaho.

The track of the sticky stuff someone had used to attach something to the desk left a sticky, unwashable, unremovable, horribly visible 8 inch smear on the desk. It was like renters abandoned the place after a ripping, barfing, drinking spree, and then they tore everything they had off whatever it was attached to, for drunken fun, and disappeared. The carpets and walls going into the bullpen area looked like hunters or winter loggers used it to park sharp and dirty things, with torn fabric and long, dark scrapes all over pale tan walls. Just surveying this feed lot completely humiliated me.

They were about to execute me.

And I escaped.

John Martinell got me an interview for a job to be one of the 5 people doing strategic planning for the company President, Dr. Earl Fray. Martinell arranged for me to bid for it only days before my execution date.

I won the position and narrowly escaped being forced to take a mind-numbing job washing the radioactivity out of dirt in the Idaho desert as a nuclear garbage man. The INEL really was washing an acre of desert dirt in spite of its well documented stupidity.

My new office cubicle contrasted the feed lot and was formed from brand new, eye-level high portable partitions. My space had no door, and the opening walkway faced the 8 foot wide walkway. But it was on the third floor where two company Vice Presidents had their offices. Their east facing windows faced the Grand Tetons, sometimes visible 60 miles away on a rare clear day. And I had weekly, random access to the laboratory President. This made it less humiliating.

Most important: several Vice Presidents all used the same bathroom as the one I used. You must be that close to have influence. I learned that one from General Dynamics. Fight for that one.

None of us from the space nuclear program who escaped had offices any much better. Even John Martinell lost something. John had been head of a whole department of people who did some of the space activity. At least John got an office with a door.

The good news included my having access to the President of the lab and escaping slavery as a Nuclear Garbage man.

The bad news, INEL and all the Department of Energy national laboratories were in the crosshairs of Clinton's machine guns. It did not help at all that Idaho voted Republican and that Clinton came in third. We were in danger.

Space was dead. Nobody was going to Mars. Nobody cared if an asteroid were going to hit Earth and end civilization. Nobody cared that the comet Wilson Harrington was about as accessible as Mars once every 4.2 years, and that it almost certainly has a billion tons of water ice, more than enough to fuel an Exodus to Space. Nobody cared, and all the money for space was gone. All of us in the space nuclear division had either found other work to do here at INEL, or have quit.

Even Dr. Warren Madsen quit. Warren knew how to make a nuclear rocket engine that would actually start. Everyone else only knew theory. Warren was one of the young engineers who worked on the first nuclear rocket program, during the 1960's at Jackass Flats, Nevada. But Warren got mad went to work for himself. He took a quiet, competent, independent space analyst with him named David Van Haften. He kept doing nuclear rockets as a consultant.

I never knew who actually paid Warren Madsen's bills, or if it really was NASA, as he claimed. The one time I visited Warren's office he had a 9 mm handgun draped casually in its holster over a clothes rack. He was draped casually in his chair, apparently happily analyzing away. I always liked him.

The INEL had also come to a complete halt, all by itself. It was completely stalled from doing anything at all because the contract

for managing the \$600 M per year lab was due for renewal with the DOE.

The Laboratory Director would not commit to anything because everyone knew he could be gone and everything would be all changed the next year. Nobody would follow his Vision. The Department of Energy would not commit because they did not know which way DOE Headquarters wanted to take the INEL with their choice of new contractor.

So, for the last year the INEL stopped embarking on any plans, stopped proposing anything, doing anything, and definitely avoiding everything new. No strategic plan of any kind could be taken seriously. They stopped.

The new contractor would be announced sometime before September because they would take over the INEL in October, and it was now May.

Earl Fray was hoping our strategic plans would be so good that he could include them in the proposal to win the contract. He worked for EG&G. His competitors included Lockheed corporation and Westinghouse. I hoped EG&G would win because I had a head start at the top.

Sitting there in this cubicle, planning strategically for what the whole company would not do in the next several months, my thoughts wandered away from strategic planning. I knew for sure we could power the steam rockets to occupy the inner solar system. All my calculations showed it. Except for one little detail.

The little detail, the only thing really stopping me was the lack of any water in space close enough and accessible enough to use. Sending people to land on a dark comet made of super-fine, static-sticky, super-fine powder, dirty coal dust and that only came by once every 4.3 years was just not practical.

Staring through the wall next to my computer I heard Beason from the White House and Air Force Academy say to me "have a nice life." Then I heard Rutger from DOE Headquarters say it. They were right.

We needed water close by.

I heard Gene Shoemaker's voice tell me about those hydrated clay asteroids as we were walking to the hamburger place on the corner of the road of the San Juan Capistrano meeting during late 1993.

Just as I was biting into the juicy medium rare hamburger he said "They could be up to 40% of the population. They're so crumbly we almost never get to see one when they hit." I felt that glimmer of hope again.

Then I felt that despair again. I didn't know which asteroid, near earth asteroid, was the clay one with the water. Nobody did. Nothing for sure. We needed for-sure to change the world, to fuel the Exodus to Space.

I looked at the new, gray-blue-green fabric of my cubicle wall.

We were in a dead end. And I was exiled in Idaho, almost having been condemned to insanity as a nuclear waste management slave. Terri and I had left San Diego and its highly technical environment and technical, high paying jobs behind. We were stranded.

And then Gene Shoemaker called. In the fraction of a second it took to recognize his voice, I wondered why he would be calling. He rarely called, and then only when he had something.

"I betcha there's water ice at the lunar south pole. Can you do anything with it?" he said, taking me completely by surprise.

"Probably not," I replied immediately.

Gene was on the phone, and his words were causing an instant traffic jam of flashbacks rushing through my head. He said "water on the moon," just like Larry Redd said. As soon as he said "moon" I thought "high gravity." I had practiced using that line in public every time I gave a talk. But I did not expect him to call me and say there really might be water on the moon.

I had calculated the situation a month or two before. The Larry-Redd flashback played, at very fast-forward speed.

Larry Redd had asked me one day, clear out of the blue, "What would you do with water on the moon?"

I was sitting in his cramped office across the street at the DOE Idaho building where he worked. I looked at his black board, a 2 x 3 foot felt-pen board with 8 different color pens, more pens and colors than I had. I saw the piles of documents and papers all over his windowless office, and beautiful posters of space and skiing and Colorado, and the hand-marked chart of the Japanese stock market on his wall.

Larry Redd had worked for the head of space nuclear planning at DOE Headquarters in Washington DC. He had lived there on and off for a year.

"Water?" I asked. "Where?"

"One of my friends told me there might be water on the moon, deep in craters, somewhere," Larry replied, as he stopped and looked at me.

Then he winced and with a contorted face and highly inflected slow enunciation said "I don't know," indicating with voice inflections that I was pinning him down and he didn't have the detail I wanted, but please would I keep talking with him.

He persisted, because he was the type to figure something down to the telling detail before giving up.

"How would that change things if there were? I know there isn't any, but how would that work out?" he asked.

Somehow, Larry always seemed to hear the scientific rumor before anyone else, and he did not seem to be on the phone much trying to do so. I did not know how he did it. He was quite skilled at this whole-systems analysis and demonstrated he knew how to do this kind of calculation. One time he had analyzed how extracting oxygen from the moon rocks would work (not very well, he showed), and he published it.

That must have been how he found out. His network included the guys who must have said "there's probably water on the moon, and getting hydrogen and oxygen out of water is a lot easier than getting it from rocks."

It was clear that the moon had crushing gravity, which made the value of moon water low. Larry and I had discussed how the value of any place in space is opposite to its gravity. The comet with 10,000 times less gravity than the moon is 10,000 times better, because a rocket can lift 10,000 times more off the comet than from the moon, each time.

It was fairly simple to figure. We did it right there without needing a hand calculator. If a little rocket could lift 1 ton of space capsule, occupied by a couple of astronauts who pooped their pants for the privilege of being there, a few bags of moon rocks, and their chairs and oxygen bottles, then the same rocket could lift 10,000 tons of stuff off an asteroid or comet that has 10,000 times lower gravity than the moon.

So, the moon was 10,000 times less valuable than a comet or asteroid. Some asteroids and comets have only 1000 times less gravity. It's still 1000 to one against.

So, I told Larry after we talked a bit that "It looks like the moon is worse by 1000 times," and I left his office.

But, just as I was trying to jump the ditch in the melting snow to take the shortcut across the street on the way back from Larry's office to mine, I realized the moon might not be so bad. I wondered how many times a day we could get on and off the moon. I thought it was every 2 hours or so, because an orbit around the moon was about 2 hours.

But every two hours means 12 times a day for a year, and that would be 3000 times more trips in a year, 12,000 times more trips in the 4 years, comparing it to the time it would take to go to a comet and back. Things ought to cancel. The moon would be 1000 times worse based on gravity, but 12,000 times better than the comet based on total payload, and trip time.

The flashback and all its key elements was over in less than a second. There were two answers, opposite to each other, one good, one bad.

Each time I talked with Gene he would tell me one more place to get water in space, and each time closer to Earth than the last.

Realizing Gene Shoemaker might actually be serious about the water on the moon, I immediately recanted and said "Well, maybe."

I knew how to calculate this in a flash. I had this programmed in my pocket calculator, it was so simple.

While Gene was telling me about the Clementine space probe, I pressed the calculator keys for 300 megawatts. I put in a 2 ton rocket, multiplied by 6 because that is moon gravity.

He told me about the radar they used to make the measurement, and I pressed the keys for the force, and $9.8 / 2.2$ to get metric.

While he was telling me about the shallow angle of the radar and how it was really a communication radar, I saw 67,000 pounds on the calculator readout, meaning 33 tons of payload.

While he was telling me how they could just barely peek into a crater rim, my calculator read 33 tons of payload per trip.

"30 tons" I said, all in the time he took to tell me about the clever radar measurement over the phone.

Most of the calculations were already programmed, and all I had to do was enter the power and specific impulse. This was rocket science. It was very simple.



\ clementine_moon.gif

Then I said remembered I had to take the payload to lunar escape, and then send the rocket back to the lunar surface and do it again. That would cost another 1/3 of the payload water.

"No, 20 tons.

It looks like you can only launch about 20 tons per trip."

and I hesitated to look at the calculator again.

" ... 20 tons to lunar escape each time. Not that much." I said.

Suspense.

Did I do this right?

Water on the moon?

That was the bad answer.

What about the good answer?

He mumbled something about they have to check it yet, they are going to publish the results and that he was the science advisor to the team that sent the Clementine probe to the Moon.

"Wait a minute." I said, and I was punching the simple numbers into the calculator as I spoke,

"If you launch 20 tons every other orbit,
that's 6 times a day,
for 365 days a year,
that's ...
43 thousand tons a year."

"Wow!" he said.

"That's more than we have launched in the history of space." I interjected.

I often used that line that when I would speak about space to crowds, but I might be off a little because I did not know what the Russians really launched, with all their secrets.

He liked the answer, and we hung up.

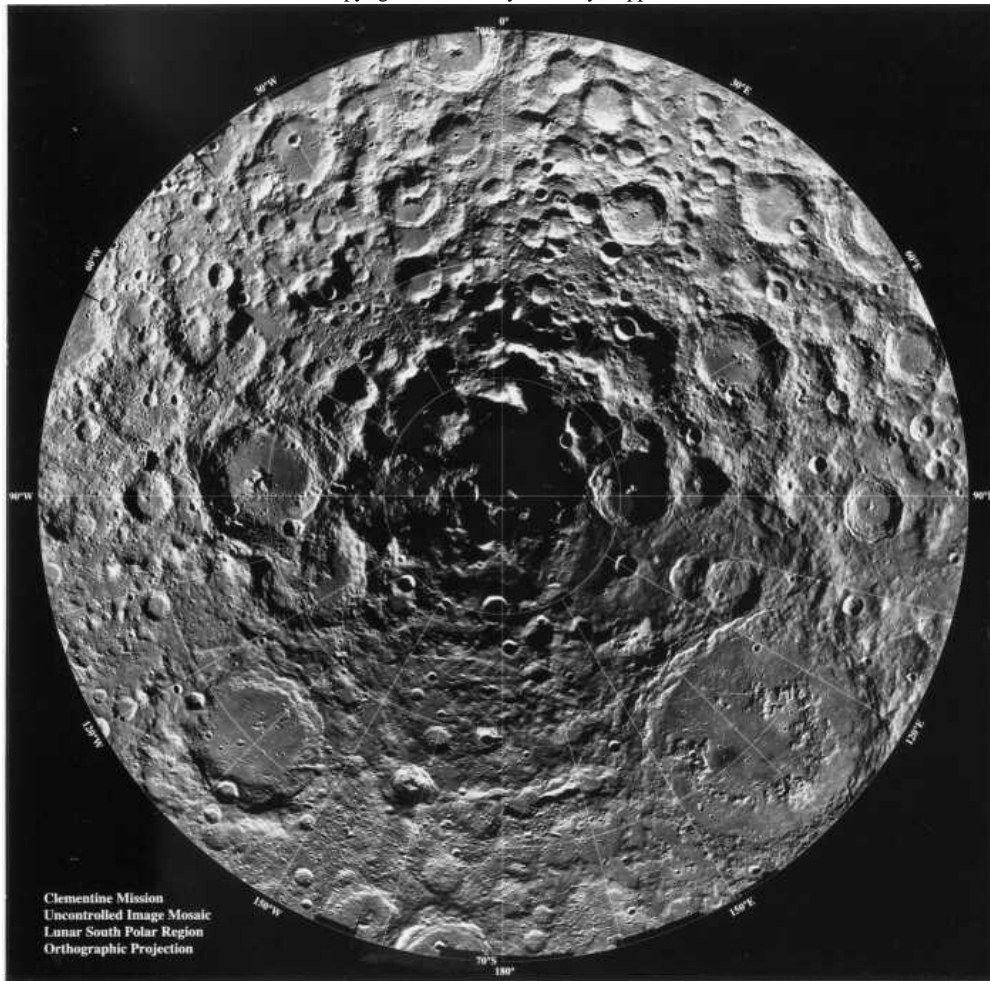
Gene knew very well what water meant. That was why he kept communicating with me. He understood instantly that water was rocket fuel to a steam rocket. He knew it during our first conversation during the spring of 1991.

I had to get up and walk around. The revelation changed everything instantly, like seeing the winning lottery number on your ticket. With his own eyes and his own Q clearance, Gene had seen the same nuclear rocket I did at Jackass Flats. He personally knew.

Col. Pete Worden and Dr. Stu Nozette invented and planned that Clementine probe. Stu showed me the napkin he sketched it on during an evening supper. They had chosen their team very cleverly. Chris Lichtenberg, the team member in charge of the communication radar, was the same radar person who did the planet Mercury radar work. He knew exactly what the radar was supposed to do. He also knew exactly how to make the measurement. Their radar and their method was just like method they used to find ice at the bottom of several permanently dark craters at both the North and South poles of the planet Mercury, 2 years earlier.

Clever of them, because the Clementine probe was just supposed to be a Pentagon test of a star wars device. The clever team parked the Clementine probe around the moon while they waited for the right alignment of near earth asteroids. They were supposed to leave the vicinity of earth and hit something in space, like a good space defense system should. While they were at the moon, they conveniently took pictures of the whole thing and used the radar to communicate the data.

The pictures were stunning. No one ever looked at the moon from its bottom, looking up at the South Pole. The strange part about the moon's orbit is that the south pole never sees the sun. I never heard of that before until Gene explained it to me. This was just like the planet Mercury. Strange.



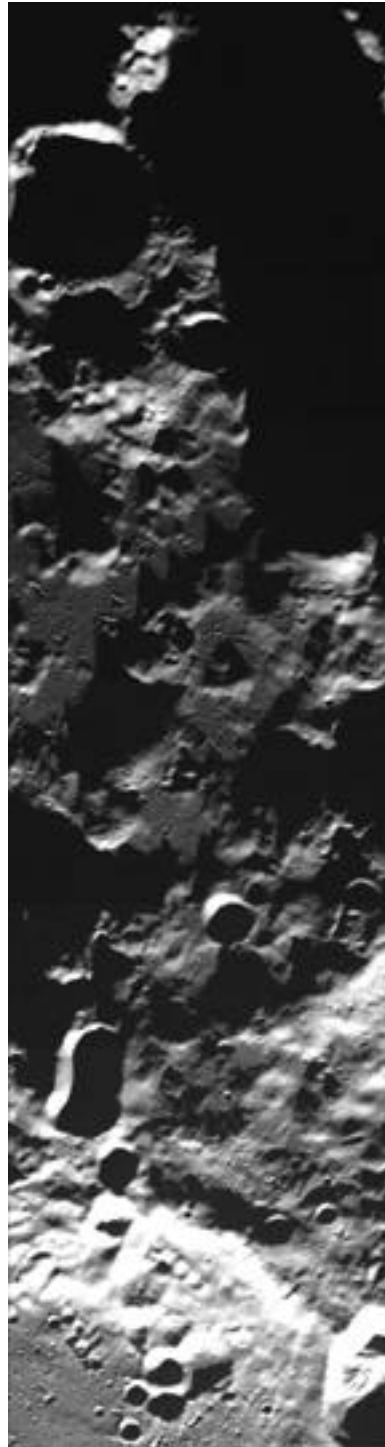
\ clementine-southpole-r700.jpg

The Moon, from it's underside.

The radar found water in the forever-dark craters. The black nothing hole at the south pole was always in the dark. Any water vapor that got there, would stay there forever, or at least longer than the age of the sun. The close-ups just showed pitch black craters. That's the only place where ice would not evaporate away.



\ SPOLE.Orbt120_2in.jpeg.JPG



\ SPOLE.Orbt68_2in.JPG

And I forgot if Clementine ever hit anything.

I walked around the entire east end of the building, not noticing anyone and completely agitated, lost.

Gene was the one who told me to go to the near-earth object comets for water ice, and sure enough, we found dozens of them where the steam rocket would work. Gene showed me that comets had water for-sure. He was the one who said they were a lot closer and slower than the comets everyone sees, like comet

Halley or Hale-Bopp. He was the one who showed me the orbital mechanics equations I used. He pointed out that these periodic comets are "catchable" because they were moving rather slow and some came rather close to Earth, rather often. They were close enough to bring back 30,000 tons of payload at a time.

That moon water could change everything was just plain clear.

I walked around some more, towards the other end of the building, dazed.

without the nozzles.

If he is right, I could fuel an Exodus, and sitting here in this crummy office would be irrelevant.

I could take it from here and win.

I am at the right place, the INEL, the only place in the USA where we could test nuclear heated steam generators attached to rocket nozzles, because we already did that here,

Perseverating, dwelling on thoughts, I walked around the corner to the coffee pot isle next to Dr. Tom Dolan's office, thinking only one thought over and over:

Now we really can fuel an Exodus to Space.

• **speaking to students**

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Lean Times 1995

It was the year of 1995.

It was a lean year.

The new contractors from Lockheed did not give a damn about space.

Meanwhile, 200 million comets and hydrocarbon objects were discovered in a belt like the asteroid belt, just past Neptune.

Karen Hollister, a petite blond that had been divorced for many years and had two teenagers, a boy and a girl, had her office just across from mine. She set me up to speak at the vocational school, "EITEC." And she set me up at local schools to talk.

She was my psychotherapist for a while. I talked with her about space and my visions for space. I was frustrated because nothing could be seen on the horizon for space. Nothing was going on. Idaho was not interested. The INEEL was not interested. But the students I talked with were interested. I was entertaining them.

**1995.01.20 EITEC Karen Hollister set up: Valiquette,
Nancy: #1: Chad Strums, Rigby Jr Hig
Science, 20jan95;**

**1995.01.30 EITEC Karen Hollister set up: #2: Valerie
Gorman, Eagle Rock 8-th Grade, 30jan95;**

The Iowa State University paid for a vocational-related conference on space for its students. They wanted to find jobs for their aerospace graduates. So they paid people to come there. They called it the "Mid Continent Space Development Conference."

Somehow they found out about me. They paid my way to go there. I could not go any other way. They paid the ticket and gave me a room on campus.

An aerospace student was assigned to take each speaker from the airport in Des Moines, Iowa, to the university in Ames, Iowa, about 40 miles to the north. It was always held in winter.

Pretty quickly I noticed that the only place I had ever been that was more dismal than Idaho Falls in the winter was flying and driving

in Iowa in mid winter. The extra depressing element was that from the air one could not see any mountains anywhere in Iowa, and we could in Idaho Falls. We could see majestic mountains from an airplane above Idaho Falls. Like the Grand Tetons.

I met Dr. Robert Forward again. I had not seen him since the Sandia days. His hair turned white. He was deeply involved in space, with tethers. He gave a talk on it.

I met Dr William Gaubatz, program manager for the Delta Clipper, a vertical landing and taking off rocket, talked with me. He presented clips of how the device blew one of its 4 engines, but landed ok anyway. It landed vertically. It was supposed to be a fast clipper to Australia, a 45 minute ride. Take off from any old football field sized launch facility. Fly directly half way around the world with 4 people. Land at their football sized field.

I told Gaubatz in the car on the way to somewhere after our talks, that "they will be sorry they targeted that asteroid instead of a comet." referring to the asteroid mission.

"Why" he asked.

"Because the asteroid is just a rock in space."

I met Seth Shostak. He was involved with SETI (Search for Extra Terrestrial Intelligence, funded by David Hewlett of HP). He said he did TV productions. During his talk I realized that we can't observe extra terrestrial intelligence because the encoding of information will necessarily be indistinguishable from random white noise. The Shannon Theorem shows that. Already modems sound like white noise.

Irene Shaland was originally from Russia, St. Petersburg, and was working for NASA.

"The Russians look like us, talk like us, dress like us, but they are not like us. They are Russian. Their ways are not like our. Don't be fooled."

She bragged at the supper table with the group of us how her grandfather was shot by the commies.

Charles Lauer actually wanted to do things in space and start a company to do so. "A real estate business man. A business park in orbit around Earth." He forgot about something fundamental, some fundamental physics. His electric generator needed a heat sink in space, and he had none. He bragged during his presentation that he was a businessman, not a scientist. But that was his Achilles heel.

1995.02.18 mcsdc95;

He did not know that the reason there were no electric generators in space was at least, among other hard problems to solve, that there was no place to dump the waste heat. All the electric generators that run off some kind of hot, heat input need a place to dump cold waste heat. If no cold heat dump is available, the engine stops.

I raised my hand to ask that question in the audience.
“Where is your heat sink?”

“I don’t know. I don’t have it shown here,” he replied.

“It violates the second law of physics. You need a heat sink. That’s why there aren’t any in space today.”

I was supposed to be the featured evening speaker. But Robert Zubrin, also there on no money, said it would really help if he could speak in my place and I speak at his place. I should not have let him. It is a status thing to be the featured evening speaker. Zubrin did not publicly thank me for trading. That was the rub. Never again, Robert.

Zubrin talked about colonizing Mars. I talked about the water ice on the Poles of Mercury.

Channel WOI TV interviewed me. It was aired somewhere.

I realized why there was no money for manned space activities. Not a single thing was practical. Not a single thing would make a clear profit. Unmanned things were ok in the space around earth, like satellite TV. But not manned things. Not one single manned thing would make a clear profit. Even Gaubatz Delta Clipper.

1995.02.17 19950217mcsdc95 supper Friday +theta: zuppero, anthony; berns, chris; shaland, ms irene; lauer, mr charles; stringfellow, steve; hughes, mr frank; forward, robert; shostak, seth;

1995.02.17 MCSDC95 mcsdc@iastate.edu, fax:(515) 294-3262
Fourth Annual Mid Continent Space Development Conference at Best Western Starlite Village, Ames Iowa; stevenson, andy 15nov94 & ltrs Ramsey, Jeanette (515) 292-2619; Gonzalez, Tomas (515) 296-3096 berns, chris ride; cupp, adam; duffee, mr steve; early, brenda k; fisk, kimberlee; forward, dr. robert, forward unlimited, 21st century space propulsion systems; gaubatz, dr. william mcdonnell-douglas, delta clipper; hughes, mr. frank johnson sfc, chief of spaceflight training div. (astronaut training); huset, ben; kessler mr. thomas international space enterprises; lauer, charles j. u. mich., near term real estate business park in orbit; lowther, scott & parents; miller, jason; moorman, cory; potter, dr. seth new york university, solar power satellites; schele, tony; sears, john; shaland, ms. irene nasa lewis, international cooperation and ssf; shostak, dr. seth seti institute, the search for extra-terrestrial intelligence; smith, shirley & jerry; stringfellow, steve q's all nite; tedro, matt; tiala, sylvia; seversike, laverne; riley, roger ch 5 woi tv;vaughan, dr. arther jet propulsion laboratory, hubble space telescope; wright, dr. bruce boeing, space station; zubrin, dr. robert martin-marietta, colonizing mars; zuppero, dr. anthony idaho national energy lab, h2o and mercury's poles;

1995.02.18 WOI TV

1995.02.24 EITEC Karen Hollister set up #3: 24feb95 Shelley Junior High, 8-th Grade Physical Science: Dave McArthur, angela young, toni Jorgensen, emily Swanson;

Summer Students

1995.06.00 summer students june 95;

1995.06.21 19950621usumars Pathway to Mars Workshop: redd, frank; siahpush, ali; pantalos, george m; licht, greg; vanderford, john; zuppero, tony; smith, james; batty, j clair; williams, brian; harris, lynette; ryzhenko, alexander;

1995.06.21usumars;

Bannock Native American Students-

The Bannock Indian students were here, downstairs. Leanne Medema asked if I would give a space talk to them..

This was going to be a hard sell. Indians did not give a damn about space. They were earth people.

As soon as they started to walk in and sit down I could tell.

Wanting to show them how smart I was about nature and knowing that they knew a lot about hunting and fishing, I challenged them with a question I knew the answer to.

“Hey, you guys probably know. Why do the fish go up the same river every year?” I asked.

A rather handsome, thin, 18 year old male responded with what I believe was a genuine warmth I did not expect.

“The smell. The fish smell the water. They follow the smell.”

By god, the guy was right. I was about to tell them it was chemical sensing.

He knew.

They listened to my space talk and asked intelligent questions. We liked each other. This was a satisfying talk.

After my talk, Leanne Medema walked up and commented on “how clever that was of you to soften them up before the talk.”

That was the first time I ever realized what I did naturally, to make the audience like me. I started to talk to them immediately, casually. This was like any school engagement. I would talk to them before the talk, to soften them up.

From then on, I liked Leanne Medema, from the Public Relations Department.

1995.06.30 bannock indians neospace;

Three of us from INEEL flew to Boise to talk about our vocations and how wonderful it was to be an engineer or scientist, for the INEEL. I talked about space. It was ok. A nice trip to Boise. Lots of school teachers.

I met Wendy Schmier of the Public Relations dept, and got her interested in the Zoo.

1995.08.01 19950801boise Idaho Vocational Summer Coinference, of Idaho Vocational Associatio; Meyers, karyl chair, college of southern Idaho; zuppero, tony; schmier, wendy; griebenow, brad;

1995.11.09 N-START RFP zjm, zca, JLL, dpe@inel.gov (Donald E. Palmrose), ray.marble@lmco.com, barbara.rogan@lmco.com

- “Changes Everything” said Worden

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“Changes Everything” said Worden

"Changes Everything"

Winter as most people know it had already started in Idaho. Grey skies, cold nights, frost. This was 2 October 1994, Idaho Falls. We never saw the leaves change color, because our trees don't have green leaves. EG&G lost the contract, and Lockheed won.

Most of the new Lockheed managers imported from Palo Alto and Sunnyvale, California and Austin, Texas, and elsewhere had already moved into their 1970's style, temporary apartments, complete with weather-worn dirty walls and doors worn ragged by hunters and Navy trainees. Out in deep suburbia, 15 driving minutes away with never a traffic delay, energy efficient, highly insulated brand new homes awaited these new contractors because they were coming with fresh buckets full of out-of-state, California Big Money. All they needed to do was stay.

Nobody we could find in our wide network of contacts had ever heard of any of the key people Lockheed was bringing in and bragging about. But "it's OK," we said, hoping it would be OK.

Everybody knew being transferred to Idaho Falls was not the reward assignment. It was the other one.

My boss, the Vice President of Business Development, said his wife stepped off the plane, took one look at the town and told him he could visit her any time he wanted, in their home in Washington DC. Another key manager, a Vice President for Systems Engineering whose name was specified in the Contract, stepped off the plane and got back on 3 weeks later, never to be seen again.

Everything was on still on hold, as it had been for the year and a half while contractors prepared their proposals.

The Exodus Path was not on hold. I was making sure of that. Ten days earlier Lockheed, one of the largest aerospace and defense contractors in the world, took over the contract to manage the INEEL. I expected the next several years to go down in history as the start of the human occupation of the solar system.

A colleague from DOE congratulated me when Lockheed won. "Why?" I ask, thoroughly puzzled. A surprise puzzled look crossed her face as she apologetically said "Cause they're space." I agreed, but these new guys seemed to have no connections to anything or anyone. I checked. No one knew any of their names.

And the Exodus Path was definitely not on hold. The conference hall was full to the last chair in the back at the biggest convention center room at the biggest hotel in Idaho Falls. The lights were down and only Pete Worden, a tall, impressive United State Air Force Colonel with his perfectly tailored, blue Air Force uniform stood out sharply. His deep, commanding voice projected the voice of authority and importance. He looked straight at different people around him and in the audience in a commanding manner exactly like we expected the Chief of Technology for Star Wars to look at us. He projected strength.

This meeting was the "Eighth Annual Idaho National Engineering Laboratory Computing Symposium"

I had secured a session all to ourselves, and space. We would announce the water on the moon discovery here, too.

The billing read:

Eighth Annual Idaho National Engineering Laboratory Computing Symposium Aerospace Applications

*Thursday, 1:30 PM through 4:55 PM , Yellowstone Room
Session Chair: Anthony Zuppero
Idaho National Engineering Laboratory*

Computing and the Conquest of Space
*Panel led by Dr. Robert Zubrin
PO Box 179
Martin Marietta
Denver CO 80201*

Panelists will provide concrete aerospace examples of how recent computing advances enable robotic explorers; extremely small resource exploration satellites; converting Mars atmosphere into rocket fuels; neural networks patterned after reconstructions of mammalian brains; and hyper-spectral sensors and multi-modal, assimilation perception systems.

Panel will include introductory presentations, described below, by panel members.

Most of the new, Lockheed managers were somewhere else. They could not be bothered with a mere technical meeting. It did not seem to matter to them that this was one of the few technical meetings everyone at the INEL looked forward to and prepared for.

We could understand that, because "Idaho is backwards, of course," the New Guys, the Winners, seemed to agree.

It did not seem to matter to them that important government people who could bring money from Washington DC would actually come to this meeting. It did not matter that Idaho was actually known to be superb at something valuable to the USA. The new managers were mostly missing.

Colonel S. "Pete" Worden, a Colonel from the Department of Defense and former Director of Technology for the "Star Wars" space defense program with an office in the White House, took the podium as the Keynote Speaker for the session related to space.

The audience got quiet. He spoke. He spoke well. He had a lot of practice at the Pentagon during the Bush and Reagan years. He told the Idaho crowd of people how his team invented and sent a Department of Defense micro-satellite into space, put it into orbit around the moon, and took stunning pictures of it.

And then he told them how his team believed they had discovered water ice in the forever dark, cosmically cold craters at the South Pole of our own Moon.

Colonel Worden and I had rehearsed what we would do when it was time for questions. "Leave nothing to chance," a wise old businessman from Albuquerque told me during the late 1970's. The businessman died in his airplane, with 6 ladies on the way to a ski trip. But I still believed him when he said "... nothing to chance." We set up a Plan.

The Plan had me strategically planting myself by the door, where everyone enters. People turn their heads to the door when they hear a voice from the audience. Worden would then pause for just a moment when questions would open, and I would immediately raise my hand. He would then clearly designate the focus of attention to me, and I would announce a clear question.

"When you said the Clementine Team found water on the moon, doesn't that Change Everything." I asked in a loud clear voice.

The simplest possible statement, posed as a question. Everyone turned towards me, as planned. And then he authoritatively answered "Yes. It will definitely change everything."

The audience chuckled a bit. And then he elaborated a slight bit.

The Voice of Authority had Spoken.

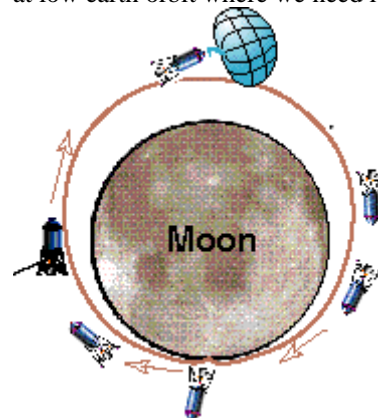
But I did not quite do it right. I did not sit Pete down and show him just exactly how simple it would be to change the world with moon ice.

I fretted slightly while the audience asked a few feeble questions.

"Ice on the moon changes the world," I imagined telling him, "because it can put massive amounts of rocket fuel into space,



at low earth orbit where we need it,



and at near earth escape, for space travel."

He would look down at the small pictures and nod his head with a calculating stare.

"40,000 tons a year is huge, more than we have launched in the history of space," I would continue.

He would get a slight look of surprise on his face.

"The 40,000 tons could also be space cement to make space ships as big as aircraft carriers," I would conclude, drawing a mental image of something big enough to hold 5000 people and that he could picture.

But I never did do that.

And Colonel Pete Worden did not say that. So the local press, who were supposed to be here somewhere, did not say that either.

That evening we fed everyone of importance at my home. Nothing left to chance: each of the 8 speakers had one of us from Idaho assigned to take care of them.

The new Lockheed Chief Scientist, Dr. David Cauffman, was specifically invited and reminded to come, and shown exactly how to get there.

In the dark of early evening each one of them edged their way out of the dismal plains of Idaho Falls, driving and slowly rising up a hill, with their backs to the city and facing the dark night and driving into a more and more desolate road to the eastern most boundary of the Idaho Falls and INEL basin.

When they got to the highest house on the hillside, almost so far that it seemed they had gone past it and into the desolate hills, the house appeared on a little hilltop. They either drove up the 210 foot long, 2-car-wide paved driveway, or they parked in the paved entryway between the gentleman's barn and the helicopter port, in front of the stables.

As soon as they walked up towards the west facing deck stairs toward the front entryway door, the view exploded into lights, 180 degrees of panoramic view, above the city, above the entire valley. A stunning view of Montana mountains in the early evening silhouetted 80 miles to the northwest, and the outline of the mountains of Sun Valley 120 miles to the west, and the clear view of city lights, and the panoramic speckle of lights of the countryside and suburbia contrasted to the extreme dull of the flatland and dirty backwardness of a 1970's potato town they just left. Like looking back at Earth from a spaceship.

That's what I felt when I first visited the home when we bought it. The overview entranced, hypnotized.

We made sure anyone who mattered at the INEL was invited and reminded and guided to the home. And then we made sure we loosened their tongues as best we could. The home was designed for this.

The previous owner was the head of security for the INEL. He held parties for VP's. The first owner was a major home developer for Idaho Falls. A significant fraction of the 30-something males of Idaho Falls had beer keg parties at our home with the first owner's 4 sons. A carbon dioxide pressurized, commercial grade beer tap ran the bar. We made sure the refrigerator under the bar was turned to "cold".

Everyone talked a lot, as designed. Gourmet food, cold beer, and unlimited booze, which, not surprising, no one seemed to abuse.

And then, since we made sure the invited guests did not have to drive and did not have a pressing meeting the next day, we engaged them. We engaged Pete Worden.

Marland Stanley, my boss, was superb at this. He knew exactly how to arrange this "meeting" at my home. He found out Pete liked and understood the wine-tasting-like nuances of single malt scotch.

Our only objective was to engage him. Not to get him to tell us anything special or privileged. We did not need that. Not to give us money. He didn't have any. But to get to know each other.

Our common bond:

The Department of Defense and the Department of Energy discovered how to use water ice to change the way humans travel the solar system.

NOT NASA. They lost. Our team found the propulsion. Worden's team found ice on the moon.

That would change everything.

He drank little, carefully controlling his vulnerability in public. He drank slowly, and only the highest quality thing we had, our single malt scotch. We sipped as he told us stories about the Pentagon.

He enjoyed telling us how he stood his ground against the Arrogant Powers in the White House, and against Dan Goldin, the Head of NASA.

During the weeks that followed I wondered how we could make something happen, and wondered why nothing seemed to be happening.

I expected some brand new Lockheed bosses to come to my home at a big party and talk with the White House hero, and be convinced that we have a great discovery about to initiate the exodus of man from Earth.

He said it, one of them came, and nothing happened.

I expected the press to say something. Nothing happened.

I expected the crowd to start asking detailed questions, and they didn't catch on.

Nothing happened.

Maybe we just needed time for our Visions to incubate.

- **Kuiper belt comets**
- **S4 CH 044-Kuiper-belt-comets-Bh-.doc**

Clear Cutting the Kuiper Belt Comets

The Hubble telescope had just discovered 200 million new comets, and we proposed to vaporize every one we met so we could joy ride around the solar system using their water as rocket propellant.

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It was 24 February 1995. James Smith was a senior high school student from Shelley High School. Shelley was a small potato town, 20 miles south of Idaho Falls and the INEEL where I worked. The Department of Energy came up with some money for a summer student, and James won it. It was supposed to show him how wonderful it was to interact with the top people in space exploration and habitation.

The half mile of main street Shelley was lined on one side with muddy, worn out, farm town convenience stores. On the other side, hefty pairs of railroad tracks dwarfed the street, flanked by several, 100's of feet long, apparently almost unused, cinder block buildings, equally worn out and that looked like they stored what used to go into the trains.

The cinder blocks of the long buildings seemed to disconnect in jagged straight lines along the building block seams and were clearly coming apart. The long cracks seemed to wrap the whole building like black line nets.

Everything looked like it had been new and prospering during maybe the 1950's, and then aged by dwindling use, without vandals, just lack of business. The smaller town of Firth another 10 minutes down the road was the same, only with half as many old stores and disintegrating buildings.

The freeze-thaw cycles of 50 years of Idaho winters seemed to slowly loosen both the brick and the wood buildings of the hardware store, the low-cost clothing store and the fast food stores.

Minus 30 degrees, plus 20 degrees, minus 12 degrees, plus 32, all winter long for 8 months. This was mid winter.

Paint would have made it quaint. But neither quaint nor paint was in the Idaho culture.

Dave McArthur, a dedicated science teacher at Shelley Junior High, had invited me to speak at his 8-th Grade Physical Science class. Dave Smith had been in that class a few years earlier.

That was the day when I found out that most high school graduates would almost certainly never see the inside of any school again, except maybe to vote once or twice. I had never been this close to this kind of dead end.

Almost every student from Shelley High would graduate, because that's the way it worked. Then they would probably find low paid work on the potato or wheat farms driving a truck or tractor, lifting sheep, pushing cattle, or doing something about one inch higher on the status ladder above the Mexican laborers, and maybe only a dollar per hour better paid.

The Mexicans moved the irrigation pipes in the wheat and potato fields. They would move one 20 foot long segment of an aluminum irrigation pipe at a time, for 10 cents a pipe, all day long. Eventually, half a mile of pipe would be moved over by one irrigation squirt distance, about 50 feet. Then it would irrigate while they moved a different pipe.

Hard work, no money. It was muddy. Freezing water squirted from the pipe joints and soaked them in the Idaho-cold and the heavy, metal pipes numbed their hands. When they finished a day's work, they would be scorned and called "beaners" at the supermarket where they spent the money for food. I really felt for them. They worked the hardest and got paid the least. But they only came here during growing season. This was dead winter.

Most of the students were Mormon-descendant white, most probably with Norwegian and Swedish ancestors. After they graduated from Shelley High, they might be lucky and get a job at the potato processing plant. I was never in one of those plants, but I heard James's father worked there on the machines that cooked potatoes, peeled them and made French fries or potato chunks. A teacher told me "that was good job." It seemed to me there wasn't much money in that work, but it seemed to be enough to buy a used car, some stereos and cheap clothes, and to pay for the mobile home.

Potatoes fed the French Fry factory year round. Farmers stored the potatoes in long garages. The garage storage bins were about as wide as five pickup trucks, as high as a bridge underpass, as long as a football field, and half buried in the dirt, literally buried. The dirt seemed to be the insulation of choice. Many of the potato garages were buried from the ground up to the roof gutters in dirt. The farmers a century ago also covered the entire roof with dirt. We would often see some of the old, abandoned potato garages, with the dirt roof half collapsing through rotting wood framework.

There were other jobs the young students could get after graduation from Shelley High in eastern Idaho, like work at a tire store in Idaho Falls and change tires for the farmers, the sheep and cattle ranchers, and the government people who worked at the Idaho National Engineering Lab. Or, they could load sacks of feed grain on pickup trucks for anyone who kept animals. Or they could work at the Thrift Store or sell farm sprinkler parts at the irrigation supply store. Or they could sell nuts and bolts, guns, cattle medicine and field fence, and truly tasteless, ugly, gaudy black rubber boots and gloves for working in mud, at the C.A.L. farm and ranch store.

This was not poverty. It was a trap that kept them well below the middle. The life style let them make just enough money to pay for a hunting rifle, the snowmobile, some CD's, a barely running 4x4 pickup truck, and enough free time to go hunting and fishing all year.

Almost none of the Shelley student's families owned a farm or ranch. That would be too much money for a Shelley person. A square mile of potato field would be worth a million dollars, plus or minus, often plus, and that was the minimum farm size. A plot with that much land was that size that belonged to a much smaller set of families, those Latter Day Saints who came there during the 150 years earlier. The tractors and plows and such they needed to work that land also cost a minor fortune, a fraction as much as the land. A typical farmer grew 1,200 acres of wheat, or 640 acres of potatoes, or 3 sections (square miles) of barley, depending on the year and the market. These were the employers of unskilled Shelley High graduates. These farm and ranch owners never did make much money, about the same as an engineer at the INEEL, but had minor fortunes tied up in land and equipment. Relatively risky business with a low return on equity. These farmers and ranchers were not the people of Shelley.

An aggressive Shelley High science teacher named Mike Winston tried outrageously bold things to try to get the kids to escape. To spring the trap.

I was part of his bold thing. At an earlier student event in Idaho Falls Mike Winston watched me excite kids with stories of nuclear rockets and comets and space. Winston helped discover me, and arranged for me to come there and tell 8-th graders about how I started long ago just like them, and how I got to be a rocket scientist. He just wanted his students to see a greener pasture, an escape route, something to show some exciting reward beyond hunting and fishing after high school.

"I just want them to keep going, maybe to EITEC." he said, referring to the technical vocational school recently started in Idaho Falls.

"They could go to Poci," he said, referring to the Mormon-dominated Idaho State University just half an hour away in Pocatello. Most Shelley people were either Latter Day Saints ("Mormons") or "jack Mormons," those who were raised Mormon but didn't keep it up. Like anyone else, Mormons often felt comfortable in a college of their own kind. Idaho State was a state

college, but Idaho was a Mormon state, so the Mormon studies building was right next to the library. It was just like the Deep South, only Mormon instead of Baptist.

"That would give them some kind of edge on life. They could escape this cycle of going nowhere," he said.

Any education at all would give them a chance to do something better, any brand of better. It would be trivial to escape. But Shelley Idaho was far away. For school things, it was half an hour from Idaho Falls, half an hour from Pocatello, and that was far. And it was infinitely far away from Cleveland, Chicago, Boston, Los Angeles, Silicon Valley, and mainstream United States.

Everything was far from Shelley, except the mountains 3 hours away, of course, because that was "good huntin 'n fishin."

Shelley was in a time warp, stuck somewhere between 1950 and 1970.

In the class, I played my stories about space. One thinner male who looked like a 13 year old version of the 50 year old farm hand that worked for my Grandpa Joe and lived in the barn during the late 1940's. The 13 year old was sprawled out, half asleep in the back of the room of about 30 eighth graders. Another kid that looked like him was not watching or listening. The rest were the typical motley crew of gawky 12-13 year old kids.

I told them about space in the Solar System, about how we were at the INEL trying to make the engines to take people to Mars, told them the scary story of near earth asteroids.

And the first question a relatively well dressed, neat and confident 8th grade boy sitting towards the front of the room asked was
"How much money do you make?"

"85 thousand," I replied, after hesitating for a moment, realizing that revealing salary was politically incorrect.

"Usually nobody tells how much they make. But you guys wanted to know," I continued.

No one seemed to squirm or make responsive face gestures. Perhaps they could make that much lifting sheep or pushing cows. Maybe some of their parents made that much at the INEL. That was at the high end of wages for physicist Ph.D.'s at the time. I felt insecure.

No one seemed to gasp at how much \$85 K was, so I thought maybe I was not making enough money. This was 1995. Ph.D. engineers and physicists were making about \$60 K in Idaho and \$70 K in San Diego. Were these guys expecting me to make a few hundred thousand? Their faces showed they were not impressed.

"Is that enough?" I asked them. I did not expect the stoic faces.

Nobody asked me how long I had to go to school or what I courses I had to take, like the kids in other schools usually did. They didn't ask much at all. I failed. My talk was not interesting to them. I must have used too many technical terms. Maybe I didn't say anything they interesting about my work or about space ships.

The teacher thanked me anyway.

"Most of them will go to work locally after high school," he said.

"What about that kid who was half asleep?" I asked.

"He has a hard time making it to school. We were glad he made it today. We've had trouble with him before."

"Does he get into trouble?"

"No. It's not drugs. He just doesn't show up."

That a science teacher would show students a way out must have been outrageous for Shelley. I could never figure out why, but the town and the head of the school system thought his methods to show the students a way out was shocking and grounds for severe reprimand.

In normal towns Terri and I had lived in, like Albuquerque, New Mexico, Livermore, California and Poway, California, this teacher would be just another dedicated teacher, and not even unusual.

"Would you be interested in mentoring some seniors?" Winston asked, somewhat smiling. His face showed some kind of hesitation.

"Sure. What do I have to do?" I replied. I never mentored anyone before. It might be interesting.

He looked shocked and relieved. Apparently, most INEL engineers did not have time to work with students. Most engineers and managers were too busy and most would refuse. I understood that. But how much time would it take? Not that much.

"James Smith and Jesse Wheeler are doing a project on space. They would do whatever you say."

That was fine with me. I was happy to get students excited.

James Smith and Jesse Wheeler drove up to my home in their dented old car, and we talked about steam rockets and comets and space and the human occupation of the solar system.

James seemed intensely interested, and Jesse seemed to treat it as just a senior science homework thing. So I focused on James.

The senior project worked out ok, and mentoring seemed to be fun. I got to talk to them about space when they came up to my hill to visit. And they told me about life in Shelley.

Then Winston did something unusual. He connected with the INEEL people in charge of public relations with the community and he came up with money, real money.

"Would you like to mentor James Smith as a summer student?" the INEEL community relations person asked.

"I don't have any money to pay him. What does mentoring mean?" I asked.

"He would be a summer student, he would get paid to work at the lab for a part of the summer," she replied. "Can you find something useful for him to do?"

"You have any money?" I asked. She did.

I asked another person in the Public Relations department why and how they came up with money for this.

"You want the people here in Southeastern Idaho to like having 52 nuclear reactors just down the street from their potato fields," he said. "You want them to get jobs here, to have a vested interest. If we can get them to go to college and come back here to work, we have done our job."

"You want locals to work here?" I asked, wondering why in the world you would want such narrowly trained people.

"It's hard getting qualified people to move here, to come here to live in Idaho," he replied. I understood that one very well.

Some of us knew that nobody in their right mind would volunteer to come to work here if they had to choose between here and civilization. The INEL technical library was worse than the public library in Poway, California, where I left 4 years earlier. The nearest place to find technical colleagues was at Utah State University, near Salt Lake City.

Colleagues at other DOE national labs told me that the INEL was just a reactor test area, not a national lab. They pointed out that some DOE Idaho bosses treated the INEL engineers and scientists like a bunch of contractors building a house, not like people who were specifically hired to know better than the DOE bureaucrats what should be done. Real national labs (like Sandia, Los Alamos, Oak Ridge, Livermore) told the DOE people what needed to be done.

So experts tended to leave here, and sometimes they spread the word not to come here.

The only reason I came here was that Marland Stanley had the same contact in the White House I did, and Marland had the charter, the money and the facilities to test the nuclear engines to go to Mars.

Lockheed, our new contractor to manage the lab, seemed to send outcasts here, people they didn't know what to do with, and old guys who were about to retire. I could understand. Idaho Falls

was not a reward duty. If you did well in Lockheed, you sure don't get sent to Idaho as the bonus. It sure showed.

James Smith won. He got to take home some of that money reserved to encourage local students to become engineers and scientists, and to someday work here at the INEL.

All I expected James to do was find some pictures of local comets. "Document they are real," I told him. That was all, nothing more. Everybody in any audience I knew of loved those pictures. I always included a picture of a real comet when I would talk about space to local groups. Pictures were mandatory. Without pictures, those comet blobs of rocket fuel and space oil shale in the sky were no more than black, invisible figments in a wild eyed scientist head.

We gave James an office not 25 feet from mine, which was status. He was close enough to a pack of nuclear scientists and engineers that he could see how they got to live and work. We also gave him a summer job, with real pay. Not much pay, but real pay. Best of all for him, he got a fast internet connection.

"Why don't you talk to some of the comet people?" I asked, trying to introduce him to a powerful way to learn what was at the forefront of science. "You have a free long distance telephone. You can call them all for free. And you're calling from a Department of Energy national lab. You got status."

"What would I say?" he asked.

"Tell them you are here working with me, and you want pictures of any periodic comet."

"I've never talked with anyone like that before," he replied, clearly a bit at a loss as to what to say. I think it scared him.

"Just call them up," I said, again.

Fear criss-crossed his face, and I could see his stomach and chest tighten and his eyebrows and eye lids open.

Then I realized that he had no experience at all talking to scientists, famous people, or on the phone to strangers.

"Just tell them what you're doing. Tell them you are a summer student here. Tell them in your own words what we would do with the comets. Then tell them you would like to know were to get pictures of them to show people," I instructed.

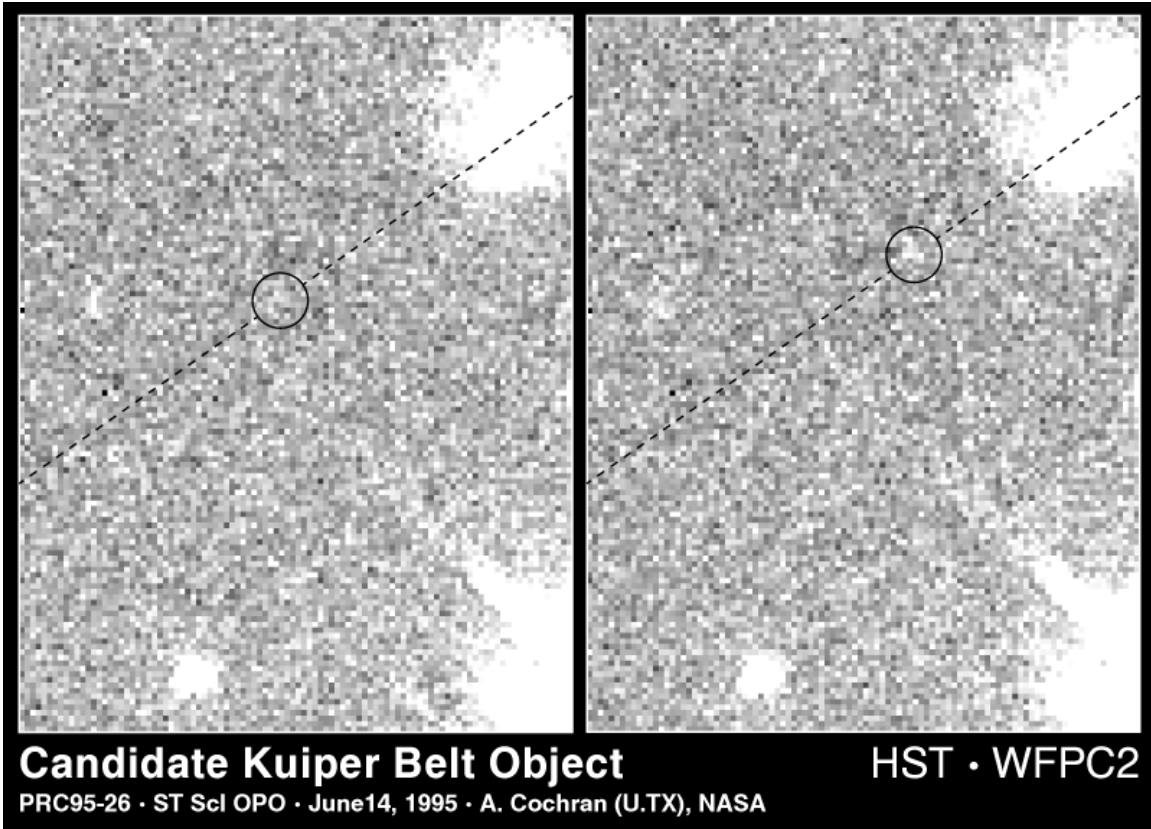
I didn't distract him when he made the phone calls. I made sure I was not there. Having some boss type or teacher monitor what you say when you are trying to talk to someone you never met before on the phone causes stuttering.

I gave him a list of people to call, for starters. David Levy, the Sky and Telescope person who discovered a dozen comets and the comet that slammed into Jupiter. Brian Marsden, the Director of the Minor Planet Center, Smithsonian Astrophysical Observatory and keeper of the Central Bureau of Astronomical Telegrams. Gene Shoemaker, also one of the discoverer of the comet Shoemaker-Levy-9. Dr. Don Yeomans and Dr. Glo Helene at the Jet Propulsion Labs. These were famous people. He should like that.

"Why don't you look up some people on the net who work with comets, too." I added.

This was a big task I gave him, but I didn't know it.

I gave him an image to work with.



It came from a NASA news release.

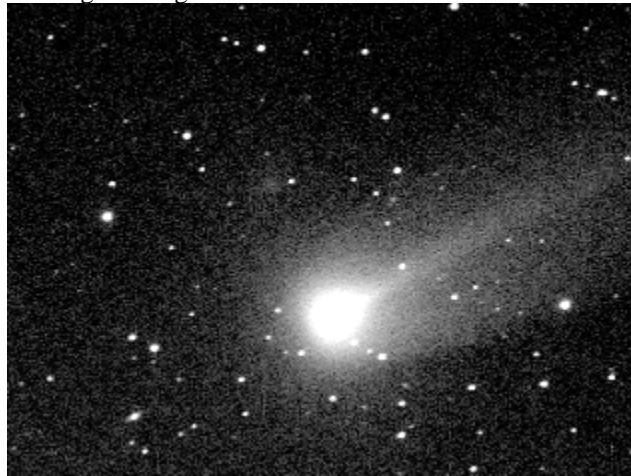
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From NASAnews@luna.osf.hq.nasa.gov Thu Jun 15 12:42:00 1995
Date: Wed, 14 Jun 1995 15:43:56 -0400
From: NASA HQ Public Affairs Office
To: press-release-nasa@mercury.hq.nasa.gov
Subject: Hubble Detects Long-Sought Comet Population Beyond Neptune

... Based on the Hubble observations, astronomers estimate the belt contains at least 200 million comets that have remained essentially unchanged since the birth of the solar system 4.5 billion years ago. The region is thought to be the source of the comet that struck Jupiter in July 1994.

"For the first time, we have a direct handle on the population of comets in this outer region. We now know, conclusively, that our solar system doesn't end at Neptune. The solar system just got a lot more interesting," says Anita Cochran of the University of Texas, Austin. "We now know where these short-period comets formed, and we now have a context for their role in the solar system's evolution."

About two days later he came back with some digital images of comets.



p- 1994 P



P/ West

“Did you get David Levy to help you at all?” I asked. He hesitated and mumbled something. I figured he had not gotten the courage yet to call.

He went off for a few more days to look up some more comets on the internet.

“Did you find anyone doing comets on the internet?” I asked.

“Yeah. I looked up the lady astronomer who wrote about those comets in that article you gave me,” he replied, as he looked down, somewhat dejected.

“So did you call her up?” I asked.

“She didn’t want to help me at all,” he said, as if admitting to a crime.

“What do you mean?” I asked, wondering how that could happen. No astronomer had ever turned down a young student and never turned me down.

“She didn’t want to give me any pictures. She said she didn’t want to help me at all,” he replied.

“Why?” I asked, totally puzzled.

Why would she not want to talk to us? I could not figure it.

“She said we were ruining space. She said she didn’t want anybody destroying the comets,” he answered.

“Who is this you talked with?” I asked, preparing to call her myself and find out what the hell she was doing ruining a student’s self image like that.

“Professor Anita Cochran,” he answered, tersely.

“Where is she at?” I grilled.

“In Texas, the University of Texas.”

Suddenly I realized what had happened.

He had called her first. Her name was at the bottom of a digital camera photo I had given him of some newly discovered Kuiper belt objects. It was also in the NASA press release.

Her blood pressure went up. Her voice tightened. I imagined exactly what must have gone on. I imagined that James had just told her how we made nuclear reactors here in Idaho. And we made nuclear rockets. And we were going to go to the closest comets we could find and vaporize them.

We would turn on a nuclear reactor full blast. We would heat the ice and make water vapor, and demolish all the delicate structures in the comet, melting a 4 billion year of the history of the solar system into mucky ice water.

Somewhere on the internet I found:

Dr. Anita Cochran, University of Texas Comets, left over from the origin of our solar system, can tell us a lot about how our solar system became what it is.

...

I could see the broken stalactites on the cave floor.

About 20 years earlier Terri and I and Bill and Sarah Bishop were crawling, spelunking, on the floor of a cave. The Fort Stanton Caves somewhere in the middle of New Mexico. A few days before we went there, Bishop had to get the secret combination for the lock at the gate to the completely unmarked cave entrance 20 miles from the nearest real highway and two miles off an unmarked dirt road. The metal gate was there to keep people out.

I was crawling on my stomach through the 2 foot high, 50 foot long space deep in the cave. When I took a rest from the awkward crawl I looked up at the ceiling 1 foot above me. The carbide miner's lamp on my head illuminated the little round marks where stalactites used to be. I looked to my side. I saw a 2 inch stalactite on the floor and some refuse from human visits.

"Where did all the stalactites go? There's only one on the floor," I asked Bill Bishop.

"Ass holes ripped em off. That why there's a gate," he replied with the same disgust I was feeling as he said it.

As we got to a distant corner a quarter mile deeper into the cave, we came across a small hole with some rebar blocking it. ("rebar" is reinforcement bar, a 1/2 inch thick steel bar used to strengthen cement structures). The hole was only about twice as big as the hole inside of a metal coat hanger. The hole was one of thousands in the cave. The hole was small and tucked away and hard to find. Bishop pulled a big chain from under the hole somewhere and got hold of the industrial strength combination lock. He undid the heavy chain and undid the rebar. We went in.

After the four of us crawled another quarter mile through the locked, secret hole, we dropped into an area full of beautiful, flowing stalagmites and stalactites, still forming and wet, complete with natural color and form. The area had no refuse at all. Bishop even made us carry a plastic bag to put our poop into, just in case we had to go. We were all of the same mind: preserve.

Preserve the formations. Don't touch them. The finger oil changes them forever. Don't disturb the dirt. Our breath moisture and our hydrocarbons would change everything. Leave it. It has to be this way for a 10,000 years. Don't destroy it.

Without anyone ever explaining it to me, I understood. Don't rip off a beautiful formation just to sell it for \$1000 at some rock shop. Leave it. It is a history that can not be reborn.

The formations were like a living child hit by a drive-by shooter. Once killed, nothing can bring the child back to life. Once snuffed out, it is dead forever.

Then I saw Terri and I back in Cleveland. We had driven to Toledo to the pit mine where they dug a dirt they made into cement. A white sign at the cement pit entrance declared that we were going there at our own risk.

It was a fossil bed, with stunning, perfectly preserved brachiopods, trilobites with bulging black eyes, ferns, whole ferns, and crinoids with pyrite crystal stems. Every bucket of hard clay muck was saturated with the fossils. The cement pit people let us crawl around their cement pit on weekends to collect whatever we wanted. I recalled that I still coveted that trilobite I found. I kept it perfectly preserved and protected in a heavy brass container.

During the week they ground up truckloads at a time and baked them, completely destroying huge quantities of irreplaceable, beautiful fossils, and turning the formation into cement. Forever lost, turned into a sidewalk.

I thought of the clear cutters, mowing everything off the mountain sides of Oregon. Destroying everything. Not just old trees. Not just young trees. Everything. Clear Cut.

And now the Professor lady from Texas, Anita Cochran, smacked us across the side of the head because we said we wanted to vaporize comets, something that took a few billion years to make, so a few joy riders could squirt across around the solar system, destroying stalagmites and fossils, clear cutting everything in our path.

James a did find a few more pictures, but he could only find a few. The photos mostly looked like the noise on the TV picture tube when the station goes off the air during a storm. Not very exciting. Almost useless.

We were the bad guys. And she didn't give a damn that we wanted to Occupy the Solar System. We were just a bunch of insane, redneck clear cutters.

After James Smith worked with me for the summer, I never saw him again. I heard he did not go on to college. He just got a local job like all the rest of the graduates of Shelley High.

At the end of the summer, when the students were awarded and recognized for their work, James was accidentally passed over. I wondered why. His parents were there. They were proud of him. I met them.

Cochnauer, Tiajuana M, of the DOE Idaho, in charge of the money for this, deliberately overlooked him. She had some kind of thing against space.

Her boss boss, Nichols, Dr. Clayton R, told me that his son was inspired by my work and went on to do great as a direct result of

me. I was honored. But Tiajuana Cochnauer did not like space.
She only liked it later, when she found out that the VP liked it.

Lecture at Utah State

Utah State was green. The 20 or 30 buckeye trees formed a canopy on the path between the visitor dorm room building and the administration buildings. They reminded me of Ohio. I had not picked up a buckeye fallen from a buckeye tree since the 1960's. During the fall the trees turned color. The campus was always inviting. James was with me.

Professor Frank Redd had invited me to speak at the Utah State University "Pathway to Mars Workshop," 21 June 1995. Every time I spoke at this annual workshop I had something new to tell them. This time, it was pictures of the lunar south pole craters where the Clementine mission found the water ice.

My address book recorded who I talked with.

19950621usumars Pathway to Mars Workshop: redd, frank; siahpush, ali; pantalos, george m; licht, greg; vanderford, john; zuppero, tony; smith, james; batty, j clair; williams, brian; harris, lynette; ryzhenko, alexander;

James sat in the same lecture room as 30 or 50 others, mostly high school teachers, listened to me. I showed them the lunar crater photos. The same teacher fell asleep during my talk as the last time I was here, no matter what exciting thing I would say. Most of the others listened intently.

The whipping James got from Cochran, the Texas comet professor lady, made me a little hesitant.

"Here is a picture of an object in the Kuiper Belt." I declared, pointing out a small white dot on a photo full of all kinds of star dots.

"There is an awful lot of hydrocarbons out there. These things are supposed to be comets, big comets. There is a whole formation of them,"

They didn't look impressed.

"Not everyone believed this belt existed.

Even Dr. Prof. Tom Geherls, a famous astronomer looking for near earth asteroids, said 'What Kuiper belt?' when I said something about 'in the Kuiper belt.'

He mocked those who said it might be real.

He knew I was just a rocket person.
He didn't believe in the belt.

But here it is."

I was declaring the discovery of a huge store of space oil shale and ice. But I was not the expert, and the astronomers had not yet discovered very many objects there.

"The farther out you go from the sun, the lighter the stuff of the object is," I said, explaining why the objects out there were not just a bunch of rocks in space.

"You know the planets?
Mercury, Venus Earth Mars Jupiter and such?"

These were high school teachers. I needed to give them some examples on how to tell their students.

"Mercury is made of heavy stuff, heavier than Earth rocks. closest to the sun.

Earth has a core of iron.
Farther from the sun.

Mars has more aluminum, lighter than iron.
Farther than earth.

The asteroids in the asteroid belt are mostly rock, not iron.
Just past Mars.

Jupiter, Saturn, Uranus and Neptune are gas.

Farther out you go,
more gassy they get.

The objects in the Kuiper belt,
past Neptune.

Made of
hydrocarbons instead of rock.

That means oil shale in space."

They were supposed to see how this was oil. Unlimited oil.

"Pluto may be one, a comet."

These were most probably left wing, liberal school teachers. Probably environmental extremists. I could relate to that. But, I could not resist the temptation to poke a stick at a hornets nest.

"We have an unlimited amount of oil."

Startle them, I thought.

“We’re not out of oil.
We don’t need to preserve oil for future generations.”

Anti-conservation epithet, I thought.

They ought to be thinking global warming, and I knew they did not have a clue that we have a 15,000 year supply of hydrocarbons right here on Earth.

“We don’t need to conserve oil at all.”

They were not responding to my epithets. Were they all asleep?

“Hydrocarbon objects are everywhere in the solar system,
so many that it’s a threat,
not a promise.”

The Prof. Anita Cochran sensitivity enhancement exercise gave me a little practice on how to continue.

“There’s enough hydrocarbon out there
that if we brought it all back,
we could lay a sea of goo
all around the earth
like an ocean of tar.

That ought to get them, I thought.

“It’s a threat,
not a promise.”

It was a threat, to have all that oil out there in space. But the bigger threat was from right here on earth. We had plenty enough oil right here to cover the earth with a global warming blanket of CO₂. They weren’t responding anyway, so I just kept on with the rest of the story.

I skipped the part about how the comets out there, nearly all of them, had dirty hydrocarbons, very dirty, with high sulfur. I skipped the part where the galaxy ought to have hydrocarbon objects everywhere, and where the whole universe should be full of hydrocarbon objects. That would be another story, where hydrocarbon objects dominate the orbits around stars.

I skipped the part where there ought to be hydrocarbon space aliens everywhere in the universe.

Then a lady teacher asked:

“Where do the hydrocarbons come from?”

Somebody was awake.

“I don’t know.

Nobody knows yet.
It’s just there.

The Europeans measured it.
Their satellite went through the tail of comet Halley.

They had this thing, device, that collected debris
as it flew past the comet tail.

I showed a picture of comet Halley.



“They said “what’s this?”
Vat ist zis?
Diese ist oil shale?
Kerogen?
CH₂ polymer?

These are European guys.
NASA didn’t measure anything.

Nobody knows where it came from or why.
It’s just there.”

- Jack Schmidt and space oil

jackschmitt

- Jack Schmidt: “10 miles down”

Life Forms: 10 miles down

"Where do you think the life forms will be on Mars?" I asked the last guy to walk on the moon.

After looking at me for less than a quarter of a second he promptly asserted,
"10 miles down."

It was the first of June in Albuquerque, New Mexico, 1996. At 7 am in the morning, the motel at the crossroads of two interstate highways in the middle of the city sheltered only some of the passing truck sounds. The building shadowed some of the view of the blue sky and Sandia mountains rising a mile above us 7 miles to the east.

We were scientists, astronomers and engineers here at a meeting about outer space and most of us came here to present what we found or figured.

A free breakfast including truck stop-strength coffee, flat, pasty dough things with fake jelly, plain bagels and cream, and plenty of butter was supposed to lure us deep into the basement of the conference part of the motel building to meet with our session chairperson. The room had about 10 round tables each with 6 to 8 chairs, and half the tables were unoccupied.

Both Hale and Bopp were here. This was the year that the comet Hale-Bopp was supposed to put on a stunning, monumental display in the sky. Trusted astronomers told us it would startle everyone in the northern hemisphere. It was going to happen. But didn't happen yet, and no one knew if Hale and Bopp were really going to be really famous or if the comet was just going to fizzle.

We were all at the same meeting, so I had breakfast with both of them at the same time. Thomas Bopp brought his father Frank Bopp along. Dr. Alan Hale and the Bopp's were hanging around together for breakfast. I thought having breakfast with them would be interesting. After all, Hale and his buddy Bopp got to name the comet after themselves.

Frank Bopp, the father, was very friendly. His 60-or-70-or-so year old face and smile and handshake all proclaimed loudly "I don't know anything about those comets, but I sure like visiting here at this meeting of rocket scientists." He sat next to me, I guess because I was friendly to him. Thomas Bopp seemed like the typical nice, clean cut fellow one would meet in the middle of the night at an astronomy camping meet. He was clean shaven, not hefty, as short as me (about 5 ft 8) and casually dressed, exactly like a suburbanite.

We all sat down to feast on those free, pasty dough things, with unlimited coffee and fake creamer. Hale's strong focus on stuffing the pasty things into his face and his focused gaze down on the food all seemed to indicate he really liked this cheap, free breakfast made specially for astronomers. Meanwhile, I was setting up a trick question aimed right at him.

"What's that comet made of?" I asked Hale.

I knew damn well what it's made of. I wanted him to make sure he would say so in public. A comet contains hydrocarbons. The European space ships had flown through the dust trail of a very similar comet, Haley, and analyzed it. The Europeans discovered that the dust was strikingly similar to dirty oil shale.

Hale responded with a smile, knowing he knew the answer. Rocking left and right a little in his chair, he smiled and started to bask in the light of attention. Then he started to tell me, an astronomically ignorant colleague with whom he was having breakfast, about comets. He was practicing what he would say in public. He knew I was a rocket science type, and that he was the astronomer type, about to become very famous.

"Well," he started, and then with a voice of authority he said "we like to think of them as dirty snowballs."

"Snowballs?" I remarked, instantly unhappy.

Hale proceeded to completely miss it, I thought, and get the wrong answer. He told me it was water and dirt.

"What about the hydrocarbons?" I asked, trying to give him a reprieve, one more chance to answer the question right.

"Well, yes, there are some hydrocarbons."

His body language and the way he said words dissuaded me from making any attempt to tell him what his astronomer friends in Europe had just learned, about what comets were made of.

I gave up on him without a fuss. He missed it. I was completely disappointed that he knew so little about what comets are made of. He was going to waste his fame.

I wondered if he knew about the discovery of the third branch of life. I didn't ask him. I guessed he probably didn't. The correct answer would be "Archaea Bacter." That's what big comets, big moons and planets of the Solar System ought to have a few miles

under their surfaces, inside them, space bugs. That would be too deep for him.

For the next 20 minutes we just made small talk about how he and Bopp discovered the comet. Most of finding the comet seemed to be that they spent a lot of time out there in the middle of the night looking at the sky.

Hale was supposed to explain to me in detail how that comet had about 500 years worth of hydrocarbons. When we looked up at the comet Hale Bopp, we could be looking at a 500 year supply of dirty tar from space. Another, different calculation gave a 5000 year supply.

The United States could live for 500 or 5000 years on just that comet, if we converted the tar to oil. He had a golden chance to tell everybody he would talk to about the hydrocarbons-from-space story. And he was clearly going to miss the chance.

As I left the room to get ready for the space meeting I realized that I failed to meet with my session chairman like I was supposed to. I met with Hale and Bopp instead. Instinctively, I shifted the blame to someone else, and mumbled to myself,

“Someday I will write about this.

The moral of the story is that not even Hale,
a famous guy who found a comet,
knows that comets are a frozen hydrocarbon soup,

a tar pit from space,

maybe even an egg waiting to feed space bugs.”

Barbara Sprungman was on a mission. We were outside in the open courtyard with blue sky and the noonday sun of Albuquerque above us. Barbara started to talk to a group of us sitting around some tables. She wanted us to help. Barbara was using her pretty-ness and smartness to try to get scientists to stare at her long enough to get interested in distributing educational material to grade schools and high schools. She was holding her pack of literature and trying to get their attention. She wanted them to take things back with them to the schools.

Her straw blond hair on her petite body caught my attention. Almost chuckling out loud, I could see that my colleagues, the typical, meek space geeks, were focused on her. I was a geek. I was focusing, too.

She wanted to put something on the desk of every schoolchild in the nation. One of my goals was also to put a copy of the New Solar System, with the space of near Earth objects, on the desk of every schoolchild in the nation. She was doing something related to space on a national scale for schoolchildren. She had access to the entire nation of fertile minds.

“That’s my entry point,” I thought. “That’s how I will meet her and talk with her.”

In a knee jerk, I instantly got up and went for her.

She understood immediately. She could see I was on a mission.

Out of the corner of my eye, just past the student, I noticed a famous person with no one swarming around him. This was proof that Presidents of Hospital Research Foundations, former moon-walking Astronauts and former Senators still have to scrounge and work hard for attention. Dr. Jack Schmitt was all three. I could see he still had to work for attention, because his booth had no people around it.

"You would think people this famous would have a flock of people swarming around them all the time. Not so," I said to the grad student.

Harrison "Jack" Schmitt was a Ph.D. Geologist and was one of the last guys to walk on the moon. A few years earlier I heard him tell a small group of us about how the space suit gloves didn't quite fit. The faulty gloves pried his fingernails loose on the moon when he was trying to do work. It was a form of torture. Because I had talked with him before, I knew that would be an entry to talk with him.

I asked the student:

"You know who that guy is over there?"

"No" he said.

"That's Jack Schmitt."

I waited for that look of surprise on his face. But it didn't happen. The kid clearly didn't know anyone by that name. Then I realized, Schmitt had walked on the moon about when this guy was born.

"That's the last guy to walk on the moon." I told him, trying to impress him.

"Wow." he said.

A slight surprise came over his face, but not much, and that was that. I never would have expected that lack of a response.

"I'll go introduce you to him."

The long awaited, surprise expression finally came across his face. He was slightly startled by it.

It never even crossed the graduate student's mind that one could just go up to him and meet him. I had expected that kind of response. Most of the scientists in this room didn't know they could just go up to Jack Schmitt himself and talk with him, and almost every one of them would want to.

As we started walking away from the brownie and coffee table, he said with a glee,

"Wow, I like history."

We walked over to Jack Schmitt, I introduced him to the student and we all had a nice, long chat.

Back to the science sessions, and Barbara Sprungman and I sat together for the rest of the meetings. She told me of her childhood and of the strong literary heritage of her family, and especially how proud she was that Leonard David her husband had "a byline."

"What's a byline?" I asked.

"His name," she replied.

A byline was the intellectual accomplishment that made Leonard David acceptable to her family.

--

That evening, in that same open courtyard where I met Barbara, but now set up with food and tables, we all started to look for places to sit. Jack Schmitt the Famous, and one of the last humans to walk on the moon, saw her and they started talking. Milt Swartz, a retired wealthy architect who thought he would invent and bestow upon us some brand new ways to build things cheaply and functionally on the moon, better than those engineers from NASA or universities could ever do, because he was a famous and wealthy architect, he saw Barbara and Jack Schmitt, and they all started talking. After Jack said "lets get in line for our food" Barbara talked with him, including me in while we went through the food line. When we got back to the table she maneuvered the sitting arrangements so that I got to sit right next to Jack Schmitt.

She was on the other side, and Swartz was opposite me. Some others at the table didn't say much.

"I will do anything for Barbara," I thought, "getting me to sit next to Jack Schmitt."

"Well, Barbara didn't do all the introduction," I thought again.

One would think Barbara Sprungman was alone at this meeting, even though her husband was at the same meeting. The two of them would seldom be in the same place at the same time until late in the evening, after the formal part of the meetings. Then they would be drinking beer with famous people. His name was different from hers and hard to figure which was the first name and which was the last: Leonard David. They were both writers, focusing on space.

Schmitt and I were about to sit down in our chairs, still holding the plates we filled in the food line. I did not quite know what to say. I had just been granted the chance to have supper with the last guy who walked on the moon. I was trying to think of something intelligent, something serious. This was different from that nice long conversation in the conference room, with the student standing around.

If you tell someone "you're history." it means they've had it, that's the end of them. They are out, someone else is in.

"Hey Jack, you know what that student said about you? He said 'your history.'"

Why did I say that? What a dummy.

Jack laughed.

"Yeah. I know what you mean." he said, and we sat down to supper.

I didn't know what he meant. But he was no longer a United States Senator, and he was no longer an astronaut. Now he was the President of the Lovelace Foundation, a research-type hospital. And nobody visited his booth. This was just one more time I failed to learn tact. He did indeed know what "you're history" means.

My curiosity would not let me stop.

I wondered if Jack Schmitt had seen the eye flash from space.

"You know, space is radioactive." I started.

Almost nobody knew. NASA didn't say much about that. They wanted our money. They didn't tell us how they knew that space was far more radioactive than eating raw plutonium. That is not an exaggeration. Space was so radioactive that anyone who floated around out there would suffer a 1% chance of deadly cancer for each year in space.

The Galactic Cosmic Radiation, the evil GCR, is the culprit. It would shoot bare, ionized atomic nuclei right through your spaceship wall. The particles would go right through a carbonoid flesh animal like a person. The ionized atomic nuclei GCR would do the same thing as atomic, nuclear fission products from nuclear reactions. Except that the GCR have far more energy. The GCR would go right through you, a humanoid.

As explained to me, the GCR would blast a split second trail through your body. They would smash the meat and blood so hard that they would create a flash of white hot atom plasma wherever they pierced. Like a white hot spider web shooting through your body. But the web-like pierce was so thin you would not feel the heat before the surrounding flesh would cool the plasma.

When you, an astronaut, are in space, these GCR particles are going through you like a swarm of hyperfine needles, all the time. They go through your whole body. your legs, your stomach, your liver, your ears, your brain.

Every once in a while one goes through your eye, one or the other eye.

The "eye flash."

The first astronauts saw them when they were told to close their eyes and try to go to sleep. They told the ground control people that

they were seeing a flash every once in a while. At first, people thought it was space sickness, hallucinations due to weightlessness, isolation, excitement. The astronauts insisted they really did see the flashes.

And then someone figured out the astronauts weren't crazy at all. The space doctors figured out it was "cosmic rays." When I read the technical data I learned that when their eyes were in the dark, they would see a flash about once every three minutes, at random and in only one eye.

Only one eye because the GCR would have to be going in exactly the right direction to hit both eyes at once. It was a bit like a bullet hitting both eyes. Possible, but I never heard of anyone getting shot in both eyes with one bullet.

GCR are space bullets.

Space is radioactive, dangerous, and I was having supper with a guy who lived through it. He was still gun-fight quick and razor sharp, and smart as hell, too.

So I asked him,

"Did you see the eye flash?"

He started to come out of his chair to turn directly at me. His face took on the look like I had insulted him.

"Of course I saw the eye flash." he answered instantly.

His face and the way he said it clearly said what his words did not: "What did you think? I'm not a real astronaut? Any astronaut worth anything saw the eye flashes."

I did not expect his sensitivity, this sore nerve. But I didn't care.

"What did you see?" I asked, wanting to know what it felt like.

"Did you actually see a line, a flashing line? What did you see?" I repeated, not even giving him time to answer.

"You know, a flash, like a cloud chamber," he replied,

A cloud chamber? Yikes! That's like lightning, but inside your eye. All I could think of was "Wow."

But he hesitated and didn't look at me directly when he said it. I could not figure why.

We kept eating, and I kept asking him questions.

Jack Schmitt traveled everywhere and talked to everyone, so I asked him what he observed about people in other places.

"Do they think like we do?"

"No."

He surprised me.

"Kids here in the United States are fearless."

"In South America they don't think that way. They think of you as a person of immense stature, someone who is some sort of person beyond anything, like a person they can't ever be like. Like the Pope."

"Here, anyone you pick is confident they can do anything. They can be anything they wish and get anywhere. You see somebody doing something, and you think 'I can do that.' We have a sense that we can achieve anything we desire. Anyone can be the President."

He told me how when he visited in South America as a dignitary astronaut,

"people don't imagine they can change themselves and rise to a position of stature. Their social systems are more locked. They idolize people because of their position. No one thinks they can just do anything. They know they can't change their social status, or change their situation in life."

"That's true," I remarked, somewhat stunned, "I think I can climb as high as I wish, if I just work at it."

I didn't expect him to make such a profoundly philosophical observation about people. Jack Schmitt observed that we Americans are indeed completely different from most peoples of the world. We are the ones who can choose to rise to whatever level there is to rise. The others don't have the option to choose.

Life in Deep space, and The Archaea Bacter story

I had been rehearsing in my mind all through the food line how I would show Jack how really smart I was. I knew something about the carbon based life form that almost no one else knew. Something scary. Something spacey. I was just itching to hit him with it.

"Where do you think the life forms on Mars will be?"

He looked up slightly, and then looked at me and said, "10 miles down."

Instant reply. No hesitation. Almost. Like he knew exactly where they would be and why. I thought I was the only one who knew.

"You know about the Archaea Bacter?" I asked.

Oil company drillers had found some slimy stuff when they were drilling for oil somewhere in the sea near Norway. It looked like a life form. They knew it was some kind of microbe, but it didn't grow, and nothing seemed to make it grow, so they just ignored it.

"Sure," he replied. He was a geologist.

But one of the oil company-related scientists figured out that to make the slime thing grow one had to adjust the environment to be

the same as it was where they found the slime, at the bottom of the drill hole. They would need to feed it whatever it ate down there. They would also need to make it warm enough, like it was down there 6000 feet at the bottom of the drill hole.

But doing all those things was rather scary. It was very warm down there at the bottom of the drill hole. It was hotter than the boiling point of water on the surface. It was 240 degrees Fahrenheit. The pressure was 20 times higher than the pressure inside a piston of an automobile engine when the spark plug makes it explode. The pressure was more than 3000 pounds per square inch.

The only thing the slime found down there to eat was gasses that come up from the deep, like hydrogen, steam, methane, CO2 and nitrogen.

So the guy who did this, probably a crazed mad scientist type, had a very hot bomb in his lab, ready to explode and spew hot, explosive gasses everywhere.

When the mad scientist did all those things (except let it explode), the slime came alive.

These slime things did not care if they ever ate anything that ever saw light. They did NOT need anything that ever saw or needed or used photosynthesis. They ate raw, chemical planet stuff.

These were NOT algae or plants. These were NOT things that relied on photosynthesis. These were *chemi-synthetic* microbes. These were the SLIMES, the Archaea Bacter.

These are a third branch of life.

"So, you knew that these things are chemi-synthetic?"

"Well, yeah," he replied.

No one suspected they even existed till they actually found them. But once we saw them, the mad scientists started looking everywhere, especially deep down beneath the surface of the Earth. They found them everywhere, deep inside the Earth. One estimate suggested there may be as much carbon based life form beneath the surface of the Earth as on the surface. What a stunning surprise.

Since I was reading technical papers about it, I thought I was smart. I thought I was the only one who figured out the meaning of the Archaea Bacter. But everyone who knew about space saw the same thing. I was not as smart as I thought.

I did not even need to ask him where else besides the deep of the Earth we might find such primitive microbes.

Deep inside Mars, of course. And anywhere else where it was hot, and high pressure. Like deep inside the moons of the solar system, like Callisto, Ganymede, Europa, or the moons of Saturn, or the moons of Uranus and Neptune.

Where else? How about deep inside any planet that had dirt and water, like under one of the several huge ice lakes at the North and South poles of the planet Mercury. Or like deep inside the comets when they first formed, maybe like the 200 million comets of the Kuiper belt.

"I guess you would know, you're a geologist," I commented. He knew the whole story.

Where else would I find them? Anywhere in the Milky Way Galaxy.

Jack and I both knew the recent verifications that stars were suns like ours and they had planets.

Jack knew that the suns in our galaxy were like the suns in any other galaxy.

We both knew there were galaxies as far as telescopes could see, right to the edge of time, the edge of the universe.

Harrison Schmitt, the last guy to walk on the Moon, figured we would likely find these microbes everywhere in the universe, just like I did.

I didn't know what to say, because he knew everything I was going to tell him. I knew what his answer would be, and I asked him anyway.

As I glanced up to the now dark blue, almost dark evening sky I asked the last guy to walk on the moon,
"Do you think there's life out there?"

The last guy to walk on the moon made up for what Hale didn't know.

"You would expect to find Life everywhere in the Universe," said the one time Man In The Moon.

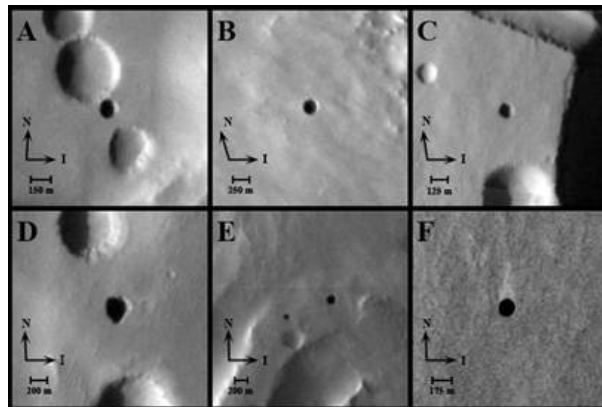
19960603space96+++ Albuquerque Hilton 1-6 June 1996 baird, mark; barr, edward, b.; billings, tom; blocker, norm; bopp, frank; bopp, thomas; boslough, mark; brooks, phillip mapquest switchboard; calhoun, bob & shirley; cramer, karen; david, leonard; duke, mike; gehrels, tom; gies, john v; hale, alan; hansche, bruce & chris husted & jenna; hoover, mark d; jacobs, cliff; jenkins, lyle; johnson-freese, dr. joan ; kargel, jeff; kaya, nobuyuki; kuck, david l; lauer, chuck; lenard, roger; levy, david; makenzie, bruce a; mcquade, frank; mink, mike; nagovitsyn, oleg; nantel, jacques, m; nelson, terry; petit, don; prsbrey, mike; prsbrey, t. keith; risvold, debee.; sanchez, felix & clorinda; schiff, steve; schmitt, harrison; schwartz, milt & son; sharpe, burt.; shoemaker, eugene; snead, j. michael, p.; sonter, mark; spalding, dick; sprungman, barbara Itwister, arrival; mystery science theater.; tagliaferri, ed; wachinski, anthony m.; willoughby, alan; worden, col. simon p;

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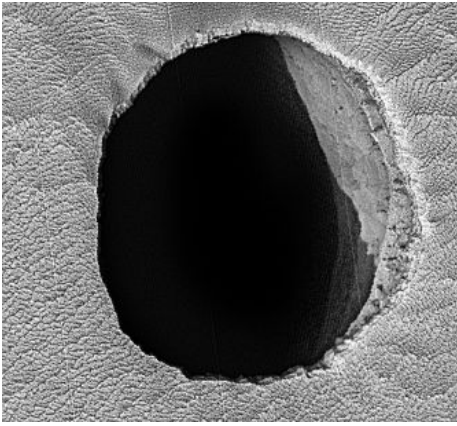
Caves on Mars

Posted: Monday, March 19, 2007 2:51 PM by Alan Boyle



NASA / ASU / USGS

This series of pictures shows seven proposed cave skylights. Clockwise from upper left are Dena, Chloe, Wendy, Annie, Abbey and Nikki, and Jeanne. Arrows signify direction of solar illumination (I) and north (N).



http://hirise.lpl.arizona.edu/PSP_004847_1745

"Jeane"

Looks like a blow-hole to me. I bet there is life and water and interesting things down there.

- Zuppero speaks: water and oil in neospace

Water And Oil In Neospace

I missed the whole point of finding water in the Solar System with this presentation.

I missed it when I wrote about that presentation, 5 years later.

I missed it.

The point should have been we could inhabit the solar system.

Nobody cares about oil in space.

Every picture in this presentation is a water ice object. Just quickly scan the pictures.

The only thing I got right was "stories",

they want stories to entertain them. That is their desire.

See if you give a damn about "oil in space".

See if you can even get through reading this chapter.

When you are done reading this, did you care?

I think not.

17 July 2009

A. Zuppero

Oil From Space

“Discovery Of Abundant, Accessible Hydrocarbons Nearly Everywhere In The Solar System”

It was my turn to speak. June, 1996. Albuquerque. Each technical session was held in a small conference room. About 6 small rooms surrounded the main, large conference room. Most technical sessions, 6 out of 7, were expected to draw so few listeners that they would all fit in the 20 or so chairs in the small rooms. All the sessions of the entire space conference fit into these rooms. An

overhead projector and a slide projector were ready and waiting to make an annoying fan noise when they were on.

Only about half of the people wore their suits, like I did. Two typical, slovenly, overweight, disheveled perpetual attendees were in their usual front row chairs, were not wearing a suit. They were not familiar faces, but they never were. They were

always there, poised to pounce with a tangential question out of turn.

Nobody expected anything to happen in space. These were the Clinton years. Space was bad. Nuclear was bad. We were both.

I walked up to the podium with a confidence that clearly showed I knew what I was going to tell them and exactly where we were going with the presentation. General Dynamics taught me how important it was to do that.

“The audience knows within the first ten seconds whether the talk is going to be any good or not,” I heard Del Ritchhart tell me.

Seven years earlier, Del had coached me on ways to make a good impression on the Admirals and Captains in the Pentagon.

“Did you ever notice, when you’re watching a live play, how the audience can tell immediately when the person with the charisma comes on stage? They know within 10 seconds. You’ve got to project that,” he coached.

“I’m going to show you how
we recently discovered
both,
that the solar system is full of something like oil shale,
and
that we discovered how to transport it
back to Earth.”

It took 2 days, on an off, to write that line. A criminal lawyer I sat next to on an airplane during the early 1970’s told me that “trick.” Wondering if there was a method to winning court cases, I had asked him “How do you know what to say?”

“I work on that one sentence that tells the whole story. Then everything else follows. Sometimes takes me a while. Take’ three days to get that sentence. Then it’s easy.”

So, that’s what my one sentence did. I told them what I would do. I would show them why we, the collective “we” of all the scientists in the world doing any related work, found out the composition of the solar system and how it was like oil shale.

And then I would tell them that we knew how to transport it, using my steam rocket, of course, but I would not dwell on that part. I would first show them that humans will run out of spare earth before we run out of spare hydrocarbons, such as oil.

I put a picture on the overhead projector. “Always start with a picture of something real,” I heard an Old Bull mentor from General Dynamics tell me. I showed a picture of a comet, spewing what could be fire, for all we know. It was the only picture I had of a comet itself. It was the only picture anyone had of any comet itself. It looked kinda neat.



\ Halley-r.jpg
Comet Halley, close-up, from the European Giotto.

With the picture on the projector, to indicate that something interesting was going to happen, with pictures, not equations, I began:

“I’m going to show you
how there are way more hydrocarbons out there than we can
use.

It’s more like a threat than a promise.”

“I’m going to tell you”

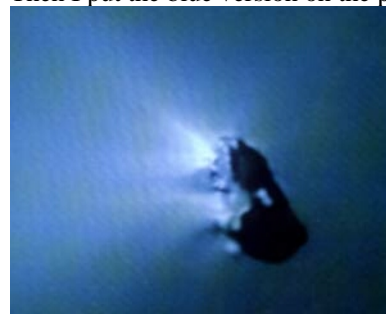
and I held up a “#1” finger,
“they exist,”

I moved two fingers like the second point,
“they’re kinda close”

and then I just moved my hands like any good Italian,
“and we can transport em.”

“This is a close-up of the Comet Halley,” I said, of the rusty colored version of the picture.

Then I put the blue version on the projector.



“The Europeans took this picture. It’s the comet Halley itself.”

I drove a big pointer toward the projection screen, towards the white cloud of the comet, and said,

“Their satellite flew through the tail of the comet.”
“Their sensor picked up the dust.
“to their surprise,
it was CH₂ polymer,
kerogen,
identical to oil shale.”

I paused for a second, so they would not hear anything else, just the echo of the words “identical to oil shale.”

Pointing to the black part of the comet,
“You are looking at
about 200 times as much hydrocarbon material
as the OPEC produces in a year “

Presumably, they knew that OPEC meant “Oil Producing Exporting Countries.”

Then, like a typical physicist, I gave them a measure of size that would be easy to remember,
“One, 1, "OPEC" is about a billion tones.”

Then I stood in front of the picture a little bit, trying to block its view just a little, trying to get the projector light to shine on me, instead of the comet, to make me light up.

“They were shocked.
they were shocked that it was indistinguishable from oil shale.

An’ they were shocked that it was so big.”

Moving out of the way, I pointed to the smaller, bright spot of the comet,
“Their telescopes could only see the white spot.”

Then I pointed to the black part
“They couldn’t see
the **Big**
black part,
with earth telescopes.

This thing was 4 times bigger than they thought.
That meant it was 4
cubed
times as much volume,
and that meant it was
4 cubed times
heavier.

This thing was 20 km across.
That’s as big as the entire city of Albuquerque,
where we are sitting,

from down in the valley by the river,
all the way to the Sandia Mountain.

And it’s roughly 1/3 oil shale.

Maybe 1 / 5 th.”

Letting them look at the picture for a moment, I gave them the first clue that the dark sky hides a huge amount of dark surprises:
“This is 4 times darker than anything they had ever seen.
It’s 4 times darker than the inside of a chimney,
4 times blacker than soot.

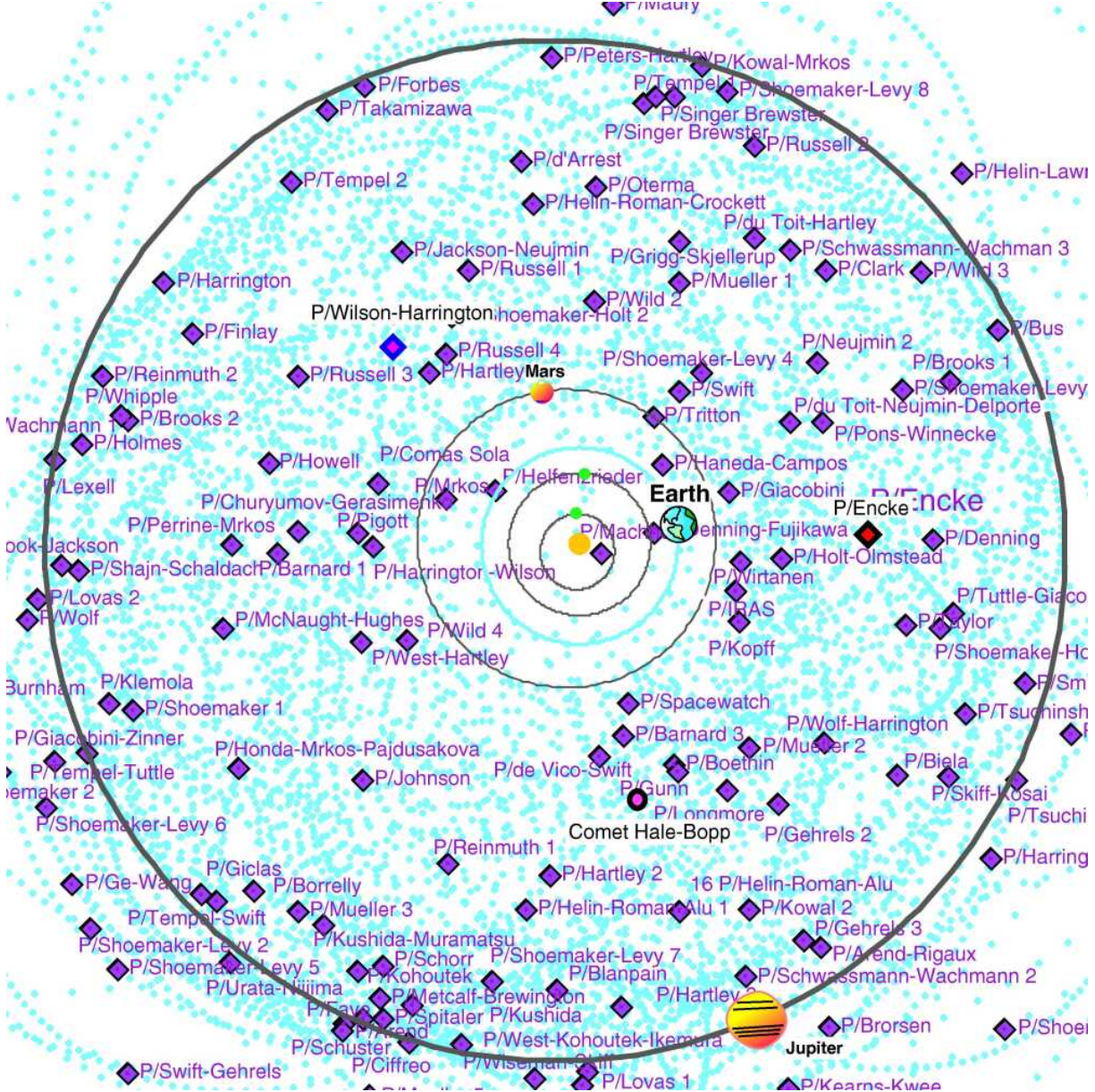
Its albedo is 1 to 2% instead of 5% like soot.”

This was not rocket science.

“We didn’t know it because we didn’t see it.”

They were thinking oil. They were looking at oil shale from space.

Then I put up the shocking picture.



\ cometblu-com-lev2-bin-cr-cr-r-r.jpg

To put them directly into this picture I pointed to the center of the picture,

“Here’s the sun,”

With a pointer starting at the sun, in the center, I then moved out one planet at a time, pointing to each planet,

“Mercury,
Venus,”

And I paused when I got to us,

“Earth,
You live here,”

I paused, to make it sink in that we were in this picture, as we sat in this meeting room,

and then pointed to the next planets,
“Mars,”

And then to the lower right edge of the picture,
“Jupiter.”

And then I pointed to all the comets between Earth and Jupiter,

“And these are the periodic comets”

I wanted them to think “comets everywhere,” and the picture helped.

“These are the Jupiter Family comets,
the “Periodic comets,”

It’s a formation with about 150 comets
mostly between Mars and Jupiter.”

Then I wanted them to see oil every time they looked into the night sky.

“When you look up at night,
you can’t see them.
They’re 4 times blacker than soot.

It’s not soot.
It’s black oil shale.

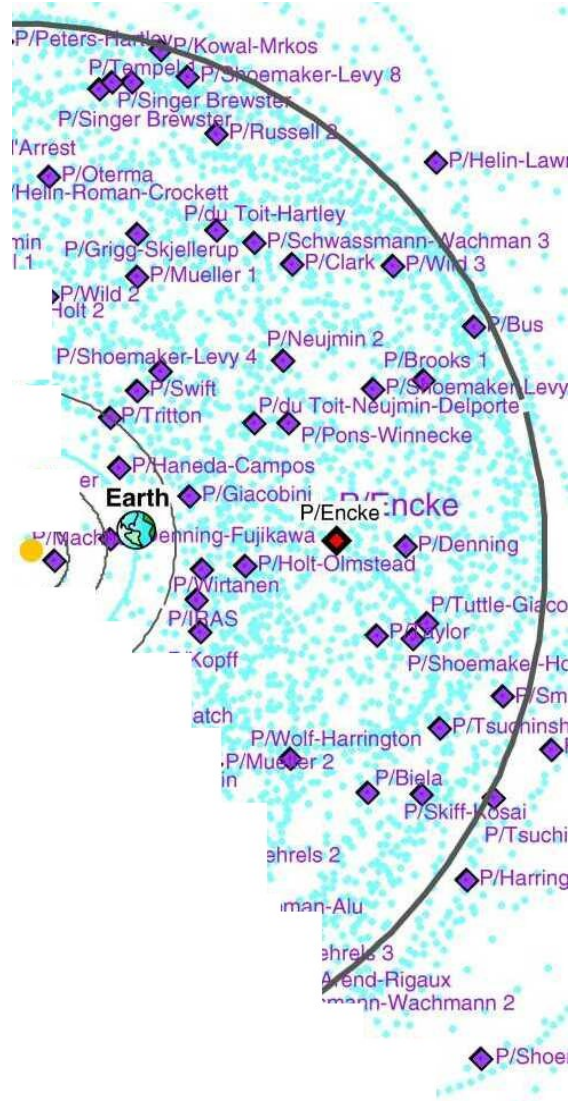
They’re there.
You can’t see ‘em.

99% of the time,
they don’t have a comet tail.
They’re turned off.”

Pointing directly at Earth again, so they would understand that we were in this picture, I pointed away from the center of the picture, away from the sun, and then started with the pointer at Earth again, and moved away from the sun again,

“That’s the night side,
away from the sun.”

Then I pointed to all the comets on the night side of Earth.



Night side of the Earth, the comets we should see, but they are too black

“At night,
look up at the sky,
if you could see them,
you would see about 1/3 of them.

That’s about 50 of them.

If you could see them with their comet tails,
you would be scared out of your mind.”

Most of the people in the audience were paying attention. They were just like the 4th graders. They were looking at the picture, not me. It was working.

“They are all in the ecliptic plane.”

A mistake. I made a mistake. I used a term they didn’t understand. If I didn’t fix this immediately, their attention would wander, like the 4th graders. I had to do something, quick.

I walked in front of the projection screen again, with the projector light shining directly into my face, my eyes.

“You know the path in the sky where the sun goes.?”

I turned my back on them, and made a big arc with my arms, starting from the left, pointing to the left, and pointed from sunrise to sunset, way over to my right.

I turned back to them. It was physical antics calculated to get their attention away from the big, strange, unfamiliar phrase I accidentally used: “the ecliptic plane.”

“The moon goes in the same plane.”

I turned around and made the big, wide arc again.

“All the planets are in the same plane.”

I turned back and faced them again, and pointed to the comet picture.

“The asteroids and the comets are all in the same plane.

You can't see them, but they are there.”

They were watching, focusing on the picture.

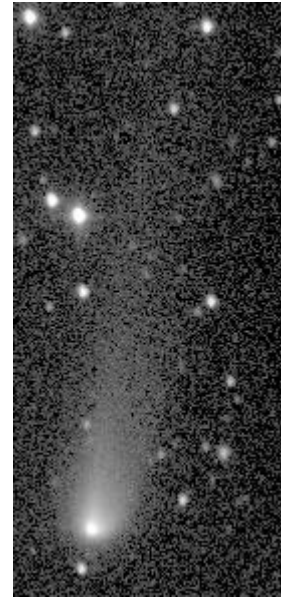
“Most o' these comets are a bit smaller than Comet Halley. We estimate they contain between one tenth and 500 OPEC apiece.

With 150 of them always out there, there ought to be between 15 and 75,000 OPEC of hydrocarbons between here and Jupiter.

Probably 10,000 years worth of hydrocarbons.”

That was the punch line. All the rest was entertainment.

“Here's some pictures of hydrocarbon objects, space oil shale oil from space.”



\ 116P_951231_js1.jpg

“This is P/ Wild 4. It was taken with a 1 meter telescope.”

Almost certainly, everyone was thinking, “Did we miss this one? I didn't remember seeing this in the sky. Everyone wants to see a comet. How come we missed this one? Did the news miss it?”

Mysterious. Ominous. Portentous. I wanted to transmit the fear, the aura of something black, something invisible.

“You can't see these things. They're black. You need a telescope.”



\ 116P_951123_tp11

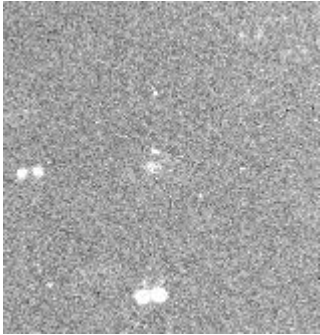
“Without a telescope, all you see is some kind of faint star.

This picture took half an hour”

Motioning with my hands something about 1 foot across, I continued,

“and the guy used a 1 foot diameter telescope.”

A one foot diameter telescope is big for plain old people. Galileo didn't have one of those.



\ 120P_950830_sl1.jpg

“This is P/ Mueller 1. It's the little single star in the center, not the double image stars.”

She used a 1.5 meter telescope. Big. I met her.”



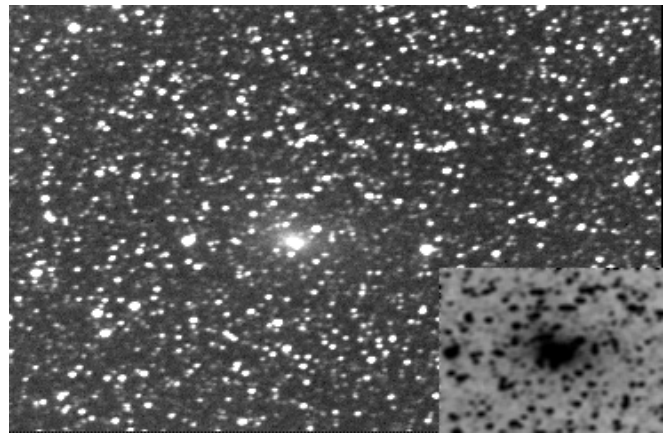
\ 122P_95S1_951006_tu1-r.jpg

“This is P/de Vico, if you had a telescope.”



\ 122P95S1_950924_tl1-r

“But you would only see this. Probably not know which one was the comet.”



\ 22P-Kopff_960510_tp1.gif

“This is another one. P/ Kopf Kopf is a guys name. Most are named after the people who found them.

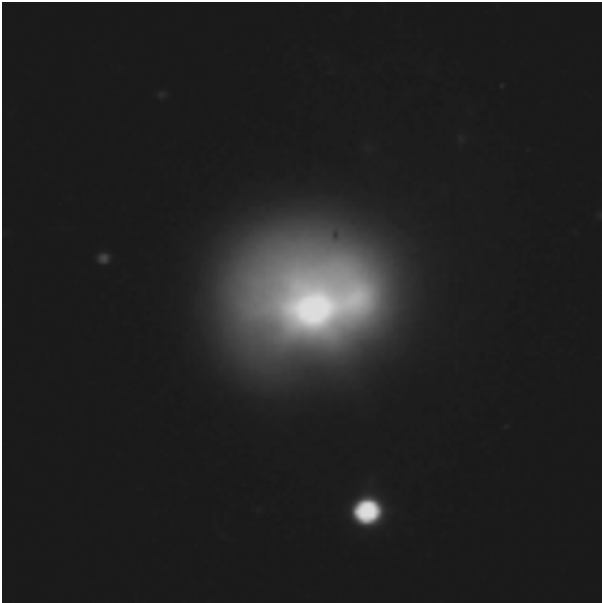
Just looks like a star.

Fuzzy star.”



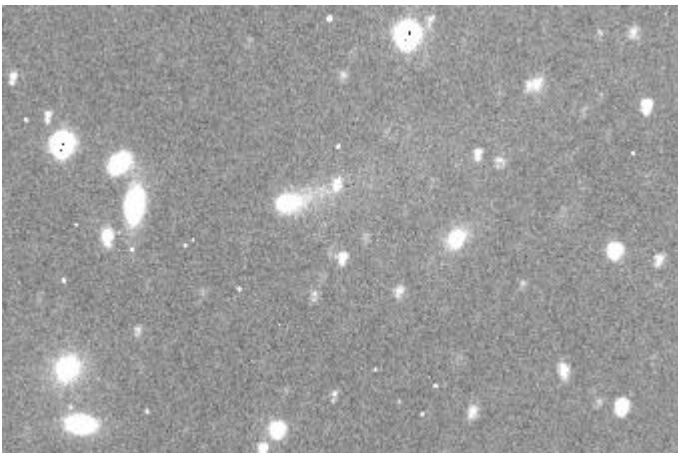
\ 29p_schwas_wach.GIF

“Another one. It's just a bright star. looks like the other bright stars. The fog cloud is sky shine.”



\ 29P-Schwassmann-Wachmann-1__960227_gg1.gif

“same comet, up close.”



\ 32P_Comas-Sola-950830_sl1.jpg

“Comet P / Comas-Sola. That’s all they see. a slowly moving thing with a tail.”

My Big Stick looked something like this:

I was showing comet pictures rapidly, one after another. They were supposed to associate the page full of blue comets between Earth and Jupiter with these real pictures.

At this point I needed to insert something else into their minds.

They needed to believe that many comets just like these were accessible to humans. This would be a little tricky. I would keep showing them comet pictures, but I needed to insert something to show that we could actually bring space oil shale back to earth orbit from some of these.

How would I do this?

I had fretted over this for many days before the meeting.

One option I considered was to do it right.

“Right” would mean explaining the orbital maneuvers that would be used, showing a set of rocket delta-V’s needed to execute the maneuvers, and finally, showing how 10% of the comets would only require a small delta-V, small enough delta-V to be credible.

That ought to be simple enough. But, that would scare away nearly everyone, except the two slovenly fat guys in the front row who were always there and asking pseudo-astute questions.

I decided to treat the rocket scientists like 4th graders, and act like President Teddy Roosevelt said, “Speak softly and carry a big stick.”

So I proceeded to make a Big Stick, which I would not use unless needed.

The “Big Stick” was a set of viewgraphs with the delta V data for each and every one of the P/ comets I was showing them, with every detail.

Near-Earth Comet Hydrocarbon / Rocket Fuel /Resource Candidate

	a A.U.	e deg.	i deg.	P yrs	V _∞ at Earth km/s	ΔV rendezvous			ΔV to Capture					
						at comet km/s	Mission ΔV km/s	%	% over minimum Δ					
									lo	med	hi	0	50	100
neo-comets														
1979 VA #4015	2.64	0.62	2.8	4.3	8.19	0.1	1	3.1	4.64	6.14		3.0	4.50	6.00
P/duToit-Hartley	3.01	0.60	2.9	5.2	8.59	0.6	11	3.9	5.52	7.15		3.3	4.89	6.52
P/Tempel-Swift	3.18	0.64	5.4	5.7	8.95	0.5	8	4.0	5.78	7.53		3.5	5.25	7.00
P/Haneda-Campos	3.29	0.67	5.9	6.0	9.12	0.4	4	4.0	5.86	7.67		3.6	5.43	7.24
P/Finlay	3.64	0.70	3.7	6.9	9.36	0.3	2	4.1	5.99	7.88		3.8	5.68	7.57
P/Blanpain	2.96	0.70	9.1	5.1	9.10	0.6	9	4.2	5.95	7.75		3.6	5.40	7.20
P/Tuttle-Giacobini-F	3.10	0.66	9.2	5.5	9.17	0.5	7	4.2	5.99	7.82		3.6	5.47	7.30
P/Barnard1	3.07	0.58	5.5	5.4	8.73	0.9	24	4.2	5.92	7.59		3.4	5.03	6.71
P/Denning	3.80	0.70	5.5	7.4	9.55	0.5	5	4.4	6.34	8.30		3.9	5.87	7.83
P/Hartley2	3.40	0.72	9.3	6.3	9.54	0.5	6	4.4	6.34	8.29		3.9	5.86	7.82
P/Schwassmann-W	3.06	0.69	11.4	5.3	9.41	0.6	10	4.4	6.31	8.22		3.8	5.72	7.63
Oljato	2.18	0.71	2.5	3.2	7.65	1.74		4.41	5.74	7.07		2.66	3.99	5.33
P/Wirtanen	3.12	0.65	11.7	5.5	9.42	0.7	12	4.5	6.39	8.31		3.8	5.73	7.64
P/Swift	3.73	0.65	3.0	7.2	9.33	0.8	18	4.5	6.40	8.28		3.8	5.64	7.52
P/Howell	3.15	0.55	4.4	5.6	8.69	1.2	37	4.5	6.18	7.85		3.3	4.99	6.66
P/Churyumov-Geras	3.51	0.63	7.1	6.6	9.33	0.9	23	4.6	6.51	8.39		3.8	5.64	7.52
P/Lexell	3.15	0.79	1.6	5.6	9.05	1.1	32	4.7	6.44	8.22		3.6	5.35	7.13
P/Kushida	3.78	0.64	4.2	7.4	9.39	0.9	27	4.7	6.62	8.52		3.8	5.70	7.60
P/Lovas2	3.57	0.59	1.5	6.7	9.07	1.2	35	4.7	6.53	8.32		3.6	5.38	7.17
P/Neujmin2	3.09	0.57	10.6	5.4	9.12	1.2	36	4.8	6.60	8.40		3.6	5.43	7.23

If anyone wanted to fight, they would have to fight with this.

I made a whole set of these Big Sticks, one for each of 3 different difficulties of maneuver and for 3 kinds of capture at Earth. I had the data for each and every P/ comet ever seen.

Instead of showing these charts, I just told them how I would do it, and my conclusions. I had decided to use the 4th grade approach.

“The way you bring the space oil back to Earth is to start at the comet, take some of the comet ice and melt it into water.

Put the water in the nuclear heated steam rocket propellant tank, and push Two Million Tons of space oil into an orbit that will hit Earth.”

“Hit Earth,” a deliberate use of the phrase, to scare them, to cause subliminal goose bumps, to get them to pay attention.

“Two Million Tons,” about 20 times more than the payload of ocean-going oil supertanker.

I knew that many of them knew that my “Two Million Tons” was way bigger than the meteor that exploded over Tunguska Siberia, 1908, and blew up, leveling 1000 square kilometers.

I got their attention. I watched their eyes. Nearly everyone was looking at me. Staring at me. Only a few people were fidgeting. Nobody was making any noise. Just like the 4th graders.

Then I let them take a peek at the weapon I was packing. I put one “Big Stick” transparency on top of the comet picture they were looking at, without taking the comet picture off the screen. They could see all kinds of numbers and data.

“When you get to Earth, you turn on the steam rocket brakes,

and you are in an orbit around Earth.”

Just like that. Simple. And then, without saying a word, I transmitted a concept to them using mental telepathy:

*“If you wanna fight about it,
I will take the comet picture out from under this spread
sheet full of data,
and we’ll fight.”*

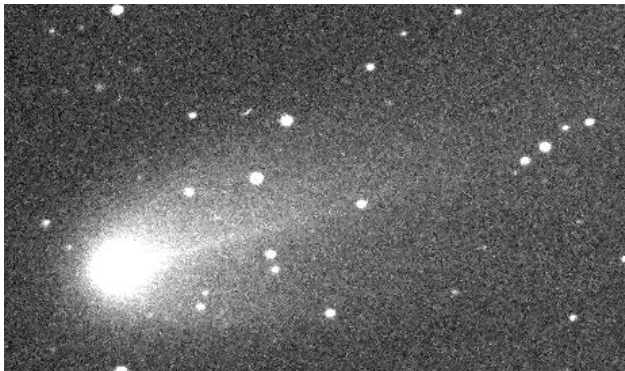
All I had to actually say was,

“When I calculated the mission delta-V’s,
10% or so were doable.”

Done. They looked at me. Nobody wanted to fight.

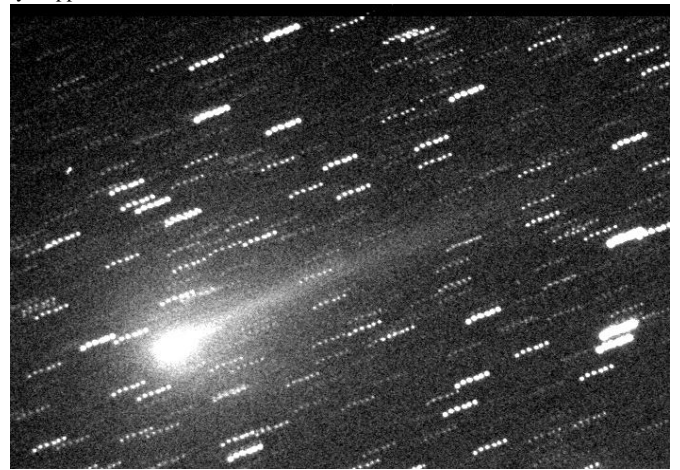
In fact, Shoemaker and I had already gone over this concept. I had used his orbital maneuver, which had been published and proven. I had used the data Brian Marsden at the Smithsonian had for the P/ comets. I had calculated with the INEEL people what the steam rocket would and could do. Shoemaker and I then both realized that 10% or so were accessible. We had already gone through the “fight,” and humans won.

I pulled the Big Stick picture away, and they were back to the comet pictures.



\ 41P_Tuttle-Giacobini-Kresak_950823_gg1.jpg

“Three guys found this one.”



\ 45P-Honda-Mrkos-Pajdusakava-_960131_tk1.jpg

“This one is Honda, Mrkos, Pajdusakava. Three guys again. You can see the multiple dots. They were following the comet, so the background stars seem like streaks.”



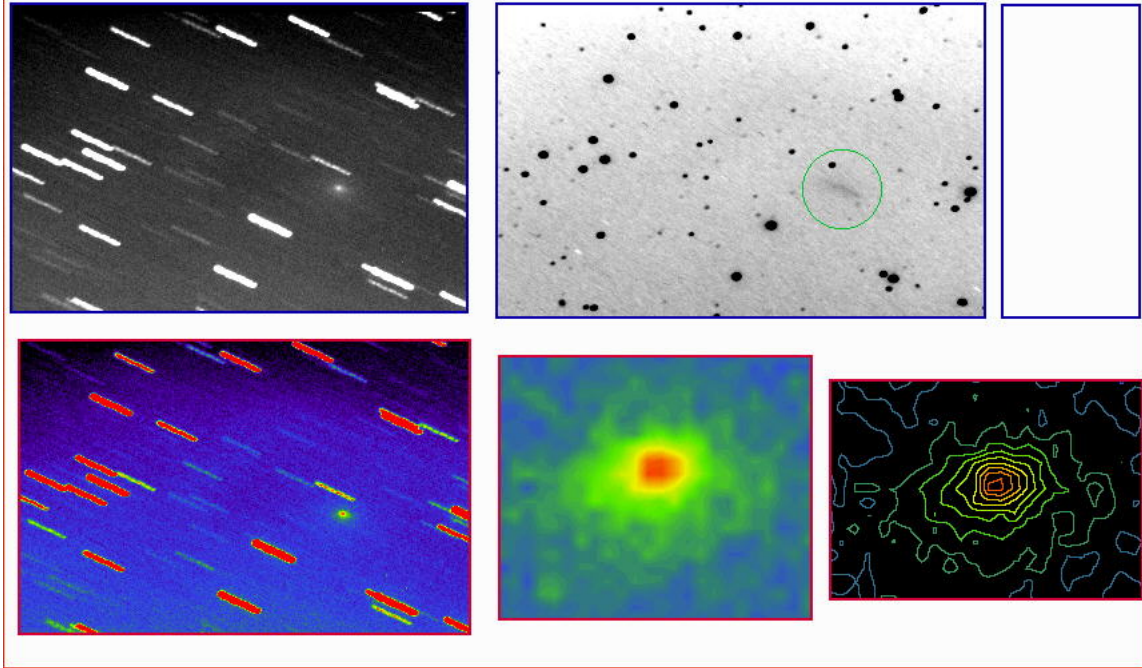
\ 46P_960709_mb1.gif

“This is Comet P / Wirtanen.
It’s the little thing in the center.

It’s really faint.
They know its a comet
because it moves.

It moves enough in a few nights or a month to determine its orbit.”

COMET 58P/JACKSON-NEUJMIN JANUARY 29 1996 01H37 UT



\ 58P_960129_db1.jpg

“This is comet P Jackson, Neujmin.

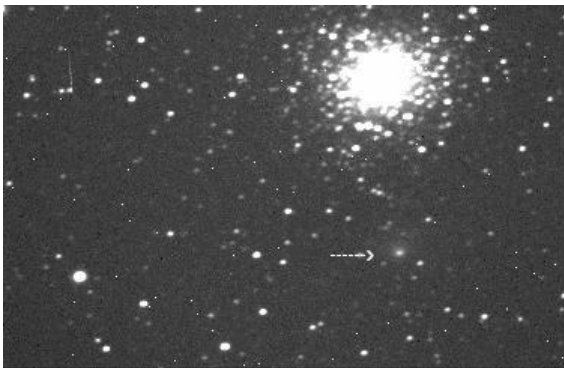
It’s the only spot in the picture of moving stars. Its the very faint thing circled. The guy who took this is a professional astronomer. He had lots of devices to measure it. He took several different kinds of pictures.”



\ 67P_951108_tp4.jpg

“This is P / Churyumov-Gerasimenko.

I got Churyumov to sign my notebook.”



\ 65P_960616_tp2.jpg
P/ Gunn

“This is P / Gunn.

The comet is the little teeny thing.

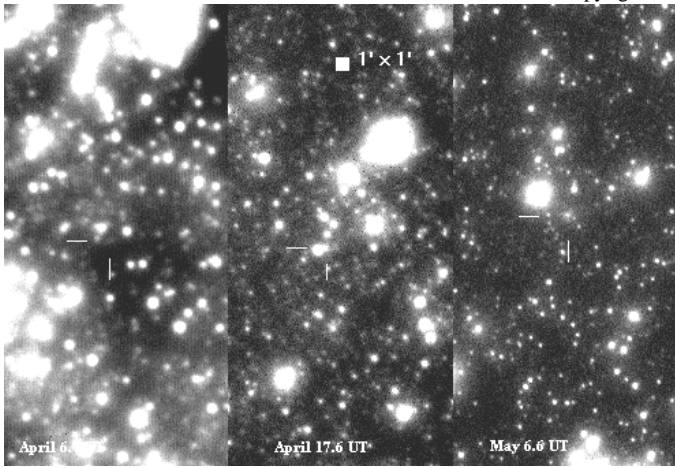
See the little arrow?
Off to the right and below the fuzzy thing?

Not the fuzzy thing, the little spot.
The little spot is the comet.”



\ 6P_P-d'Arrest951017_is1.gif

“This is P / d’Arrest.
like a little star.”

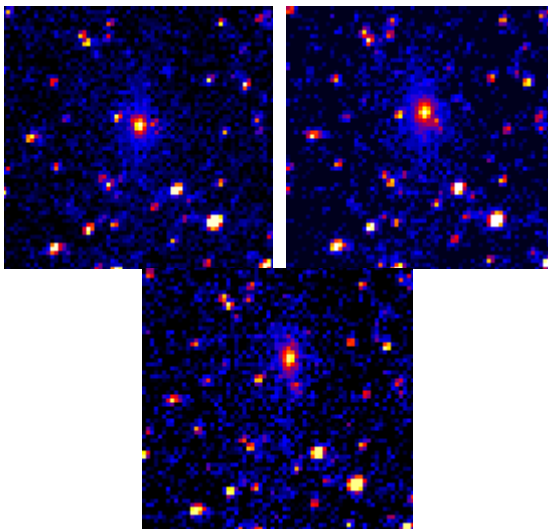


\71P_clark.GIF

“Pretty hard to see this one.
P / Clark.

The astronomer drew two little lines on each picture to show it.
Very very faint.

I don't know how they get the patience to keep looking for
these faint things.”



\71P_mb1.gif

“This is P / Clark, moving.
You can see the thing move.
The bright thing moves a little in each picture

The color helps see things.

It's false, electronic color.”



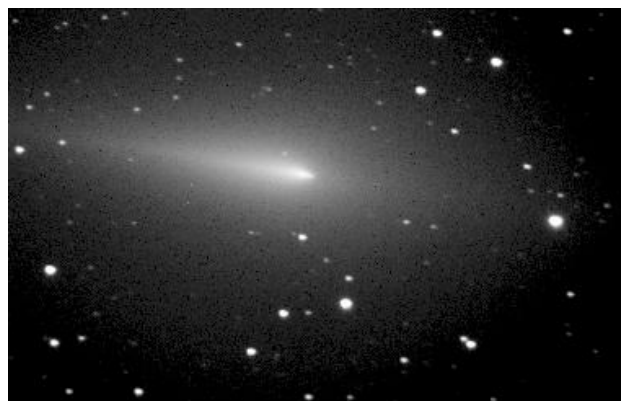
\73P_950922_gg1-r.jpg

“This is Comet Schwassmann - Wachmann 3
'in outburst'



\73P_951105_tp3.jpg

“It made a nice picture in black and white.”



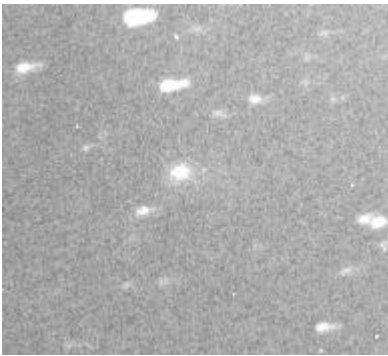
\73P_951201_tp9.jpg

“But false color made it look a whole lot better.”



\ 73P_951201_tp9a.jpg

“Much more clear in color.”



\ 74P_950830_sl1.jpg

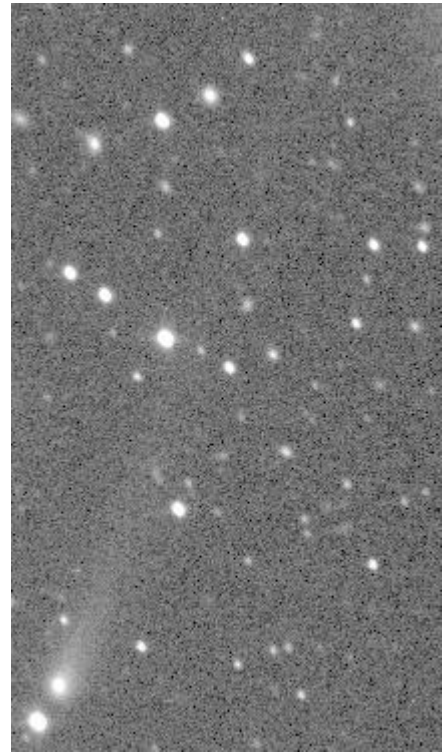
“This one is P / Smirnova-Chernykh.
It’s the little star in the center.”



\ 94P_mach2sep9.1-r

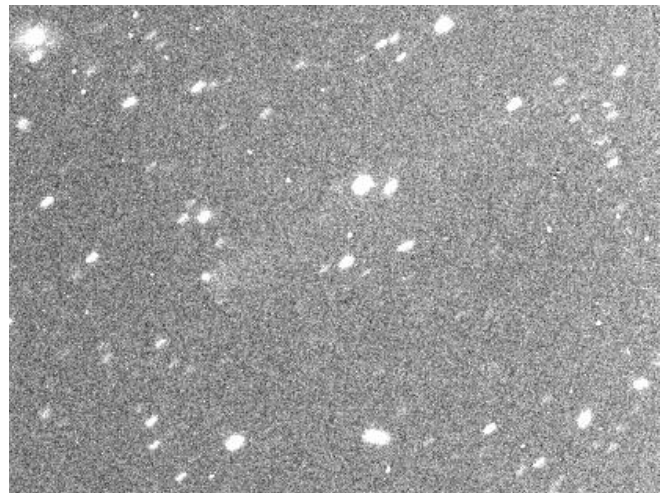
“Comet P/Machholz 2,
36 inch telescope,
Jim Scotti.

I got to sit next to his monitor once,
but not when he was taking this picture.”



\ 96A1_960114_rj1.jpg

“C/1996 A1, discovered on the night of 1996 January 14,
Robert and Vicky Jedicke,
with the Spacewatch Telescope. “



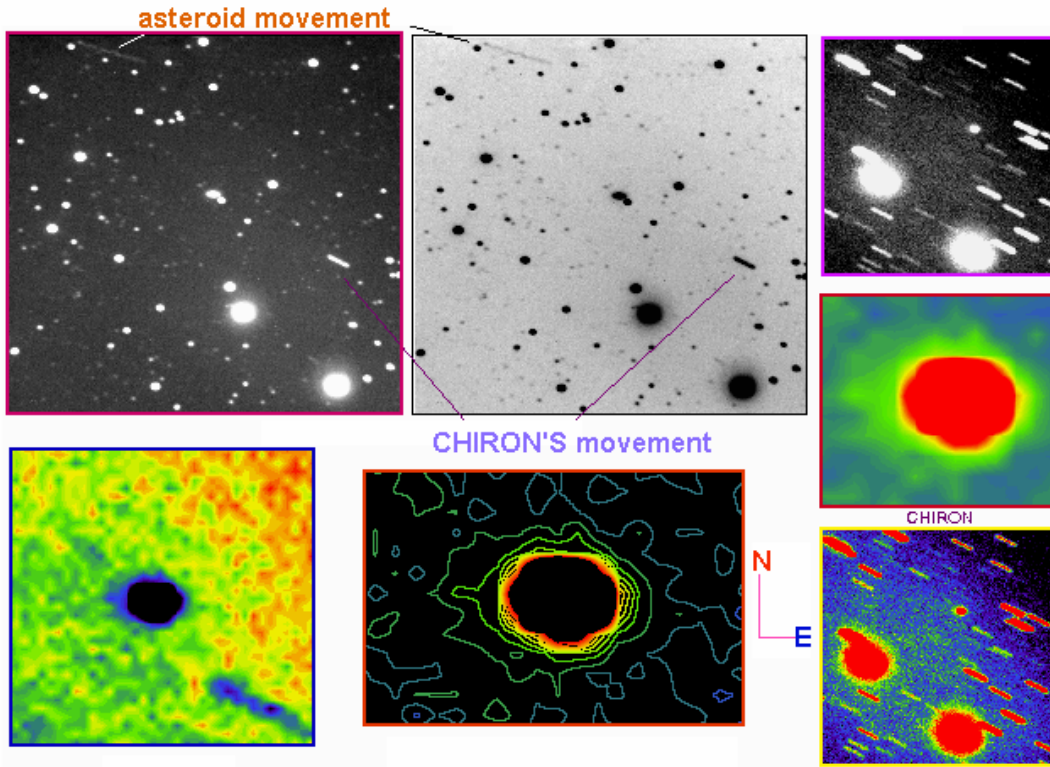
\ 9P-Tempel-1_950830_sl1.jpg

“I maybe should have saved this one till last.”



I don't know where the comet Chiron is in this picture.”

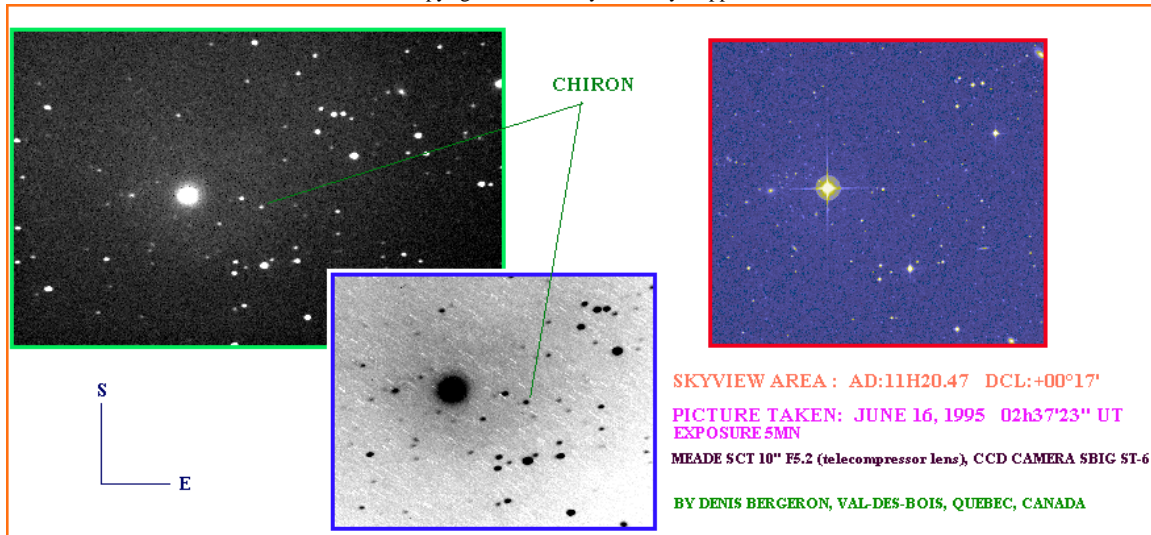
IMAGES OF CHIRON TAKEN DURING THE NIGHT OF APRIL 02th TO APRIL 03th 1995
(Observer Denis Bergeron, Val-des-bois, Quebec, Canada)



(MEADE SCT 10" F6 CCD SBIG ST-6 CAMERA SEE REPORTS)

\ chiron_950403_dxb01.gif

Chiron has a “coma,”
that's a tail,
a faint one, nearly all the time.”



\ chrion-950617.tif

“Chiron is time lapse exposed here.
Chiron’s the little line near the bright two stars in the picture.
It moved, the stars in the background didn’t move.

“You would never see Chiron,
even with a telescope
unless you were crazy,
like these astronomers.”

It’s one of the faintest things in their telescope.

The reason I should have kept Chiron for last is that it is about
5 or 10 times bigger than a typical comet.

It about 80 km across.

If 1/5 of this is hydrocarbons, then 1/5 of 80 kilometers cubed

means Chiron has about 100,000 OPEC.

Chiron would have about 100,000 OPEC of space oil.

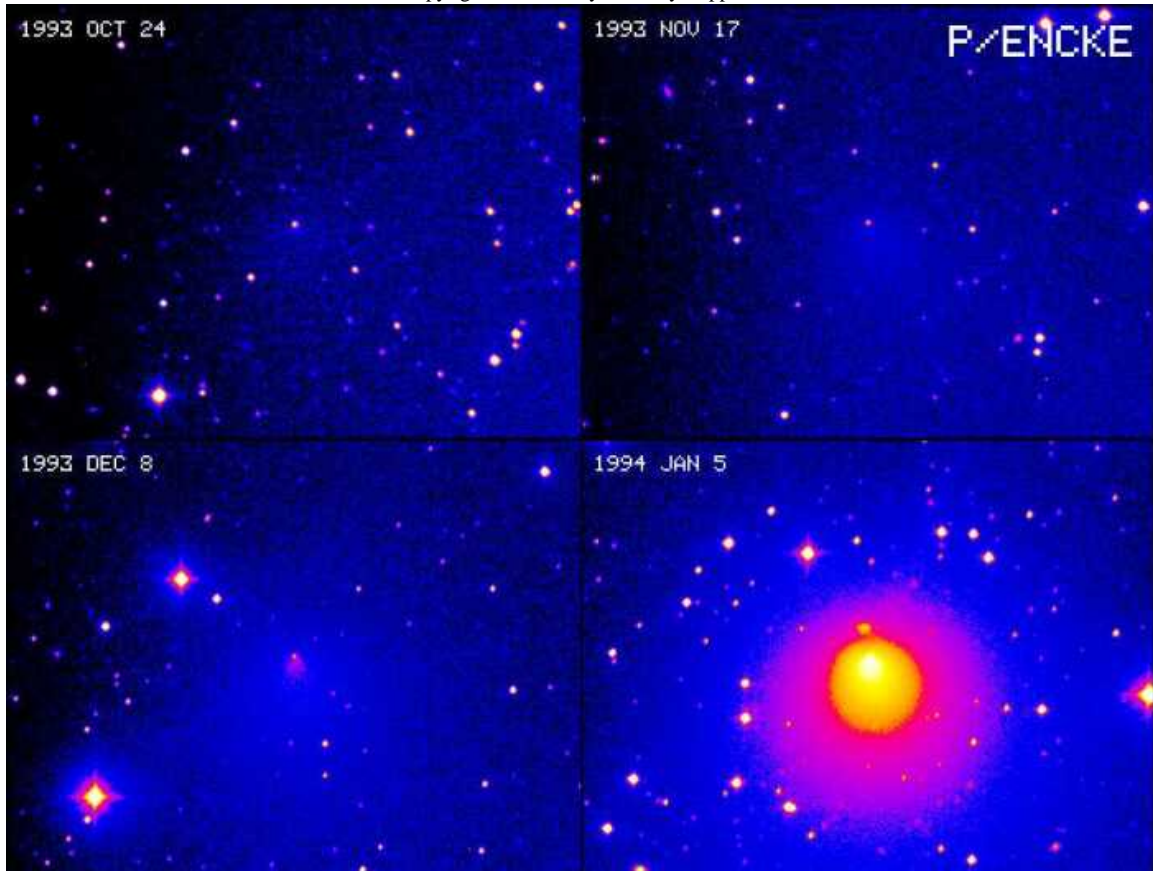
Chiron is a Trans Neptunian Object, a “TNO.”

There are at least half a dozen “Trans Neptunian Objects”
out there with this much hydrocarbon content.

In other words, there is enough to be a threat, not a promise.”

Hopefully, they were overwhelmed with real pictures of real
comets that were out there all the time, every night, filling the
sky, but invisible, and all made of oil shale from space.

I had to include one that was there often, even though it was not
as easy to get to.



\ 2Pencke.mos.2-r.jpg

“This one flares up every 3.3 years. When it comes close to the sun, it flares up.

you need a telescope to see this. It's P/ Encke”

“I kept this one for last because it's the closest known comet to Earth.

This one comes within 20 earth moon distances of Earth's orbit, about once every 4.6 years.

It takes almost 5 years to make an orbit, and it swings out almost to Jupiter's orbit.

It is a comet that we can get to.

We would go to it because it has water, which we would use for propellant.

I don't much care about the space oil.

I want the propellant.

This comet is all rocket fuel to me.”

I was done with the pictures of comets. As far as I was concerned, I had just shown them so much space oil shale that they could take it as a threat, not a feature. A bug, not a reward.

They could taunt their greenie, enviro-friends blabbing and nagging about conserving the precious oil for future generations with “we could lay a sea of goo around the earth, there's so much oil out there.”



\ comet-4015-n-r.jpg

Since this was a space meeting, I was obligated to suggest that we do something about it. As I collected the pretty comet pictures and proceeded to put them into my briefcase, I concluded the talk with a passing phrase

“We should send some space probes out there to sample these comets.”

This time people cared, even though they didn't jump up and down. I realized that rocket scientists and space engineers loved being entertained, just like any other 4th graders.

Proof was that they bought me beers, food, offered me free web space, made me sit with them late night at the conference room bar, gave me their emails, phone numbers and business cards.

The only bad thing I knew lurking out there was that a manned mission to a comet was a 5 year event. Great 40 years from now, but I was 52 years old already. 5 years is way too long for me.

And people loved the stories.

Finally, a breakthrough.

“Stories.”

19960603space96+++ Albuquerque Hilton 1-6 June 1996 baird, mark;
barr, edward, b.; billings, tom; blocker, norm; bopp, frank; bopp,
thomas; boslough, mark; brooks, phillip mapquest switchboard;
calhoun, bob & shirley; cramer, karen; david, leonard; duke, mike;
gehrels, tom; gies, john v; hale, alan; hansche, bruce & chris
husted & jenna; hoover, mark d; jacobs, cliff; jenkins, lyle;
johnson-freese, dr. joan ; kargel, jeff; kaya, nobuyuki; kuck, david
l; lauer, chuck; lenard, roger; levy, david; makenzie, bruce a;
mcquade, frank; mink, mike; nagovitsyn, oleg; nantel, jacques, m;
nelson, terry; pettit, don; prsbrey, mike; prsbrey, t. keith; risvold,
debee.; sanchez, felix & clorinda; schiff, steve; schmitt, harrison;
schwartz, milt & son; sharpe, burt.; shoemaker, eugene; snead, j.
michael, p.; sonter, mark; spalding, dick; sprungman, barbara
Itwister, arrival; mystery science theater;; tagliaferri, ed; wachinski,
anthony m.; willoughby, alan; worden, col. simon p;

- Shooting a TV doco

Shooting a TV doco

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It was Friday, 14 June 1996. They flew me here to help them make a TV documentary about the killer asteroid story and about how crazy scientists would deflect one. They had two of us who would deflect it, without using atomic bombs, of course, and one of us who was already searching the skies to find it.

Leaving a cool day of June in Idaho Falls, I fully expected to step off the airplane in the Tucson, Arizona desert and enter directly into an oven at 110 degrees Fahrenheit. But it was only very warm, not an oven, and Mark Sykes appeared out of nowhere to pick me up, heavier, half shaven, more sloppy and relaxed than I had ever seen him.

I did not expect Mark to be here. In my email to him two weeks earlier I told him about the “shoot,” of a “doco,” which was their slang for “documentary,” and inadvertently, my schedule. I also told Mark how I had told the TV people who asked me to go there that the audience would “forget my name by the time they go pee.”

Mark must have thought I expected a free ride or something. How embarrassing.

When I first met Mark Sykes, Ph.D., at the San Juan Capistrano meeting, the “First International Meeting On Near Earth Asteroids,” he was handing out beer to mock the meeting hosted by Dr. David Morrison of NASA Ames. That was 6 years earlier. Mark’s clothes were much too gaudy then, like calico colors, which made him look a bit out of place among nerdly dressed astronomers, like most people at that meeting, and like business-suit aerospace people, like myself.

“We only have till 6:05 PM, because I have to go to Flagstaff and sing, and I have to see my fiancée’ and do things first,” he said, explaining everything in one short, very friendly, smiling burst of excitement as he took me to his car. This was Friday night in a warm city, and he had a fiancée’. That was new: he was engaged. He didn’t need to dress up, especially in this heat.

This was an astronomer type. Mark was the first to use the rattlesnake eye of the NASA “IRAS” telescope in space to discover the thin, invisible dust tracing the orbit of near earth comets and asteroids. Nobody had known that the dust was there, tracing out the orbit of the near earth objects. Invisible to us on Earth when we tried to look up through our opaque atmosphere, the dust reflected or emitted just a little bit of infra-red light, . The space telescope could see it because its eyes were like that of a rattlesnake. Rattlesnake eyes can see infrared.

“I made the first interactive PTA web site,” he boasted. PTA meant “Parent-Teacher Association,” and that meant he and/or his fiancée had kids he cared about. Mark was consistent and reliable.

“But I had to stop it, because I was getting threatening phone calls, at my house.”

“What do you mean?” I asked.

“People getting mad,” he answered.

“Why?”

“People say whatever they want and it appears on the web site, no censors,” he replied.

Mark Sykes was the driving force for our putting together the 1993 Space Resource Utilization Workshop, where I got both the Department of Energy and Department of Defense to put up the money for us.

“I’m doing some work for the DPS,” he stated, shifting to what he did all day long, and would do all evening long if his fiancée’ and children weren’t there. DPS was the Division of Planetary Science, NASA. I didn’t care much what NASA did. They were flyboys doing athletics in space for TV, like a sports event.

“Those guys are backwards,” he stated, like the opening bid of a card game. “There’s no moving them away from ‘normal,’ ” he said. Mark was trying to do something different from “normal.”

“The skilled ones left NASA,” he asserted, trying to engage me, to get me to ask what antics the bureaucrats were pulling on him. I believed some of it because Bill Bishop told me the same thing about 15 years earlier when he went to work there, and then left. But I personally worked with some pretty skilled ones, so he was just interacting with the wrong ones, probably, I thought.

He could see I did not give a damn. The good guys left NASA because the big money went elsewhere.

“What do you think about life on Mars?” I asked. I was guessing that he was the kind that would be on top of it.

“You’re going to find microbes inside of comets and inside Mars,” he answered, perking up, “pretty soon, too.”

“You know about the Archaea Bacter?”

“Unless you’re blind. We’re not the only ones out there.” he replied.

We were both referring to the discovery of microbe life deep in the Earth, that metabolizes iron or hydrogen, or methane for its energy, and does not depend at all in any way on photosynthesis. Reports started to go public during around 1992.

“Flying saucers?” I asked, taunting him. If he answered “yes,” I would be totally surprised. Any alien space thing that comes by with no fingernails and a Halloween face mask for a head, and who is fascinated by wiggling the tooth of a strapped down humanoid in a sterile, 1970’s style, steel coated, examination room gurney, with a bright light shining down on your face, is no advanced specie. That would be a typical fear hallucination.

“The microbes could evolve in the hydrocarbon soup inside a comet. They’re finding them deep inside the planet. You don’t need photosynthesis,” he stated, succinctly, all in one compact statement. He knew.

“On Mars?” I asked. We both knew if we found primizoid microbes deep inside Earth, sure as hell we would someday find them deep inside Mars.

“When they find microbes on Mars, All hell will break loose,” he replied.

“Really?” I replied, with my voice inflections begging him to tell me how, or why, and that I don’t believe it.

It was only priests and preachers who told us that “God made us at the top of the pile.” Objectively looking at that system, the one with people, namely us, and observed data, calculated mathematics and engineering, technology all around us, and a few satellite TV demagogues with deliberately acquired speech impediments who told us god talked to them and we better believe it or else, then I conclude “no,” I thought.

He was focusing on trying to find out which street to take. After a moment he replied.

“That’s going to change everything,” he said, gravely, intensely, asserting ominous changes about to happen.

“What?” I asked, “what’ll it change?”

I felt frustrated that not much would change no matter what we did or found in space, because that “change everything” was exactly what didn’t happen. Nothing changed when we found enough resources for us to occupy the solar system.

“It completely upsets the belief system,” he replied, not quite able to figure how to cope with the obvious Grand Canyon my voice inflections were asserting, between his and my perception of the same situation. He knew that I believed and knew about the strong possibility of carbon based life everywhere in the universe just like he did.

We drove silently for a few moments.

He was slowing down and trying to figure how to change lanes and where to turn right, and we were passing some green lawns being manicured by a thin, 35 year old, brown skinned, healthy fellow, and approaching a gas station with a dark blue sign high above the right corner of the street.

I pointed to the price-of-gas sign.

“How much would that price change?” I asked.

Then I pointed towards the brown skinned fellow who was now next to us near the sidewalk, and to his lawn.

“How much more often would you mow that?” I asked, pausing, and then adding “if life were found on Mars?”

He didn’t answer. He just thought while he drove, with his right hand on the steering wheel.

It wouldn’t make much difference one week after CNN announced it, I thought.

We abandoned the subject because it wasn’t interesting enough.

Mark took me to the Radisson Hotel at 6555 East Speedway, Tucson, Arizona. Then he stayed long enough to have a little bit of the free junk food. But he had to leave. It was close to 6:05 PM, and he had to go singing.

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They flew us here. “Here” was going to be the next day at the Kitt Peak National Observatory, 50 miles west of Tucson, Arizona, high on a mountain top of huge telescopes and far away from the city lights. “They” were Australians with “Beyond Productions” doing work for a United States company “Discovery Communications.” They were supposed to be staying at this hotel.

For supper, I ate the complimentary junk food at the happy hour. I had my two, free, weak margarita’s. Where were the TV people?

The only person I saw to talk with was some older guy. I thought he would be my age plus 5 years and apparently more worn out. He was a technical writer, a technician, working for an electronic company called Loral. He had a tale of misery and woe, and was actually from Minnesota. Without a technical degree, he had to go where they sent him, no matter what, even to some defense base here in the Arizona desert. He told me about how economies worked and how Minnesota was a highly socialist state, with many people on welfare at his expense. “Good thing I got a Ph.D. in Physics,” I thought.

I was here to do a TV documentary, not to drink and cavort. Tomorrow, I was going to tell stories, exciting stories about killer

asteroids and comets. I wanted to be hot. People love stories. Even the scientists at the space conference liked the stories.

I figured that the guy from MacDonald Douglas (Stan Schneider) who had coached me during that 1992 World Space Congress was right.

“Don’t do a lot of people before the performance,” he said. “Build an edge.”

I didn’t tell the Minnesota guy very much about space or what we were doing here. I didn’t see the TV people, either, and nobody here looked like they came from Australia or like a TV crew.

So, I went to sleep immediately after eating. I got a 12 hour rest, almost. I worked on my laptop for a while, connecting with the modem. The internet and remote connections and laptops were really neat new toys. I was connected while away.

Saturday morning, 7:30 am, 15 June 1996, and I was up, bright and early. I heard that TV people got up early and worked late. Hollywood life style, behind the scenes, here I am, I thought.

Paul Grocott was my contact. I wondered where they were, or if they were even here. I began to panic. I was in the wrong place. There was no way we could find each other. I flew all the way here and would not get to go on TV.

When I got to the front desk, there was a message for me. Paul had left the message the night before to meet him around 9 AM for breakfast. I never heard the telephone ring, almost certainly because I was using the computer modem.

What a coincidence, he was in the room next to mine.

Grocott accidentally put his key into my door about 9 am, making a failure-to-open noise. Not knowing what he looked like, but hearing him open the room next to me, I snagged him. Immediately I started to lobby him, as if he were a senator or congressman and as if I needed to give him an elevator speech. I showed him space visuals he liked. We talked while we ate.

I was now officially started on the “shoot.” That word “shoot” was probably Australian slang.

They sure do start late, I thought. Don’t they know about the desert? It only cools down to “nice and warm” after all night, by 5 am, and gets hot by 9 am. Maybe we are going to work late, into the night, at the telescopes.

Slightly anxious, I wondered what kind of dynamic there would be between me and the director. What kind of chemistry or relationship I would have with the lady Boss. She was the Producer or Director, I didn’t get it straight. She could be an assertive bitch, or maybe the un-cute, plumpy bossy type. That would be improbable, I thought.

She could be very professional, like professor ladies I knew, and would emit no chemistry, no bonding, no emotion to me at all,

unresponsive to my flirtations, just business. I didn’t expect much from this shoot anyway.

About 10:15 am in the lobby, waiting for the TV crew, I spotted a distinctive, shorter-than-me lady with a hat that just simply looked like “Australian.” A black hat, the feminine version of Crockadile Dundee’s hat. Slightly kinky black hair fuzzing out just under the hat. She had a pleasant face and features.

Her legs were rather more solid than a model, but definitely she had thin ankles. That was one of my criteria for physical chemistry, thin ankles.

When meeting a new female with whom I might interact, I would typically try to imagine a pleasant, two eye-blinks long, quick and naughty fantasy about the lady. And the result would tell me if we would have a simpatico physical chemistry or not. It was male of me, I suppose. It was my standard test.

Plump older ladies with fat ankles would sometimes pass my test, but it was still the chemistry test they had to pass. If I felt good about them after the test, we would get along well.

Slight anxiety dulled my need to apply the physical chemistry test.

She walked with a purpose, but not with an attitude. She wasn’t pushing people, like the waiters or hotel people around her. Her face had the Somewhat-Field-Producer look and her body was slightly more solid than some perfect-suit, assertive, male-and-crowd-manipulating news lady would be.

I felt good about her, like one feels good about a new character with charisma first walking on to the stage.

She had rings on both hands, but not New-York-perfect stones in them. She wore shorts and a shirt fit for 110 degrees in the desert. She had boss in her voice, but team in her inflections. Within moments, I liked the person she was. I liked her from the instant of first eye contact. She was the Boss. Peta Newbold, “Field Director.”

The crew was important. I had learned that at Sandia Labs during the late 70’s. Almost by mental telepathy, they think the thoughts of the Director and then take images and sound that match. They look sloppy, they walk sloppy, they dress sloppy, they don’t say much. And they think thoughts of the Director. I got along with the entire crew just fine, right away.

Alex Garipoli did sound. Paul Ree did video. Paul Grocott did everything else; Peta was the boss. That’s all it took to make a documentary, “doco.”

While we were waiting for Professor Jay Melosh, Paul Grocott decided to eat some weird thing from Australia. Paul Ree and Eric Garibaldi started laughing at me when I wanted to taste it. “Grocott’s weird” they joked. “You’re not going to like it.” Paul Grocott was pasting it on the free hotel crackers and bread.

He let me have some Vegemite, and it tasted so good I had to dig into his jar and get more. Vegemite was like black peanut butter and tasted like that good Japanese seaweed my daughter Jennifer would buy, but all mushed up into a paste. Really good. Looked like engine grease. Felt like grease. Smelled a little like it. Tasted good.

As soon as Professor Jay Melosh showed up, the crew and Peta went off in the green van and Jay Melosh took me in his own small sized pickup truck. The van was packed tight with all kinds of TV camera and electronic things. There was no room for anything or anyone more in the van.

Our caravan of two proceeded to drive to somewhere that Jay knew about in the hot desert west of town, on the way to Kitt Peak and the telescopes.

Jay was a Professor of Planetary Science at the Lunar and Planetary Lab at the University of Arizona in Tucson. I had met him several years earlier, at the meeting where three different people each introduced me to Carl Sagan, and where Dr. Edward Teller said he would go anywhere with me.

I remembered Jay because he told that crowd of us how he would set up a 10-mile-across mirror next to a killer asteroid, focus the sun on it, and vaporize asteroid rock. The vaporized rock, he calculated, would boil against the asteroid and eventually push the asteroid out of a collision course with earth. And he would save the world.

During the question and answer part after he spoke, I asked him how he would keep the vaporized rock smoke from coating the 10-mile-across mirror. That smoke coating would ruin the mirror. One huge difference between doing that here on Earth and doing it in space was the lack of air in space. Every ray of sunlight that beamed from the 10-mile-across mirror to the focus spot was a straight line path in a vacuum, and where boiling asteroid vapor molecules could go straight back to the mirror. There was no way around it.

All the vapor molecules boiling away from the asteroid would immediately go straight out in all directions, in the raw vacuum of space, and some would hit the mirror and stick, and coat it with a thick layer of asteroid crystal dirt.

I knew the answer because I had also tried Jay Melosh's scheme, on paper, myself. And I could not find any physical way to fix the problem. Jay had a sloshy answer, not a good answer; it didn't matter; and nobody seemed to care.

Jay was a smart scientist and knew about a broad range of subjects. I verified that because as we drove along out of the city and into barren desert, I kept asking him all kinds of questions about the origin of the universe. Astronomers are supposed to know that.

To give sensible answers, he at least had to know astronomy, chemistry, physics, probabilities, philosophies, nuclear physics, and other obtuse subjects. And he did.

After driving into the desert for 20 minutes or so, we stopped on a side road for a shoot. Saguaro cactus were everywhere. The sandy-pebble ground was dry, almost barren, without grass. The nearby hill half a mile to the west rose about 500 feet and was covered with what looked to me like ancient rocks. It was an illusion I carried from childhood about Arizona rocks, as if they were from the dinosaur age.

Similar hills poked up along the horizon. The sky was darker blue than in Idaho or California, and more clear, cloudless. The bright sun had already heated the desert, but it was dry heat, so it did not feel so bad. Humid Houston at 90 degrees always made me more uncomfortable than Arizona dry desert at 110.

Peta and the crew picked a place to do the first taping. They picked out a saguaro about 75 feet from the road, with 5 big branch arms and near some green-branch trees and an ocotillo bush. The green-branch tree didn't look like a normal tree and neither did an ocotillo bush look like a bush.

The ocotillo was typically a bunch of 10 to 50 thorny, practically leafless, not quite straight, 10 foot long sticks all poking out of a 2 foot spot of dry brown dirt. The green-branch tree looked like a leafless 15 foot high apple tree with all the little twigs, leaves and branches removed, except that the bark was smooth and green.

Jay Melosh had thought a lot about how he was going to tell his asteroid-mover story. It was the same one he told us 3 years earlier. He brought along some grapefruits, smoke oil and a 6 inch magnifying glass connected to a handle.

I stood back and watched. Paul Ree the video guy gave us some flimsy sun reflectors to hold, and to aim the sun at Jay's face. Alex Garibaldi put the microphone up Jay's shirt, with the transmitter out of camera view. Jay was facing south, into the sun, with the saguaro behind him. The sun was beating down.

Jay took out a grapefruit, dripped a few drops of smoke oil on it, and then took out his 6 inch magnifying glass and focused the sun on it.

He expected the sun to boil the skin of the grapefruit and make a spectacular show.

Nothing happened. He burned a spot into the grapefruit skin, but the smoke oil would not make smoke. He tried to hold the grapefruit steady with one hand and focus the sun with the magnifier in the other, and nothing happened.

He was telling his story for the camera, and trying to make the grapefruit boil under the focused sun spot.

When I was 10 years old back on the farm in Ohio, I tried something like that with a magnifying glass in the noonday sun. I could never get the focused sun spot to do anything at all in our yard, except light one blade of grass and a piece of paper on fire. That was it.

Bugs and ants would not explode no matter what I did. The lawn would not light on fire, stones would not melt. Nothing blew up. No boiling, no sparks, no nothing.

That's what kept happening to Jay and his grapefruit. Every time he focused the sun on it, it would make a black spot as big as a pea, and make a tiny little wisp of smoke.

They did about 15 takes, over and over. His grapefruit asteroid had burn holes all over it.

He was trying to show that the sun could boil rocks and move them out of the collision course with earth. And his demo showed that the sun would not even boil the skin off a grapefruit. A bit embarrassing.

"What do you call this concept?" Pita asked Jay

"I don't know," he replied.

After thinking a moment, he gave her some feeble, solar heater words.

"Solar rock blaster" I said, volunteering. We all heard me say it. There was a blank response.

The crew started to move the equipment back towards Jay's pickup truck.

My turn was coming up. I kept wondering if I would do any better.

And as if on cue, Peta turned to me and asked, "Just for practice, would you tell me about the steam rocket."

I stuttered. This was not the same sequence I had generated with the cartoon pictures I had drafted for Pita and brought with me. I expected we would go over the cartoons and say exactly what I had scripted, like I had done at Sandia Labs. That had worked very well at Sandia.

What she wanted and what I said was completely out of context and out of sequence.

Then she started to explain it, to get me going, and began with the reactor. She had probably dealt with stuttering speakers who got camera-shy many times.

Then I tried to copy what she said and started to explain it my way, but with the reactor later.

I stuttered some more.

The questions were not right. She was depending on me, the expert and it wasn't working. I had to do something to change this situation.

"What do you think is important?" I asked her.

"Start with the submarine," she said.

Peta liked the submarine concept. I had explained to them about how a space ship going to a comet would be very much like a submarine, like a submarine with 120 people going under the ice caps of the North Pole for 7 months, completely and totally isolated. I had learned this from Dave Nickerson at the General Dynamics "Electric Boat Division," where they made submarines. It was a startling analogy.

"What else is important?" I asked.

"That the comets are close and have water," she replied.

OK. I thought about how I would say all that, and I could do the rest. It would be just like talking to the 4th graders.

I felt so right about it that when Alex put a microphone on me, my heart rate didn't even jump.

This was fun, and I didn't know why.

We started taping me. I started talking. Paul Ree the video guy, holding the camera, didn't let me get into it and said I should move while talking and not lean on Jay's pickup truck.

So I did that, but I walked the 3 feet slightly too fast and had to start over. And then I did the shoot.

I told the story, with the submarine first, to Peta. She was standing there looking at me from about 4 feet behind and 2 feet to the right of the camera. I felt like it was practice, but I was telling her the story, looking at her.

The camera guy was poking into my face, from below like he was trying to get a close up of up my nose or the roof of my mouth, getting in the way of seeing Peta.

But I kept going, and forgot about the camera guy.

This was only practice anyway. It was the first take. Waving my hands as I spoke, like any good Italian, I explained the whole concept with a compact little story. (Punctuation, such as commas, indicates the way I actually said it.)

I thought I said:

"We are trying to knock a killer asteroid out of the way.

You put 120 astronauts,
in a space ship that is very much like a submarine.

Only in space.

It protects them from the outside,
it's completely self contained,
and has everything they need for the long trip.

They go out to a nearby comet,

somewhere between here and Jupiter,
and land on it.

There are about 150 comets out there,
all the time,
and they are relatively close.

Then they use a nuclear reactor to heat up some comet ice,
and melt it,
boil it,
making water vapor.

They condense the water vapor into water,
and fill up their rocket fuel tank.

Water is their rocket fuel.

Then they collect a ball of comet dust,
the size of a football field.

And they use a nuclear heated steam rocket,
to push the ball of comet dust,
into a collision path with the killer asteroid.

When the ball of comet dust,
hits the asteroid,

Bam!

It knocks the killer asteroid out of the way.”

I thought I was done, so I stopped for a moment, and since I was
telling Pita the story, looking at her, smiling, I added, with just the
right pause and smirk,

“and we save the world,
so there!”

That was fun.

Almost immediately Paul Ree had his face stuffed into a rubber
boot-like thing wrapped around the video image monitor screen he
set on the lock box on the bed of Jay’s pickup. The biggest
earphones I had ever seen were muffled around his ears. The
earphones were like the ear protectors people use at the pistol
shooting range. The rubber boot thing shielded out the light so he
could see the TV monitor no matter where he was. It seemed like
he was in there forever. It felt like 3 minutes.

Then he took his face out of the rubber boot thing wrapped around
the TV monitor and paused with a funny smile.

He looked to Peta he said, “I think that’ll work.”

“Here look at this video.” He fiddled with the controls.

Then Pita stuck her face into the rubber boot thing wrapped around
the TV monitor. She was completely quiet. She was quiet, with the

big earphones on, looking in there, crunched over the boot-thing,
and it seemed like 3 minutes again.

Then Pita pulled her face out of the boot thing, chuckled and,
smiling, said “yeah.”

I thought “yeah” too, because it was the way I wanted the video
to be, in my mind, too.

It was me talking to ^^us, the 4th grader, carbonoid hyper beings
from space.

[[[The “^^us” is intentional. It is a cryptic thing with alien
meaning that will appear in another story.]]]

I found it strange that I could not remember what I actually said,
only what I think I said.

We needed to make at least a 56 mile trip from Tucson, up a
winding road up to the top of a mountain, to get to Kitt Peak. On
the way the crew took some filler footage and wasted time, I
thought. They taped Jay and I driving up the switchback winding
road half way up the mountain about 10 times.

That was really boring, but we were already up high enough that
I could see distant mountains and 50 miles of desert way below
us.

As we approached the top, it was mid afternoon and totally
unfamiliar. I had never seen that mountain top in the daytime. It
was completely different from being there at night. I could
clearly see distant mountains on the horizon and a lot of the
Arizona desert between. We were high, on an isolated mountain
range, looking out at about 50 miles of what was almost all
saguaro cactus, green bark trees, ocotillo cactus and ancient
rocks, all like a carpet on what seemed like little tiny hills.

I didn’t know how high up we were. But it seemed like we were
a mile above the expanse of the desert. I heard the Kitt Peak
Observatory was 6800 feet up, more than a mile.

On the way up, Jay told me how the physics theorists were
settling in on a 10 or 11 dimensional universe. They were not
quite sure what it was yet, but one of the two. When I was in
Physics Ph.D. school, we only learned about a 4 dimensional
universe, the one that governs relativity. This was deep. This
was spacey.

And then Jay told me how there was talk that there might be
some naked black holes out there in the universe.

“Naked singularities are really curious,” he said, as we were
rounding almost the last switchback before we arrived at the
summit.

“Why is that? What do you mean? What’s so different about the
naked singularity?” I asked, wondering about the whole idea.

“It’s a black hole with zero mass,” he explained.

Hawking had discovered a few years earlier that a black hole was not exactly black. It emitted radiation very slowly through a quantum effect.

“When the black hole finally loses all its mass, it still has its singularity,” he explained. “Singularity” is a physics mathematics term for “infinity.” A black hole has an infinity associated with it.

That had to be strange. A black hole that did not weigh anything at all. Could we move it at the speed of light? Maybe it would have an electric charge and a magnetic field, in which case it would weigh at least like an electron.

Could it ever grow? Would it suck things into it like a deadly vacuum sweeper, making everything vanish as it slurps trees and people and cars into it, distorting space like sci-fi movie? Whatever.

Jay was right, it would be strange, but it didn’t matter. We were approaching the summit and the Kitt Peak Observatory.

I expected such spacey things from astronomer types.

As soon as we got to the top of the hill, we met Jim Scotti. Immediately, Peta taped us meeting Jim Scotti for the first time, 5 or 8 times, over and over. I could not figure what she wanted us to change. She didn’t say.

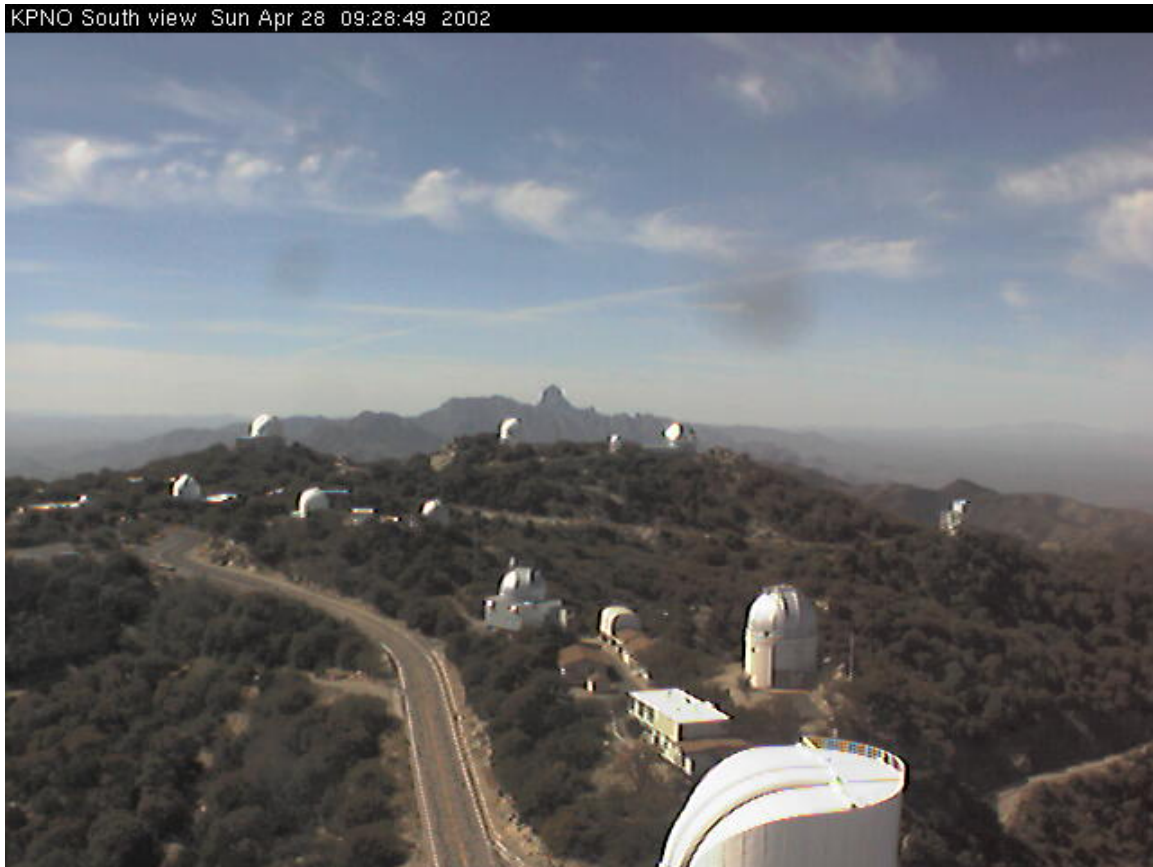
Each time I met Scotti for the first time, I was supposed to act like I had just seen Scotti for the first time in a long time. I felt just like the rehearsing for the high school play. Only this time, it would be a 10 second piece on TV.



Each time I did it, for the camera, I turned around and looked at the dome structure of the huge, 4 meter (13 foot) telescope, with its white, polytropic panels looming into space.



The darker blue sky was cloudless and clear behind it, and another, huge dome fatter than the several others on the mountain dominated, like a boss female elephant of the herd.



It was like an advanced life form from outer space had planted silent white domes, each bigger than a bank building, immovable, massive, passive, impenetrable, mysterious domes. The view was breathtaking.

When we were done with that, Peta told me “You are a natural.”

I knew that was some kind of compliment. However, her facial expressions and body language told me I was being bossy and dominating again, I thought.

I have to calm down, quit it, back off, I thought. I tried to shut up and not be bad.

This time on this mountain, we could not do any star watching at all. It was daytime. There was no sense going into Scotti’s work area.

For Scotti, I imagined this must have been like me getting up at 2:30 A.M. to casually talk with neighbors.

Scotti was an astronomer who discovered and tracked near earth asteroids. He worked when the sky was night; he slept when the sky was bright. Right now, the sky was a bright, dark blue.

Next, Pita took us to the picnic ground just next to the VLA radio telescope. “VLA” meant “very large array.” A picnic ground was set up within a short hiking distance of the telescope domes.

I had been to the first and real VLA in New Mexico, during the late 1970’s.



I took my daughters there when they were about 6 and 8 years old. In New Mexico we saw an “array” of dozens of radio telescopes. We saw rows and rows of huge, mansion sized microwave dish antennae there. There was only one here. The radio astronomers had gotten wiser. They distributed the antennae all over the world. The antennae were connected together entirely electronically.



\ kitt-peak-vbla-dish-vlbakpx-r.jpg

The crew had selected a picnic table with a good view of spacey things like the VLA radio telescope antenna and the telescope domes at the top of the hill, and in the middle of a cozy set of desert trees. Desert trees are more like bushes and small pinon trees.

We could see the dish move and twist just a little, almost silently once every few minutes. We could hear its motors hum. It would re-point to somewhere into the blue sky, and then after minutes, again move a little, and almost inaudibly, hum again from the motors moving it.

Pita wanted the three scientists to “talk” around the campfire. We could not have a campfire because this was June, extremely dry and that meant an extreme fire danger, and it was still completely daylight. We were crazy scientist types, but not crazy enough to have a campfire in the middle of a hot day in the desert. Peta thought of everything she could, but she could not anticipate everything.

So, we stood closer than I like to stand near males, because Paul Ree the camera guy told us to, and we “talked.”

He stuck a camera from below and between the three of us, looking up the noses of our 3 faces.

I wanted to know about things, space things, spacey things, killer asteroid things, dinosaurs dying things. I had talked to 4th graders, and my wife Terri repeatedly said I was still that age, or younger. I wanted to know what the 4th graders wanted to know.

Unfortunate 4th graders never got a chance to talk to the guys who knew, and the 4th graders didn’t know what or how to talk to these astronomer scientists. I did. And the TV people wanted us to talk.

I was like a 4th grader, except that I knew what to ask.

I wanted to know about the things Jay and Jim Scotti were doing. So I kept asking them questions, one question after another, fast. I kept making them tell me stories of real things.

They dug it. They did not have to make up phony small talk. I kept asking them things they knew exactly how to answer. They kept talking.

“What happened when the thing hit?” I asked.

“It blew up, like an atomic bomb.”

“You mean it had a fireball?” I asked.

“The fireball was 180 miles across.”

“What was the fireball made of?” I asked.

“It started out as a 15 mile across asteroid turned into white hot lava.”

“Then what happened?” I asked.

“It exploded.

It vaporized a hole 5 miles deep.

It blew a crater 50 or 100 miles across.

It blew molten white hot rock and dirt vapor into the sky.”

“How far did it go, in the sky?” I asked.

“Over the whole world.”

“At least over the whole United States.”

Then I started to ask questions that took more than 30 seconds at a time. It was typical of me to talk and talk. I had forgotten about the camera and video guys and started talking too long.

Paul Ree the video person interjected and told me “Don’t talk for more than 30 seconds.”

Pita just stood on the side, and I didn’t know what Paul Grocott, Pita, Paul Ree or Alex Garipoli the sound man were doing. I was totally focused on Jay Melosh and Jim Scotti, like I was a 4th grader.

“What happened to the sky? I heard the lava splashed far. How long did it last?” I asked.

“The sky was blistering white hot. For an hour and a half it went on.”

“How hot was it? What did it do?” I asked

“It fried the dinosaurs.”

“The whole sky was like a barbecue grill.
That’s why it fried the dinosaurs.”

“The whole world was on fire.”

“So everything died?” I asked.

“What about the things that didn’t face the sky?” I added.

“Mice in their holes were ok.”

“Only the water birds were surviving.
Maybe they found coves to hide in.”

“So, should we go to the opposite side of the earth, to be safe?” I asked.

“No, no. That’s a bad place. The debris focuses there.”

“What do you mean?” I asked.

“The white hot lava goes out in all directions from the impact point.
And it all falls back to earth, somewhere.
At the exact other side is a common impact point.”

“Where was that?” I asked.

“New Zealand was the antipode.
Wrong place to be.”

“How many of you would it take to find out about the asteroids that
will hit us?” I asked Jim Scotti, setting him up to give an
advertisement for the Spacewatch project he was a key part of.

Scotti then described the Spacewatch effort how he would like it to
be instead of how it was.

Peta interjected and wanted us to talk about the cure, and how the
cure was as bad as the disease.

We complied, because we were into it.

“So, what would you do to deflect the killer asteroid?” I asked.

“You couldn’t just hit it with an atomic bomb.”

“You would have to hit it with a huge atomic bomb.”

“We would have to hit the asteroid with a
huge,
nuclear weapon,
20 times bigger than anything we ever exploded.”

“That would be a gigaton bomb.”

“I’m scared of a gigaton bomb,” I said.

That was really true. I was scared of a gigaton bomb.

“It would blow up the entire state of Florida all at once, if it
accidentally went off on the launch pad.”

In the excitement I myself misquoted Dr. Edward Teller, just like the
evil journalists did, and said, with the appropriate, strong Hungarian
accent, “Ve, shood, make, gigaton, bomb.” I should have said “kan,
make.”

The “conversation” was fun, it was lively, it was somewhat
inaccurate.

Oh well, that’s what journalists and TV documentaries get to do.

Excitement. Call it like they see it, even if it’s dead wrong and
inaccurate, just so it’s lively.

Get an expert to say it and it’s true enough.

When it was all done, we calmed down and quit. Jim Scotti said I
was a good narrator. That made me feel I somewhat good about it.

I assumed that they would probably cut most of everything I said
out. I had prodded the others to talk.

We were done, but a crowd of people was converging on our
campground. They had telescopes. I knew immediately what this
was about.

I walked up to a friendly person and asked “Is this a star party?”

Hughes, the maker of satellite systems of all kinds, was having a star
party for its employees at the picnic ground. Little telescopes were
everywhere. A few had what I would consider “monster”
telescopes, for amateurs. A fellow named Steve Peterson had a 16
incher. It was connected to a 10 foot long tube. It had no numbers
on the axle connection, like most telescopes seemed to have. It
didn’t have any wheels or dials or gears or anything attached to it.

“How does this work?” I asked.

“It’s friction mounted.”

“What can you see?” I asked.

“Galaxies.”

“Do you see them for real?” I asked.

He smiled wide and proudly boasted ‘spirals’ “

“Wow.” I replied. I had never seen galaxy spirals in any telescope.

Peta saw that this was interesting, so she interviewed both him and
his caustic buddy who had his broken mashed finger in a finger cast.

We went back to Tucson, the city. Pita took us to a Chinese place for supper. and I ordered duck. We all shared dishes. Peta found a piece of metal in the shrimp, and Paul Ree tried to convince me that we should go to the moon because it was close and such. We solved the world's problems one more time. Peta was crashed. And I was too.

This was the first time anyone *really* cared.

What they cared about was stories.

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Shooting a Discovery Channel TV doco

5/1/2002 9:11 PM, draft.html 5/15/2002 9:21 PM

A Zuppero

It was 16 July 1996, and cool and clear in Idaho Falls. I was looking out my north facing top floor cubicle window overlooking square-mile, flat, farmland sections, and I was daydreaming. The wind blowing waves in the green sea of wheat grass entranced me. Two brown horses in the two acre coral next to the lab building were chasing each other.

I could see 30 miles to the north, beyond the fields. I had finally achieved enough status and seniority to command a cubicle office with a window (but no door yet). The President of the lab had the southeast corner office, with a locking door and windows with the best view of the city.

Our boss, a vice president, had a locking door office on the northeast corner, 50 feet from my office, with the best view, I thought. On a cold, clear day he could see the Grand Tetons 80 miles to the east. My boss hosted parties at Al and Tipper Gore's house. He had status.

The Laboratory Director had a row of southwest windows across the hall. He never seemed to care about what was outside. Two other vice presidents had their window offices next to his.

We all peed in the same room, different urinals. I had maneuvered properly. I had access to the President and Vice Presidents because we could pee in adjacent urinals. That works. Fight for it.

Without warning, a raspy, loud-voiced fellow called me on the phone. He said he was with some TV production company called "York Films of England." Either the telephone connection to London was bad or he was talking too loud, because it was distorting at each consonant. He wanted to talk to me about killer asteroids and a TV documentary they were doing called "3 Minutes to Impact!!"

"Do you know anyone who could help? "

"Of course," I replied and then gave him, carefully narrated to him, a list of 10 or 20 people, with their phone numbers and a description of what each of them does and how to approach them.

"Do you know of a way to deflect the killer asteroid?"

"Of course, using steam rockets that we would make and test right here, at the United States Department of Energy."

He was interviewing me for a speaking role in a TV documentary, and I didn't realize it. I just talked and talked and talked.

"Would you use a nuclear weapon do move it?"

"No. We're not NASA. We would not need to use a gigaton bomb like the Famous Dr. Edward Teller himself said at the meeting, sitting just one chair ahead of me."

"Would you tell me about it? "

"Of course."

"How would you do it? "

"I would go to a local comet. Did you know there is a formation of 150 of comets, right now, above your head. If you could see them at night, you would be scared out of your mind. It's between here and Jupiter, all the time, like another asteroid belt."

"You mean you would send people to a comet?"

"You know you could land on about 10% of them. There would always be one close enough to where you want it. My space ship would be something like a submarine, self contained, with at least one person with each and every skill, and at least two for critical skills. Completely self contained. "

"What would you do with a comet?"

"I would melt some of its ice and make rocket fuel for my nuclear heated steam rocket. We at the Department of Energy already tested that kind of rocket, you know, back in the late 1960's."

"Then what?"

"Then I would shove a chunk of comet dust, a bag of dust the size of a football field, into an orbit where it would eventually hit the killer asteroid."

"How would that move it?"

"It would be like hitting the surface of the killer asteroid with a blanket of hand grenades. It would bonk it out of the way. "

"Would you talk for our camera?"

"Of course I would. I just did that for "UltraScience." You know them?"

"Would you go to Las Vegas for the shoot?"

"Sure, if you pay my ticket. "

"What would you charge?"

"Nothing. This is the U.S. Government. You pay my expenses. Hey you guys at York Films, while you are already in Nevada,

why don't you go film a real nuclear rocket. There is one at the Nevada Test Site. I tried to wrap my arms around it, once. I can help you get in there."

I passed the audition.

I didn't know it was an audition. He was looking for animated talkative types, and listening for someone who would talk and talk and talk, with a passion, graphically. Apparently that's what I did for him. I told him story after story.

The Shoot

It was Friday, 4 October 1996. They flew me here to help them make a TV documentary about the killer asteroid story and about how crazy scientists would deflect one. They had one of us here (myself) who would deflect it without using atomic bombs, as you would expect of the Discovery Channel. And they had the one who had started the entire national effort to search the skies to find it (Dr. David Morrison from NASA Ames).

Leaving a cool day of October in Idaho Falls, I fully expected to step off the airplane in the Las Vegas Nevada desert and enter directly into a dry warm 100 degrees Fahrenheit evening. But it was only warm, not even 95.

I hoped I would see naked, topless, bottomless lady dancers in every restaurant, just like the nuclear weapon days. But Las Vegas had long since changed. The Nevada Test Site was no longer a prize feature of Nevada's economy. The nuclear weapon test site became a problem, not a feature. And the naked lady dancers slept during the day. I arrived during the day. The city was mostly cleaned up and not very interesting.

This time I collected all the contact phone numbers I could before I left, to be sure that if I got separated from the TV people, there would be multiple ways to make contact. The York Films people put me up in a nice, simple motel on a road about mile from the central strip. La Quinta Convention Center. Pretty small for a convention center. It was just a motel with some meeting rooms.

As per my plan, I didn't do people before the shoot. I wanted to be hot. I got plenty of sleep. No Las Vegas action whatsoever.

The next morning, bright and early, right on schedule, I waited in lobby, next to the free, trucker-strong coffee and the free paste pastry breakfast. Some marketing solicitors were in the lobby fondling some kind of handouts, and I mistook them for York Films.

Then Dr. David Morrison, from NASA Ames, came down. I was holding a 2 foot square draft comet and near earth asteroid map, selected just for him.

At the INEEL I had recently located a near-magazine quality, wax-jet Hewlett-Packard color printer that used a roll of paper 3 feet wide and 200 feet long. I had just figured out how to make it print the graphics of the comet formation that Mark Sykes and I had put together. The printer made stunning, 3 foot-across, striking color, high resolution graphics poster pictures. We had just printed some. They were beautiful, I thought.

During the process of learning how to use the printer, I had made a 2 foot square draft copy without the orbit points that wasn't as pretty, but it was still 2 feet square. No need to waste it. So I thought I would give it to Morrison. It was nice, just not as nice as the one for the TV people.

\ neoSolSys J-700r.jpg

When I walked up to Morrison, he thought I was one of the marketing people, trying to sell something. After all, I was holding an outlandishly large, color handout.

Morrison didn't recognize me. He had met and talked briefly with me several times before. He only recognized people who would either hunt for near earth asteroids or show how they would be a danger. Everyone else was, to him, just Nameless Irrelevants.

I was one of the Nameless Irrelevants to him. I would make rockets to take people to Mars or elsewhere. To Morrison, making rockets apparently had nothing to do with the Hazards of Near Earth Asteroids and Comets.

I did not support his solution to send an atomic bomb to blow up a killer asteroid. His political support for an atomic bomb asteroid defense was his reciprocal political NASA move to get support from the analysts at the Department of Energy's labs, Los Alamos National Lab, Sandia National Lab and Livermore National Lab. The DOE labs were actively using their super-computers to model the effects of meteor impact. They were the ones who discovered that meteors hitting the atmosphere make explosions and fireballs exactly like an atomic bomb, a nuclear weapon detonation. Those modelers did their studies because it was directly related to nuclear weapon detection and effects characterization. It happened to also be directly related to the Hazards of Near Earth Asteroids and Comets. He recognized them.

He did not recognize or remember rocket makers like me even when introduced by his high powered friends.

Morrison was politically astute. He was focused. I was not part of his relevant people, so the several conversations and introductions of me to him by Shoemaker and his real buddies did me zero good.

Morrison took the pretty 2 foot by 2 foot picture and rolled it up, ignoring it.

The York Films people converged on Morrison about a minute after I did and saved the day.

York Films would shoot with Morrison today. I would be tomorrow. They should have told me. I would have come a day later.

But I wanted to watch. I wanted to see how it was done.

“That might distract Morrison” David Taylor asserted, disapprovingly. I would have to stay somewhat invisible if I wanted to watch.

“These scientists get antsy when their colleagues are watching,” David Taylor, the Director and boss, told me.

Morrison’s Turn

We were wandering in and out of casinos. I was tagging along with the camera / sound crew, trying not to be seen by Morrison. Morrison was focused entirely on Doc Martyn, the Director, and on David Taylor, the Chief Executive. I was just watching, wandering, daydreaming.

As far as I could tell, all Morrison was trying to show was that the chance of dying due to cosmic killer asteroid attack is about 1 in 10,000 per lifetime.

Amid the entrancing sound of clanging coins rhythmically dropping into the metal trays of the one-armed bandits (slot machines) in the casino, I recalled the first killer asteroid meeting, called together by David Morrison.

The story was stunning, and I told it to myself as I wandered around, daydreaming about what we were doing here.

The killer asteroid would hit about once every 100 thousand years or so, the data showed. A meteor large enough to throw enough dust into the sky to change the weather was “a killer asteroid,”

But the scientists didn’t like that particular, unscientific, journalistic emotional description.

“A kilometer -sized” was their preference.

Since the oceans cover 3/4 of the earth and land covers 1/4, once every 400,000 years or so the killer asteroid would hit land.

It was hot outside, and it wasn’t summer. It was comfortable in here. It was always comfortable in the gambling rooms, and always colorful, shiny, with brightly lit slot machine color displays.

Some calculations showed that the dust kicked up by the blast would shield the sun all over the world, and shade the earth, and be enough to keep summer from happening, for a year.

I started to think in “teleprompter,” which was phrases chosen for the emphasis breaks and stops.

That would mean about twice very million years, animals would need to live off stored food, or fat.

I smelled the rancid odor of used, exhaled cigarette smoke, which always seemed to be thick in a casino. Drinks were typically free, but I didn’t see any food. I guessed food must be too messy.

Vegetarians would starve, unless they could eat bark or dried up grass.

An older, sloppy-dressed lady with sun-darkened, smoke wrinkled face skin and age-fattened thighs overflowed over her chair, holding a cup of change in one hand, putting in the coin and pulling the lever with the other, and focusing on the turning wheels. I looked down several rows of brightly lit slot machines. The noise of winner-bells was constant, even somewhat pleasant.

During pre-humanoid times, when giant lizards ruled the planet, 99.9 % of the vegetarians would die.

The vegetarians were those who ate plants. And, the remaining 0.1% would quickly make up for the drop in their numbers

and the next year they would have 99.9% of the swamps or prairies all for themselves.

Truly feast or famine.

The change-ladies kept making the rounds. I kept wandering, daydreaming into “teleprompter” mode.

During those bad years,
carnivores
would not have quite so bad a time.

Weak and starving grazing animals
would be so weak
that a 10 year old, effeminate pre-humanoid could
easily bonk a buffalo on the head with a heavy rock,
and knock him off.

The production crew was fussing over the camera. They were still
waiting for permission to take TV pictures in the din and clanging
of the gambling machines.

About once every million years,
things would be this bad
due to a

killer asteroid.

I was practicing saying things importantly and clearly. In my
head I was practicing. My turn was tomorrow. My only job today
was to refine my key message. I was a nameless, standing person
in the crowd.

But people like us,
those who could make a fire pit,
haven't even been here for more than half a million years.

People as we know them
have not been here one tenth (0.1) of a million years.

People who could write about it have not been here
a hundredth (0.01) of a million years.

So our guys, the ones who could write,
never saw this happen even once.

During modern times,
when computers ruled,
most of the world
could only grow enough food
for most of the people
to be mostly vegetarian
most of the time.

All the excess greens and grain
went into feeding animals,
into meat,

which most people would eat all the time if they could afford
it.

*A fake-breasted lady in a playboy-type mini-suit walked by, selling
something, I don't know what. Drinks probably. She didn't*

*register. Some drinks were free. Good booze cost money. I
wondered what she was selling. The hot looking girls were only
here to make you gamble.*

If the grain would not grow to seed for just one year,
most people would die.

Most countries would not have an extra year's worth of grain.

The world stored
nearly as much of the excess grain as they could
in chickens, cows and pigs.

"These people store too much in their fat," I thought, as I slowly
walked past three aisles with about 2 overweight, truly slovenly
people working 5 slot machines in each aisle. Why are there so
many overweight, sloppy dressed smoking drinkers in these
places?" I wondered, almost aloud.

Little did they know that suddenly, without warning, the Giant
Slot Machine In The Sky could drop a mountain sized, hypersonic
shotgun blast of dirty quarters on the entire city of Las Vegas, all
at once, and blow the whole thing up in a giant fireball.

That would be the Grand Anti-Jackpot, for sure, I thought.

More cigarette smoke. The carpet was clean. People with dust
pans and whisk brooms on long handles were scooping the place
clean. I saw how oblivious they were to all the people. They were
entirely focused on cleaning up scrap on the floor and junk by the
slot machines.

I wondered how to say what would happen here, in the casino, if
the killer asteroid hit somewhere else.

If we would loose just one year of crops,
most people in the world would starve to death.

They would shoot each other over the last 2 bags of dog food.

Dogs and cats would turn into survival food instead of
companions,
just like in Asia.

Most of the wild game would be shot.

Billions of starving people would have nothing to loose by
attacking richer nations,
suffering massive losses,
but no worse than the sure and painful starvation
of just sitting there,
painfully starving to death.

The flashing lights and color of the slot machines dazzled me. I always liked it. It always stimulated my imagination. Our species had never lived through one of these killer asteroid things.

Our species was only about 100 to 200 years old. Our species is the evolved descendant of Homo Sapiens. We are Homo Technicallis.

Homo Technicolaris sounded better. We are not the same as our ancestors. They were Homo Stupidus, Homo Arrogants, Homo Superstitious, homo sapiens.

We, the Homo Technicolor species, are so new that we never saw a killer asteroid hit.

The world would be turned upside down, this time.

I glanced across many rows of Technicolor slot machines, and got a glimpse of Morrison. He was concentrating, almost actually talking, talking to himself and moving his hands as he rehearsed. His formal suit and shirt reminded me that I didn't bring mine. I tried to empathize with Morrison. After all, Morrison was some kind of hero, a role model.

David Morrison was trying to give us a feeling for the probability concept of "once every million years."

I knew how to do that.

Since humans live between 50 to 100 years, a Million years is 10,000 to 20,000 lifetimes.

That means the chance of dying from Killer Asteroid would be once in 10,000 or one in 20,000, per lifetime.

I was now telling my close friends back at the Idaho National Lab about this.

That's all gobbledey gook to most of those people, because "probability" is a big word, and one in 10,000 could as well be one in a zillion.

Stupid people were sitting right there in front of me, inhaling emphysema, puff by puff. Did they know that they can't get ahead? That the more they play, the better their chances of giving the house at least 1% of their remaining money, more certain with every pull of the one armed bandit? I wondered if I could tell them about the Killer Asteroid probabilities in a way they would care about.

The chance of dying by car accident is about 1 in 10,000 per year. The chance of dying by killer asteroid is 1 in 10,000 per lifetime, 50 or 100 years.

Which means for every 50 or 100 people who die by car, one would die by killer asteroid.

I would not care about someone explaining the odds to me. Why would they?

"Someone has to win," I often heard them reply, when I would talk about the probabilities.

What would a 4th grade class want to hear?

The main difference, aside from the sudden bloodiness and smashed faces of the car crash, is that a few billion people would all die at once,

as if they were all in the same airplane, which we somewhat are. We are all on the same Earth, flying through space. And a few billion people is half the world.

The other difference is that instead of dying suddenly, we would take a year to die, all over the world, fighting and killing each other,

and starving on a cold summers day.

"Cold Summer's Day." I liked that one.

I imagined another phrase that would make the 4th graders pay attention.

You are food.

"All Morrison is trying to show was that the killer asteroid is probably real enough to be a real concern," I volunteered to the sound guy. He was waiting around for something or other. "Yeah," he said, ignoring me, bored. He had not done much all day, and it was already afternoon.

We started walking towards a door to the outside. "They will let us shoot for 5 minutes, by the door," he said.

I retreated into my own story, in my own mind, of me telling an audience back in Idaho about what went on.

York Films brought Morrison to Las Vegas, where the "odds" are a shorter word than "probabilities," so most of the TV audience could understand the feeling.

That is why Las Vegas makes so much money on people who gamble. They understand the “odds,” but they don’t understand the “probabilities.”

People in Idaho mostly didn’t gamble. They were Latter Day Saints, “Mormons.” Telling them about “stupid, smoking, gambling sinners” would be fun.

The odds are, you will loose money in Las Vegas. The probabilities are less than 1 in 10,000 per lifetime that you will hit a big jackpot.

You have a better chance of dying by killer asteroid than winning the jackpot.

The Giant Anti-Jackpot from God, herself.

It would be fun to jab the religious types just a little, making God a female. I was somewhat tired and my stories to myself were getting boring.

As we wandered towards an entrance of the casino, I realized this segment of the street had some kind of cover over it, which gave the illusion that the street was the inside of giant, airy mall. But I was not the focus of anyone’s attention. I was just watching, tagging along. I continued telling my audience in my mind about the Morrison story.

I recalled how I had ruined it for my daughter Alyson, when I explained the probabilities of the California Lotto to her.

Look Aly,

That was her nickname, short for Alyson.

Most people out there are not that bright.

Alyson was that bright. She did chemistry till 11 pm during high school because she liked it. She was now a graduate student in Physical Therapy in California. She would sometimes buy a single Lotto ticket when the din of a big jackpot got loud. I had taught her that. “Buy just one, so you have a chance, instead of zero chance.”

The Lotto’s probability of win is about 1 in 50 million per ticket.

If you play twice per week,
every chance you get,
you played 100 times.

Now your chances are 100 times better.

About 1 in 500,000 you would win during that year.

You in a deadly car accident,
The Anti-Lotto,
has a probability of about 1 chance in 10,000 every year.

500 thousand for the Lotto compared to
10 thousand for the Anti Lotto.

That’s 50, meaning
“50 times you die in a car for every 1 time you win the lotto.”

David Morrison spent the whole day trying to use the gambling casino to convey the meaning of “odds,” relative to dying by killer asteroid.

They were now in the doorway of a casino. The crew was setting up to shoot. David Taylor, the boss, was busy getting final permissions from the casino owners to let them take pictures of people gambling. I didn’t see why anyone would say no. But they almost did shut down Morrison’s show.

Apparently, some people didn’t like a TV camera showing that they were there in the casino blowing all the money they had and even more of what they could borrow.

I watched from afar as Morrison talked. I didn’t want to spook him. But I snuck up close enough to hear him once.

I noticed again that Morrison looked very professional and got to wear his professional clothes, his suit. York Films didn’t let me bring my suit. I knew for sure that Morrison had more clout than me.

I wondered how it would turn out when it was my turn.

Supper

Morrison went away. I saw an opportunity to lobby a person who could give my Vision some real publicity. I asked to have supper with David Taylor. Not only did he agree, he seemed happy that I would want to lobby him. I told him my stories and Visions and tried to convince him that this was a great story. We ate, and he was very pleasant.

I showed him the 2 foot x 3 foot, pretty picture of near-earth-object space, NEO Space, and he really liked it when I said he could keep it.

My Turn

October 6, 1996. It was a bright, clear, warm day in Las Vegas, Nevada. A little late, I thought, as we were on our way to the low mountains to the west of Las Vegas. Suburbanite homes were going up everywhere. I had never seen this kind of Las Vegas. Pure, real, suburbanites, normal homes. No casinos at all.

They told me to wear desert clothes, not a suit. So I did.

“We got a shooting range for you. You’ll shoot some clay pigeons,” Doc Martyn told me.

“So you took my analogy literally?”

Using my teleprompter self image, I said
*The particles hit the comet,
like a shotgun blast of hand grenades,
over the whole surface of the thing.*

“Is that how you want me to do it?” I asked.

“Something like that,” he replied.

Nobody told me exactly what they were going to do. According to David Taylor, it wasn’t exact. It was just a sketch. They had scenes in mind, but there was no script at all. They had a clear plan, but no details.

“You need a hat.” Doc Martyn told me.

We searched up and down a 3 mile stretch of a west Las Vegas suburbanite main street, stopping at thrift shops and antique stores, trying to find me a hat. Finally we got a brown one that looked a bit like an old miner’s hat. This was a waste of an hour. But they were in charge.

Then we drove west another 10 or 15 miles, up in altitude a bit and into some hills to the shooting range. We had to wait another 15 minutes for the older, heavier fellow to let us in. He was dressed in coveralls and was not groomed at all. He looked a bit like he had retired 10 years ago and was fixing his grill or his lawnmower for a few hours before he came here.

We had driven into the bowl of a small set of hills almost completely surrounding us. I saw stones, dirt, rocks, a few Joshua trees, some yucca bushes, the tightly locked up wooden shooting range building, and also that nobody on the road could see us or that this was a shooting range. We didn’t see more than a few cars on the road on the way up.

They introduced him as some kind of President of the Shooting Range. Out of his truck came two long boxes, each about as long as my arms outstretched, about a foot wide and half a foot thick. They didn’t seem too heavy. When he opened them, we saw two very fancy shotguns, one in each box, nestled in specially formed cushions shaped like the guns. They were long shotguns. They were newer and fancier than anything I had ever touched.

I wondered if I could hit anything. At least we had him here, and he could double for me, maybe. We were dressed different. Maybe York Films could airbrush his clothes to look like mine.

The President set up the clay pigeon flinger. He flicked its latch with his foot and the clay pigeon flew out. He shot at it. He missed. He shot 8 or 10 times and he hit 2. He showed us how to do it. Somebody other than him or me would flick the flinger latch.

Then it was my turn. I decided to say some words for the TV camera describing what our space ship crew was trying to do and about how hard it would be to hit one fast moving thing with another fast moving thing, which would be a fast moving killer asteroid hit by a fast moving shotgun blast of rocks and dirt and dust from a local comet.

I could see by their antsy fidgeting that the British guys were not used to loaded guns pointed every which way, and I knew that any accidental event with a shotgun would be bloody messy. So, instinctively, I became extra cautious with the way I handled that long shotgun.

“This thing is loaded and cocked. It’s dangerous. You gotta always watch out, even if I look like I’m being careful,” I reminded them. I was trying to scare them a little.

“What if an earthquake started,
right now,
while I am holding this loaded cocked armed shotgun?”

What if a snake bit me,
or a scorpion stung me,
and I lost control.
This gun could shoot anyone,”
I said, with drama.

Back on the farm, during the mid 1950’s, I was carrying the 22 rifle inside the berry sorting building, and it went off, shooting a hole in the ceiling. It surprised me. But I was carrying it like I had been taught. My father authoritatively and sternly taught me “Always keep the barrel pointed where nothing bad will happen if it goes off.”

“It’s always an uncocked, unloaded gun that shoots someone,” I heard my father chastise.

I looked at the hole in the ceiling.

“Yep.” I had been inadvertently fingering the trigger and had inadvertently cocked it. “Inadvertent” was the killer. Good thing I tried to shock those Brits.

The camera started to run. I started describing how the comet was going one way and we were going another. I was holding the barrel carefully, pointed straight up, and then slowly pointed the long barrel in a smooth motion towards the clay pigeon direction and timed it so that when the barrel was pointed towards the shooting range, the clay pigeon would be flinging out there and I would shoot.

To my surprise, I hit the clay thing. It disappeared into pieces. I shot about 6 or 8 times and hit it more than half the times.

Maybe all that practice in my back yard in Idaho was worth something. At my home in Idaho, I lived about 1000 feet from my closest neighbor down the hill. Behind me, up the hill, there was one house about 5 miles away, and another 2 or 3 about 5 miles past that one, and then none in the next 10 miles of elk-hunting mountains.

I would walk out on my back porch and shoot the 22 rifle at rocks or bright trash, for amusement. I would pan the gun across the semi-desert sage bushes, as if trying to track a duck-eating coyote, and then hit the bright thing out there, whatever it was, dirt, an old tin can, a rock. I never saw a coyote in Idaho.

I never went hunting. I only went fishing once in Idaho. And with all that practice in my back yard, I could hear the “plonk” when the 22 bullet hit the old abandoned car shell one or two football fields away.

Apparently the TV guys liked what we did.

Then, David Taylor told us to take some “background.” The camera guy kept moving me around so that a nice Joshua tree would be in the background behind me, and the distant desert in the far background. He kept trying different angles.

Finally, after 5 minutes of what seemed like a half hour, the whole crew liked it. Nobody said they were running the camera. They were just standing around. I was just standing there, somewhat facing the sun. They were shooting background.

David Taylor stood behind the camera a bit, just like Pita Newbold of UltraScience did, and casually talked with me, asking occasional questions, just like we did for an hour on the way up here when we were in the car. He and I were just talking. I told him some stories.

In the car I had told him the same thing I would tell the 4th graders. I told him how we humanoids with our big atomic bombs were just not that significant, to Nature herself. Apparently he listened, and asked me about the stories, as he stood there in the desert next to the camera-man.

"It's like you,
driving on the freeway,
and a bird hits your windshield.

You hear the thud.
You see the feathers in your rear view mirror.
Everyone in the car screams.

But the car didn't slow down.
It didn't jerk a bit.
A minute later, after the adrenaline wears off, you laugh.

Same with a megaton bomb hitting a mile-across asteroid.
Nothing happens.
It doesn't slow down.
It doesn't move very much when you hit it with an atomic bomb.
Nature laughs."

“That’s the DOE's Los Alamos National Laboratory way.
To toss a nuclear bomb at the killer.

Nature would giggle at us.
A mere
1 megaton bomb?”

Even a gigaton bomb doesn't move it very much.
Enough to move it,
but not very much.

A gigaton bomb would probably move a kilometer asteroid about as fast as this car is moving.

--
“More than likely,
it would bust it into a thousand chunks,
each as big as a football field.

That would really blow up the world.
When the 1000 chunks of busted killer asteroid finally hits the earth,
it would rain 10 megaton bombs all over the world,
instead of just
one killer asteroid,
blowing up just one nation.”

--
“All I did was show how you could chop off a small piece of one of those local comets,
say,
a chunk of comet dust as big across as a football field.
And change its orbit a little.

I would change its orbit,
push it with a steam rocket,
so a million tons of dust
would smash into a killer asteroid headed for Earth.

Like a shotgun blast,

the blast of comet dust would
shove the killer asteroid out of the way.”

--

“That’s more practical,
so to speak.”

I said this with a bit of sarcasm. Nothing in space was practical.
“More practical than a gigaton bomb.”

--

“Who would ever have thought that you could find a comet
wherever you needed?

Who would ever have thought that
Nature would provide us
with all those resources out there?”

--

When I was all done telling him a few more stories and when he
stopped asking me things, the crew and he said “yeah, that’s good.”

Wow. Hey. I somewhat suspected the camera was rolling, but
thought maybe we were all just getting ready, talking about it first.

Nobody scared the hell out of me by telling me that 30 million
people were watching. Nobody said, “Ok now, roll it.” This was a
conversation. This was me telling David Taylor and the TV crew
the stories he and I talked about.

Clever trick, they pulled.

Bare-Breasted Lady Dancer’s Horse Ranch

“We’re going to shoot some background,” he said, giving me the
general idea, but no details.

“What things should I say?” I asked, as we drove among almost
barren hills in the bright afternoon sun, 30 or so miles northwest of
Las Vegas, looking for the dude ranch.

“Nothing. Just ride the horse.”

I didn’t understand how they did things, but, it was their show.

When Doc Martyn and I drove up the 300 foot dirt driveway to the
gate of the home of the dude ranch, a perky, thin, 35 year old lady
with thin ankles, a cowboy hat, shorts, and a white shirt came out
to greet us.

It was clear she had big tits and no bra under that loose white
shirt, but we could not see around the buttons. She was definitely
a sharp looking lady. Instinctively, all 4 of us got out of our
vehicles and went right to her. Started up a conversation. Right
away. We all just knew.

Her Significant Other apparently owned the 5 acre dude ranch
with the horses in the low hills of the desert just outside of Las
Vegas. Dressed in black, with cowboy boots and a black cowboy
hat, he seemed and acted like a normal male, not a long hair, not
a cowboy. He clearly liked his 4000 square foot, sunny, airy,
clean, ranch house.

She offered to ride a horse bareback and bare ass naked, for the
camera. That sounded great to me. But Doc Martin Ives said
“Well, not right now.” He actually turned down free nudity.
Amazing.

“Why wont you tape her riding the horse naked?” I asked Doc
Martin.

“What would I do with it?” he replied.

In my mind I answered, “look at it,” but knew enough to shut up.
I didn’t know about these guys. A girl offers to ride naked and
he turns it down. I guess he was in a hurry to get back to Las
Vegas and finish editing.

We looked around at each of 3 or 5 different sized and different
color horses. The nice, sleek and spirited brown one would have
been my choice.

“No, that black one over there,” he said.

He picked a somewhat odd, ugly face, black mule-horse. I’ve
seen quite a few handsome mules, and this one was the worst
combination of horse and donkey, brutish, not handsome. But he
looked sturdy.

The horse / mule knew rather quickly that I knew just enough
about riding a horse to insist on what it had to do. I kept talking
to it, telling it we were going this way, not that, and that we
should hurry up. He listened a bit. But running, like I wanted
him to, *NO*.

Running up a hill for no reason in the hot sun for some guy on
his back? That he refused. Only an animal with donkey blood
was that smart. A horse would be dumb enough to do it.

They gave me a mule-horse, they gave me the view, the space to
myself, all to myself. They were off in the distance, one ridge
away. I could see a hundred miles in any direction.

I could see infinity above me, and it was bright, like the bright
sunlight. The partly hazed deep blue sky above me was bright,
like the deep space in the center of a galaxy, not black like the
dismal between distant suns.

I heard only the sound of the saddle and the hooves of the black,
odd mule-horse stomping the dirt and rocks as we ambled.

It was a spacey ridge I rode on.

He never did say what he wanted me to do.

identified decades or centuries ahead (the usual case), then we only
have to
visit the appropriate comet and just do it. You have just solved a big
problem
for me. I no longer have to mention nukes, when asked the
inevitable questions
about hazard amelioration.

Cheers! Gene

Supper and the 30 Million

We were done shooting. Apparently my version of how to deflect a
killer asteroid would be told in cartoons, with graphics.

“Nothing to worry about. We did great.” he assured me.

David Taylor bought me supper. It was a Las Vegas steak, a steak
served in a diner along a street of casinos a mile from the huge
casinos, a low cost, stringy thing the gamblers get, but it was
indeed a steak. We went in there for a hamburger.

He told me how he got started and how he made documentaries. I
told him of my Visions.

“How many people do you think will watch this?” I asked.

“Well, about 30 Million. That’s all over the world, you know,” he
replied, clarifying that he did not mean all at once, but together, and
incidentally startling me. I had thought maybe a million, total.

“How will that happen?” I asked, totally puzzled why anyone
would want to listen to a killer asteroid story when they usually
either watch cops and killer bad guy stories or sitcoms.

“They will play it for years, all over the world,” he asserted again.

Totally surprised, I pondered the brown steak lined with light
yellow fat, I chewed the stringy steak, and hoped that some of what
I said would be aired on TV.

And we all went our separate ways.

Gene Loves It

After I got back to the INEEL, I emailed Gene Shoemaker to tell
him what I had done. He emailed back. I loved it.

Date: Sat, 12 Oct 1996 13:44:16 -0700 (MST)
From: "ASTROG::GSHOEMAKER"@IFLAG2.WR.USGS.GOV
To: zuppero@srv.net, dmorrison@mail.arc.nasa.gov
Subject: Zuppero rockets

Hi Tony,

I love it! Using comet stuff to deflect killer comets (and asteroids).
But we don't have to occupy large numbers of comets. If the killer is

San Francisco Nerds

York Films called me, at my third floor office with a view, in
Idaho. Raili Taylor, David Taylor’s wife, offered to pay for me to
fly to San Francisco if I would consult directly with the graphics
people.

“I don’t have enough to pay you your usual salary, but I can
cover all your expenses,” she said.

Of course I would go. It was my Vision, for humans to Occupy
the Solar System. I expected graphics that would tell, that would
tell the story and truly communicate.

A visit to some kind of animation studio in Silicon Valley would
be quite exciting, I thought.

Then she volunteered that one of the animators was her own son.
“That’s Hollywood, keeping things in the family,” I thought. Joe
Smith was his name. His colleagues were Mitchell Hudson and
Olivier Wolfson.

On the plane, I imagined trying to convince the graphics people
to do schematic graphics. Bart Simpson is schematic graphics.
Star Wars is realistic graphics.

I hoped I could influence them to do schematic graphics rather
than realistic graphics. Schematics tell how things happen.
Realistic graphics would only place you into the scene, and
would assure that you will only be a victim, a victim of the
circumstances of the scene, instead of a Controlling Creator of
the scene, a Driver of your Dream.

“Look at an example like describing a car engine,” I would tell
them. “Realistic graphics shows what you see when the
mechanic lifts the hood. You would see a hot and heavy thing
with hoses and wires. Maybe you even see that there is actually a
fan, too.”

They would nod their heads and assert “Yes, we could show a
really great engine powering a really flashy car.”

“Yeah, and you would have no idea how to invent a really flashy
car, and get rich doing so. And you wouldn’t have any idea
whether the engine was any better than the competition’s gas
turbine engine, “ I imagined.

And then my way, the superior way, would use schematic graphics, instead.

“Schematic graphics would draw a box-like picture of a piston in the chamber, with the explosion pushing the piston down, and the handle connected to the piston, turning a crank.”

I would say it with my hands moving like the piston, “and the whole thing vibrating like crazy and making a hell of a racket, with no muffler.”

“With this schematic picture it is easy to see that a jet engine is just so smooth and easy, just whirling wheels and fans, nothing else.

And that old piston engine is a vibrating, exploding piece of noise generator.”

I would tell them.

They would see it instantly, and they would quickly decide to do schematic graphics.

Since I was a physicist, I dwelled on how the schematic of a jet engine would show the story so cleverly, so clearly, so commandingly.

“one fan blowing the air into a fire-jar.

Another tiny fan pumping fuel into the fire jar.

The fire jar just sitting there, not exploding like that old car engine.

The hot exhaust blowing out the fire-jar would push on a little turbine, which is a reverse-fan.

And the little fan turns the big fan blowing air into the fire-jar.

The whole thing just turns as fast as fans will turn. So smooth. So easy.”

As I looked out the window of the airplane on the way to San Francisco, I saw how a realistic picture of a jet engine would only show what I saw when I looked under the wing of the airplane. How boring.

The realistic pictures can't show anyone why they would want the better thing, whatever it is. The better-ness parts are all on the inside, just like people.

When I got there, the three of them first took me to a really great breakfast at a somewhat hippie place called the Boogaloo Restaurant, somewhere on a slightly scary street in a slightly ethnic part of South San Francisco. And after that introduction and working breakfast, where we talked about philosophies, they drove me to their “graphics studio.”

Older, dented, junky cars were parked all along the curbs and into garages under the houses that had been non-so-carefully repainted sporadically by unskilled bums during the last 50 years the buildings had been slowly decaying.

It was a simple, first floor apartment that used to be a three story one family home. Colored bedcovers separated the bedroom from the living room, dining room and kitchen. I saw a thin and pleasant, very plain wife of one of them stop in, silently, for just a moment, and then hurry off, only nodding me a glancing smile.

The “expert” had two graphics computers tucked away half under a spare kitchen table arranged in a living room section of their apartment, with a view of the hallway to the right and his wife's bed to the left.

These were apparently typical, Information Technology nerds who made their living from home. They were relatively poor, or at least not paid like the engineers in Silicon Valley, 30 miles and an hour's commute south.

They were dressed poorly. Not like druggies. Like nerds. Their house did not smell like flower-child, San Francisco hippie druggies at all. It smelled clean, almost smoke free. It was also immaculate, with a touch of college student decor.

When I looked closely at the hardware, I saw a rather expensive pair of graphics computers, like the kind we paid \$30 K for. They had high powered computers. Real machines. When I talked to them, they described contract work that involved real graphics.

But they insisted on realistic graphics simulation of what it would be like in deep space. Night background, because space is black. They had me describe what my water extractor would do, and that's what they drew. It appeared they wanted to emulate Star Wars graphics.

\ deflect_celestials.jpg

My version had a white background, and was schematic.

They ignored that, interviewed me for an hour, extracting every external detail, and did what they could.

When we were done I offered to pay them a full tank of gas if they would drive me to the airport. They drove me in their noisy, very noisy, rattling old station wagon-like car and dropped me off at the airport, happy that we stopped to fill the tank.

This was the second time anyone cared. And again what they cared about was stories.

with Gene Shoemaker, Anthony Zuppero, Duncan Steel, David Morrison, and a cast of scientists.

I hoped it would work out.

1996 Discovery Channel,

It was their show.

19961005yorkLV las vegas nevada, Sunday and Monday 5 & 6 Oct 96, la quinta convention center; tape for "3 minutes to impact" ives, martyn & taylor, david; Morrison, David; zuppero, tony;

Smith, Joe Tel: +44 171 404 7672 Fax: +44 171 404 7673
yorkfilm@dircon.co.uk graphic supervisor on "three minutes to impact" documentary; 12 Lamb's Conduit Passage, Red Lion Square, London WC1R 4RH, England, UNITED KINGDOM; mother is Raili, sister in SF, left finland age 7, graphics, Boogaloo restaurant !!; Ginny Russell 961128 & 961206: Hudson, Mitchell & colleague Wolfson, Olivier

"3 Minutes to Impact" by Discovery Channel, work done by York Films of England.

Herding Comets

Herding Comets

It was the 28th of October, 1996, and a typical cool and cloudy day in Pocatello, a southeastern Idaho college town nestled in a valley at the base of a beautiful set of mountains, and at the neck of a wind funnel. It was funnel, not a tunnel. About 3 miles downwind from the potash plant the valley funneled the typically thick smog I never could smell. I had never noticed it until a local resident told me.

The water was only poisoned with metal ions up the side of the smaller mountain where only some of the professors and wealthier people lived. The campus was in the middle of a nice suburbia.

I always noticed that the weather was mostly snowy and chilly, or chilly and cloudy, or cool and overcast, or cold and partly sunny, but always milder than Idaho Falls.

It seemed that Pocatello had more character, more aesthetic sense, more awareness of how it looked, compared to Idaho Falls. Idaho Falls was still in the late 1960's and muddy-dirty from big-booted elk hunters grinding the carpets with shoe stones. Pocatello was clean, it kept up with the times and was now in the early 1990's. Pocatello cleaned its street and seemed to nurture the historical remnants of a comfortably affluent 1940's.

Idaho State University, in Pocatello, had an engineering school, a real physics department, and produced competent technical people for the INEEL. The physics and engineering departments were only 48 minutes from my house and 45 minutes from the INEEL.

That is a very long commute, when there is a blizzard going on, or during the winter, which is most times of the year.

Professor Frank Harmon, Ph.D. and Chairman of the Physics Department had asked me to talk at one of his regularly scheduled seminars / colloquiums.

"Can I talk about the comet belt between Mars and Jupiter?" I had asked.

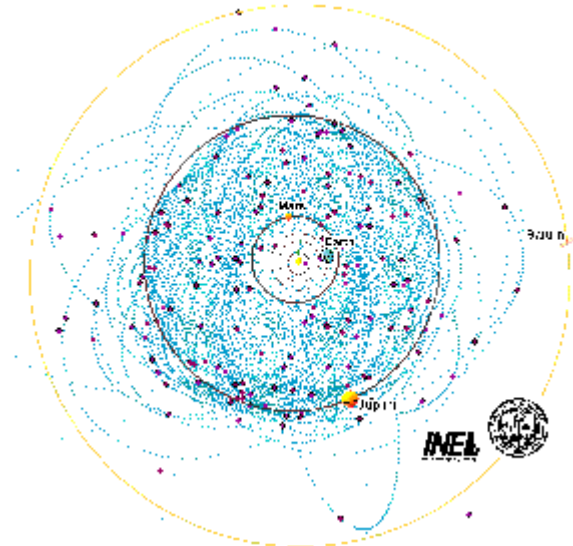
When he hesitated slightly, I had sensed he might object or reject my offer. Before he could even compose his thoughts on how to say no, I had added, "and its relation to the Idaho State University work with INEEL on nuclear propulsion."

The last part connected his physics department with INEEL, and that was all he cared about. He understood politics. All I cared about was to be asked to speak.

I was honored to be asked.

Standing at the desk-podium of the 100 seat classroom at bright-eyed, very awake Ph.D. students filing in early, several with Arab accents, and noticing a few professors, I started the usual tactic of pre-presentation conversation with the audience. I noticed in passing that one of the professors, a thin, attractive, female, acted completely indifferent to overtures to conversation. The students all talked with me.

"Unlimited hydrocarbons," I declared, as I began the lecture, switching almost seamlessly from talking with the audience to talking the lecture. My standard picture of the dark and close comets was on the screen. I had placed it there before the lecture, as subliminal background.



Comets appear herded into a donut between Mars and Jupiter

I asked them if they could see the unusual feature. No one responded, and many had confused looks on their faces. After an uncomfortable 20 seconds where nobody volunteered the answer, even though it was plain to see and even though I was giving them strong clues, I realized that the answer to my question was written on the viewgraph caption, just out of easy view. They thought I wanted them to see something different from what was written.

For the next 30 minutes I told them the usual story.

"... comets are equal parts hydrocarbons, water ice and dust ... Some 10 percent of these dark and close comets are accessible to a steam rocket ... A nuclear heated steam rocket ... rocket uses water for propellant ... uses a nuclear

reactor something like what powers United States Navy nuclear submarine ... boils the water into steam ... “

I added a personal comment they might relate to:
“You could make one of these, at the INEEL.”

I added the usual commercial for steam rockets:
“... steam goes out the rocket nozzle ... rocket pushes space tanker ... loaded with either ice or hydrocarbons or both ... heads for Earth.”

I tried to impress upon them how different this was from other proposed asteroid mining fantasies. I was showing them exactly how to move monster payloads through space, using a rocket they could really make just 48 minutes away from where they were sitting.

“Hey, the payload is huge. 30,000 tons. That's the mass of 300 shuttles all at once,” I declared.

They were already supposed to know that this was the payload of more than 1000 space shuttles all at once. The Shuttle payload was about 26 tons. I tried to emphasize how huge this would be. This huge payload was my discovery.

Nothing happened.

“You are looking at 15,000 year's worth of hydrocarbons, dirty coal, like oil shale, space oil,” I reiterated.

Nothing happened.

Maybe they would get excited if I told them we found oil in space, I thought. I was searching for something that would get them excited about this.

They weren't getting that excited. These were graduate students, not 4th graders. It was not logical.

“We are never going to run out of hydrocarbons. This is more like a threat, because these comets have way more oil than we could use. We could coat the surface of the earth with a sea of goo.”

“Don't say oil” commanded a colleague, Dr. Paul Weismann at the Jet Propulsion Lab of California Institute of Technology. But I did anyway. It was not correct. It was not oil. It was much more like dirty coal. Very dirty coal. High sulphur, high dirt, dirty coal.

It was the same old story, to me. I was getting better at telling it.

Illogical, I thought, that nobody cared about a new kind of oil well.

Maybe they were engineers, not physicists. Maybe they thought this was a physicist's fantasy.

But something new was that “donut.”

“And notice the donut hole,” I repeated.

“For some reason, these comets seemed to be herded between the orbits of Mars and Jupiter. We don't know why,” I declared, again, trying to elicit a response.

“When the comets are closer than Mars, we know they evaporate, so we can understand why they might seem to disappear inside the donut hole. But why are there so few just outside the orbit of Jupiter? We could easily see them out there. We could see them out past Saturn. Where are they?” I asked.

Professor Frank Harmon, the chairman of physics department responded with what I thought was picky picky question:

“Did you calculate it?”

“Well, no. It is so obvious. You can see it,” I responded.

“You don't know it's real until you calculate it. You can easily be deceived by what you see,” he asserted, holding his ground.

“He's right,” I told the class.

“We will have to go calculate.” I said, loosing some of my fire and admitting I committed a science sin.

After my talk, an Arab-accent graduate student wanted a copy of the space map.

“We never saw anything like that,” he said, “I want to put it into my window.”

“If you put it where everyone can see it, you can have it.”

“My window is right up front,” he argued,
“Lotta people walk by. All the time.”

I felt like his enthusiasm was too much to disappoint, and gave him a perfect, highly coveted copy. He was overjoyed. But I never got his name.

After the Arab graduate student got his prize, a rancher named Tarrell O Jones came up to me and talked. He really liked the story. Apparently, he understood it. I gave him a smaller copy of the space map.

As I drove the 48 minutes back home, I kept wondering. There was something special and unusual going on with the comets. We could see it clearly. How could we be fooled? There wasn't any way I could see how we could be fooled. The eyes of animals, like pigeons, cats, deer and us, are connected to exceptionally efficient pattern recognizing devices, in our animal brains. We could see it.

Larson Calculated It

Tom Larson was a highly skilled, meek and humble senior engineer with a superb analytic mind. He had thoroughly earned status at the lab, and his office had a door that closed.

He knew exactly how to make the steam rocket, and it was his job and business to know how. He was excited by the esthetics of the concept. He was excited because he calculated how we could make space tankers big enough to push 500 people in a monster space ship to Mars, and farther.

A peculiar fellow, he had about 4 MAC computers, one of them brand new and with the largest high resolution color monitor I had ever seen, all connected together in his office.

Tom Larson had plotted every point of every space map I had ever drawn. He knew exactly how to calculate the points and how to

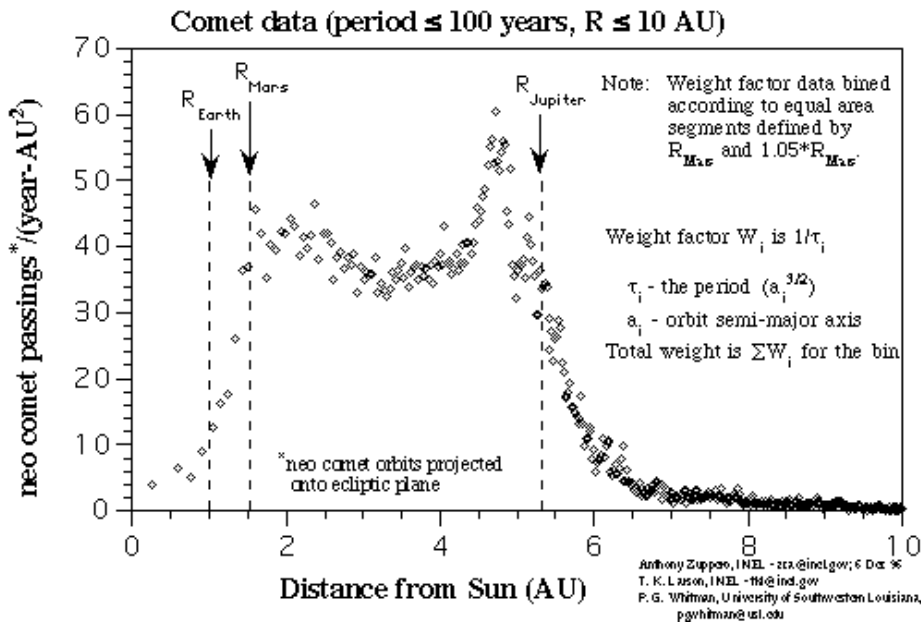
plot them so as to tell the intended story. He knew the science. He knew the art. He was a MAC user. That was probably why.

This was an engineering puzzle. Instinctively he knew the right questions to ask. "Why do we see the donut clearly? How real is it? Can we demonstrate how real it is and measure it?"

Not only did he calculate it, he calibrated it's meaning.

First, it showed statistically that the comets were pretty clearly clumped into the donut, between Mars and Jupiter. That was the good science.

Next, it showed that the comets were pretty much *evenly* herded between Mars and Jupiter, very much unlike the asteroid belt, where the asteroids are pretty much bunched into a somewhat thin ring between Mars and Jupiter.



Finally, he calculated the probability of finding a comet in a given patch of space, your choice of patch, anywhere between "this side of Earth to that side of Saturn."

Since we had just measured the distribution, and we were the only ones who ever did, we could make the statement definitively, and prove it.

It was quite clear.

I tried to think of a catchy phrase to describe what we found exactly.

"Jupiter herds, and so does Mars."

That wasn't catchy enough.
"Heavier herds better."

Nope.

"Heavy planets herd."

The heavy planets Jupiter, Saturn, Uranus and Neptune herded comets from the Kuiper belt into orbits that made them "near-earth comets."

I liked that one. It explained how the comets in the Kuiper belt would move from there to near Earth.

Why would anyone care? Nobody really cared about a practically unlimited supply of hydrocarbons.

Only I cared, and I failed to communicate.

It meant we had an unlimited supply of *water ice* for travel in the Solar System.

You could get to these *water ice* gas stations easier than you could get to water bearing asteroid because their orbits were elongated. That was a rocket science thing.

Now I could back up my new story, which I rehearsed to myself over and over:

“Jupiter herds the comets inside its orbit. Saturn herds them to inside its orbit, and Jupiter is inside and gets them. Uranus herds them to inside its orbit, and Saturn is inside and gets them. Neptune herds them from the Kuiper belt, and Uranus is inside Neptune’s orbit and gets them. There’s a couple billion of them still past Neptune. We’ve got a practically endless supply.”

nobody cared

We never did publish the calculations. Nobody seemed to care.

Only audiences cared. Technical audiences loved the story. Fourth graders loved it. We believed we found out how the big planets like

Jupiter herded near Earth objects into the inner solar system, continuously replenishing the supply of resources we could use to Inhabit The Solar System.

Stories. One more time, it was *stories* people liked. It was the passion and Vision of the speaker that made the stories fun.

Nobody gave a damn about "oil" in space.

19961028ISU Shropshire, steve, Jones, tarrell O rancher;
Hammers, C. J.; johnson, scott b ISU physics; horowitz,
irwin; rodriguez, Rene didactic comment; harmon,
frank;

Surprise at the Propulsion Conference

Joint Propulsion Conference:

Scene name time: JPC 1997

Scene: in the conference room, telling Stan

Expected: I won't know a soul; I can say I published it in a peer reviewed environment

Unexpected result:

- Totally unexpected: I know a whole flock of people and they know me;
- I find a guy who really knows tanks, tells me about PBO and introduces me to his influential TRW boss;
- Stan complains ;
- warp drive; I finally found out about the rumor
- nobody at NASA caught factor of 1000

Color: scared out of my mind on top of space needle. earthquake; me caught in the net, hanging by torn pants

His reaction: what other space agency? said Stan

My reaction:

- I blew it. DOE, DOD, DOT, and another, stupid. I failed to say it. I just acquiesced. The prick. What a dumb shit of me. A perfect chance I had.
- quake 9 magnitude, to cut me to pieces

What I decide to do next: push TRW; make a better rocket fuel tank;

- I tried to lobby Stan. We went to eat at the top of the space needle.
- I am scared out of my mind on the top of the Space Needle in Seattle. It is a beautiful view, but scary as hell. We take pictures with Stan Borowski. Stan was the NASA guy.
- A completely different crowd of rocket scientists, who definitely believe what I am doing, took me to supper at a Greek restaurant under a huge bridge in Seattle. Dr. Haloulakos son ran it.
- I learned that Arthur c Clark was still talking to the rocket scientists. he said by the time we get into space, there will be a different kind of propulsion. I learned about the Alcubierre, quantum mechanical discovery of warp drive, that NASA is paying to get more data on.
- Warp Drive, real quantum mechanics.
- And Dr. Frank Meade, Chief Scientist of Edwards Air Force Base advanced concepts, said the "cold Fusion" guys were measuring new data, they were getting isotopes.
- And, Dr. Robert L. Sackheim, friend of NASA boss Dan Gouldin, and head of the TRW space lab, said my stuff was really good and wanted to get INEL connection.
- One of Stan Borowski's contemporaries at NASA was totally mocking Stan and his absurd, self centered mannerisms, to his fellow guys, and they werre all laughing, mocking.
- I was totally surprised at this meeting, that so many people knew me, knew what I was doing, wanted to hear more, and accepted it. I wasa totally surprised.

it was joke that we are another space agency

we discover factor of 50 to 500,
tells story of factor of 1000,
and Borowski from NASA ignores it.

when I said "another space agency," only half joking
"What, other space agency?"

I was not man enough to say in public at that meeting that
we didn't ask NASA
when we launched spy satellites.

*there are
several
other space agencies of the united states government,
they just don't run a sports competition, like nasa*

It was the 5th of July, 1997. The airplane was on its way to take me, just me, no other colleagues, to the Joint Propulsion Conference in Seattle. The flight was going smoothly and quiet, almost without a bump. I scored a brand new Scientific American from the reading rack. Those were always fun to read on an airplane. Easy science stories with glossy color pictures, written for airplane travelers, masquerading as science.

"Oh, how nice, an article with Seattle in it," thought, as I started reading about the mudslide that could jostle and break loose over what looked like a county-sized area. That would be exciting. I always like to know about a place I was travelling to.

"The magnitude 9 earthquake that is due to hit Seattle, right now, plus or minus 30 or 50 years, is only that large because the fault is long," I thought I read.

Every earthquake I had ever been in or felt was somewhat fun. Nothing ever really fell down on or near me.

But *Magnitude 9*?

The fear started to incubate the virus that makes the images and emotions to perseverate, to repeat over and over, to fixate. "That's big. Very big. Way too big. That could toss you in the air. Seattle? I'm going to Seattle."

And then we landed and I took a \$9, special charter bus to the conference hotel. My room was on the 17th floor. As I looked out the window I noticed that if I pushed my nose and face against the window I could look straight down and see how close I really was to the outside. It was straight down. Outside was right there.

"If there were an earthquake right now, it could toss me against this glass window and shoot me right out the violently shaking building," I emoted. Startled, I moved back immediately, away from that dangerous window.

Walking for curiosity and mild exercise down the hill from my room, to a walking, eating, shopping area, I noticed stunning architecture, new buildings, old buildings, and it led me to a striking, wide stair step cascade with fine art sculptures.

Walking back up, I passed a historic old building, made of stones, and wondered what the Magnitude 9 earthquake would do to it. "Knock the stones off, topple the building into a rubble pile."

Walking, I slowly passed a small, 8 or 10 floor office building built like a tree, or like a corn cob with the bottom 1/2 inch of corns carefully cut away, 1/2 way to the core. The only time I had ever seen one like this was at University of California at San Diego. The offices stopped at the second floor and the entire first floor were missing. Only the center of the building remained. It was like

the upper floors were hanging in mid air, suspended only from the center core of the building. I wondered what the Magnitude 9 earthquake would do to it. Probably topple it. Or at least make it tip to the side, like a tree uprooted by the wind, and scare everyone inside.

As my path got closer to my hotel room I marveled at the beauty and the architecture of the building, and of the buildings up the hill. The glass reflected the grey clouds. I wondered what would happen, and knew that the Magnitude 9 earthquake would jar many, multitudes of those windows from their frames, and a flock of glass hatchets would rain all at once on to the sidewalk, the roadway, the sidewalk across the street.

As glass windows would accelerate from the 17th floor to the ground they would shatter with explosive, hand grenade-like force when they hit the pavement. Glass shrapnel would blast horizontally and blanket anyone on the sidewalk, cutting every body area facing the street, embedding deep into flesh. Whatever glass hit the persons first would decapitate them, slice their arms off, like multiple guillotines.

"Where would I run to hide if it started right now?" I emoted the motions.

I thought of running down and under the stairs, leading down to the basement restaurant. But the glass would fall so fast, and splatter, and slash my face, cut big gashes in my arm, blood everywhere, muscles cut, tendons ripped.

I hurried into the building. "Its safer inside, because the buildings are designed to take it." I recalled. I had learned about this from an earthquake expert in downtown San Francisco.

When I asked the Structures Expert from San Francisco what would happen to us on the 10th floor of his office if an earthquake happened right then, he said without even hesitating "oh, you get thrown right out. the whole room, desks and all goes right out."

As I rode the elevator up I wondered what would happen if the earthquake hit right now. The electricity would shut of first. We would be stuck. There would be such commotion, loss of life, property damage throughout the city that people stuck in elevators would be the last to be rescued. I would have to pee and poo in the elevator, alone, in the dark, maybe for 2 days. My voice would go silent from trying to vainly yell for help, for just a drink of water, for just a bite of food, lowered by a rope from somewhere.

My Turn, And Nobody Cared

[\S4 CH 051.7-Propulsion-Conf-My-Turn-C--.doc](#)

Chapter 051.7: My Turn

It was my turn. I was neither the first speaker nor the last. That was Good. But the room was not packed. That was Bad. I had wished for a packed room. I could see the 30 foot high, floor to ceiling windows through the open door of our conference room. It seemed like at most there were only a dozen people in wandering around the huge hall outside our small conference room, and no people seemed to be passing by the door to our room.

After I found out that I knew people here, told as many people as I could about what I was going to say and how monumental it could be. But I had no handouts or posters to advertise with. All I did was post something on the message board. I posted a single, Xerox sheet of paper with a picture of the bottom of the moon and wrote a handwritten message trying to tell anyone who would see it that something astounding was going to be told at my session.

In spite of this extensive advertising, only a few people that counted were here. I never thought I would know people here, so I did not bring any advertisements for my talk.

Stan Borowski was one of those I needed to lobby, and he was unexpectedly there, second row, almost center, with plenty of room around him.

Confidently, wearing my Pentagon suit and my wing tip, tie shoes, having removed all badges and pencils and everything out of my pockets just like I was taught by General Dynamics, I walked up to the podium and pinned the microphone on my suit, exactly like a professional Program Manager from The Famous and Highly Important General Dynamics, or from The United States Department of Energy Itself At The INEEL, or the Department of Doing Secret Things In Space. I was bringing a United States Atomic Energy Commission invention. Our less impressive modern name was "United States Department of Energy." I was not NASA, definitely not. I was not apologizing, and I was proud of it.

As I stood straight and tall next to the podium I scanned the room to make eye contact with everyone there and opened my presentation with the line:

"I'm bringing you something from another space agency of the United States."

"I'm going to tell you about how to use a nuclear heated steam rocket and the water ice just discovered on at the Lunar Poles," I continued, and paused,

"to change the price of space travel to Mars and the inner solar system," I continued, pausing again just a little to allow the long sentence to settle in, and finished with

"by what could be a factor of hundreds."

I waited for the expected anticipating look on the faces of the audience. I saw what I wanted in most of the audience, in that half that was awake and paying attention. Those awake ones looked at me intensely, just like they were supposed to. Everyone was responding to me the Important Person, like they should. I started off well.

And instantaneously, Stan Borowski objected.

"What, what, what other space agency? Where's another space agency? NASA is the space agency," he asserted, boldly asserted, insulted, instantly catching the implication that someone was challenging NASA. He was talking out loud, not addressing the audience or me, actually, just objecting to what I said.

"Well, the Department of Energy is supposed to make the engines for the rockets to Mars," I responded.

I was still not strong enough, not enough of a prick. I still had not learned to be an ass hole, or sufficiently assertive, or confident enough, or arrogant enough, to deserve the position as leader of my own discovery. I answered with an excuse, not an assertion.

"But NASA is the Space Agency," Stan asserted, talking to himself.

"Well, okay," I said, somewhat meekly, and started my presentation.

I had backed off completely.

The fact was that the Department of Energy had been putting up satellites before NASA had people on the moon. We launched spy satellites. Almost no one knew about them.

The Department of Defense had developed the rockets that could put things into orbit before NASA did.

Just before the Russians launched Sputnik, the Defense Department deliberately delayed launching one of their rockets to put our first satellite into orbit, knowing full well that the Russians would beat us to it. Charlie Zaffery told me about that. He was a young, early 20's engineer working on things related to rockets at the time. He told me a story about it, how they were all set to launch a rocket, and then got delayed for no reason.

The Department of Defense and Department of Energy had been launching their own satellites on their own rockets for 30 years, and did not ask NASA how to do it.

The Department of Defense did not ask NASA permission for a launch, not before Sputnik, not after, not after NASA put jockeys on the moon.

The Department of Commerce had been launching weather satellites since the Defense Department first needed them.

Ninety five percent of launches during these modern times were NOT NASA.

Other secret space agencies had been launching satellites.

All kinds of private launch entities funded by TV and news stations had been launching satellites to Geosynchronous Earth Orbit (GEO) to beam down to tens of millions of 8 foot satellite dishes all over the world, since the late 70's.

But I caved in.

It was probably ok that I caved in, I thought. The point of my presentation was to tell about my discovery of the performance of a steam rocket, and to compare it to the NASA rockets. I was not here to tell of how bad NASA was or of how good the other space agencies of the United states government were.

It was a simple story. I started with a picture of the south pole of the moon. It looked like a field of volcanoes with the bulls eye volcano in the center.

[insert 3 inch illustration of lunar south pole, Clementine photo]

"The Clementine satellite found evidence for water ice there last year," I said, pointing to the center of the picture, the blackest, biggest hole in the picture.

"The question is how to use the water," I continued. I somewhat blocked the picture with my body so they would have to listen, even though they had almost certainly never seen this picture of the moon and had only heard about the water ice. Most had not really connected the ice with anything monumental.

"This was a Department of Defense satellite, not NASA," I interjected, jabbing at Stan Borowski and his space agency.

"You could do like NASA says, and split the water into liquid hydrogen and liquid oxygen," I said, using my left hand to indicate NASA, "and that would power a chemical rocket. Nice and clean. Green."

"Or, you could you could use the water directly, instead," I said, using my right hand to indicate us, Department of Energy.

"Which one is better?" I asked.

I knew the answer, but these were rocket scientists. Other scientists calculated and verified what I was showing and knew that the rocket scientists would almost certainly have the wrong answer. We all knew one had to let the rocket scientists figure it out for themselves, so they would believe it. To do that I had to ask them

the question, the right question, and then put the data in front of them.

They weren't stupid, they were just rocket scientists.

My illustration of a space gas station near the Earth and the Moon showed clearly, with a white background like a cartoon.

"We want to put rocket fuel at L5, or someplace almost at Lunar Escape and Earth Escape, so we can take payloads to Mars, or Jupiter, or to the near Earth comets," I said, pointing to the gas station.

[insert lunar escape gas station picture]

This picture asked the right question. It asked "How do we fuel the Occupation of the Solar System?"

It did not ask "How do we put 3 more jockeys on the Moon?" Nor did it ask "How can we fuel the rocket to put 5 flag planters on Mars?"

It did ask "How do we make the best gas station in space, to Occupy the Solar System?"

There were two ways to do this. I did not know which, if either, would work. One way was to show how using water directly was better than splitting water. This way would show a factor of 500 to 2000 times lower cost than the NASA way. Money and the cost of things should count, so this way should be good.

The other way would show how to fuel a space ship as big as an aircraft carrier for the price of a few space cadets on the moon. That way would show how to start the Occupation of the Solar System. That way should be good.

I tried both. Since everything depended on unlimited rocket fuel in space, and where the water was, I showed the water part first. It was at the moon's dark poles.

Then I told them the story of how the poles of the moon were always dark, and how the moon rotated on its axis that it's poles were always up and down, not like Earth's.

The Earth turns so that its poles tilt about 22 degrees from up. That means the Arctic Circle is big, dropping down to with 66 miles of Anchorage Alaska. During some times of the year it's pointed away from the sun, and the Arctic Circle is always night. Six months later, the Circle is always day, when it's pointed at the sun.

At the Arctic Circle of the Earth, the sun never gets above the horizon more than about peeking over a basket ball held straight out at arm's length. Not very high, 22 degrees or so.

"Up" means: if our orbit around the Sun is like a 3 foot pizza circle on a lunch table, with a cherry in the middle for the sun and a grain of salt on the edge of the pizza for the earth, then up is up.

The moon spins like spinning a jack or a penny on the table, spinning up, The moon's poles only tilt about 1.5 degrees from up. It is like the moon ignored earth and only paid attention to the sun, when deciding which way was up. That means that the moon's Arctic Circle is small. Somewhere on any hill at either the Moon's North Arctic Circle or it's South Arctic Circle, it is nearly always daytime, bright daytime.

And the sun is always just at the horizon, never higher, ever. The sun is never high in the sky at the Arctic Circles of the Moon.

And most important of all: somewhere deep in any crater at the Arctic Circles of the moon, it is always night. Freezing cold night.

Deep in some craters that happen to be deep in bigger craters, it is so dark that the rims of the craters are dark. The sun doesn't even shine on the rims.

The temperature drops. Soooo cold. Cold enough that water freezes immediately. Water vapor freezes to the rock. Ice freezes so cold it becomes a stone.

Imagine ice skating on a sidewalk. Ice becomes a sidewalk at the 40 to 80 Kelvin temperatures in some deep craters of the Arctic Circles of the moon. That is cold.

Any comets that crashed into the moon, blew up, vaporized their water, and the vapor wrapped around the moon in less than a day. But every bit of water that hit the arctic circles condensed there and became rock. Ice rock.

It was like

the black holes at the moon poles

suck the vapor in, forever.

About 30 or 40 percent of meteors would also bring water to the moon. The 30 or 40 % are classified as "hydrated mineral" meteors. They contain between 5 and 15% water of hydration. When they smash into the moon they hit the moon dirt so hard they make sparks, hyper sparks, they explode and turn to vapor. Rock vapor. Meteor vapor. That boils the water off the minerals. And some of that water becomes ice sidewalk deep in deep crater cracks at the forever dark, extremely cold moon poles.

That was the part of the story that rocket scientists probably heard about but never heard about in any detail. NASA did not tell them. NASA had nothing to do with it.

The Department of Defense did it. Colonel S. Pete Worden and Dr. Stu Nozette did it, with their own rockets. They never asked NASA about anything.

That was fun.

Then I showed them what we wanted to do: to deliver rocket fuel to a place away from the moon, far enough away that it would be almost free of both the earth and the moon.

Rocket Scientists know that one such a place is called "L5." It is about 60 degrees from the Moon and in the Moon's orbit around the Earth. There are other places near the Moon and the Earth that may be better.

"How much water ice could we send in a year to that rocket fuel station with a steam rocket?" I asked.

This was a game. Nobody was going to calculate. They were going to sit in their chairs and vegetate, and be entertained. After all, this was a rocket science conference.

So I entertained them with real numbers.

I showed how a puny nuclear powered water heater, steam generator, could power a rocket that would take 14,400 tons per year to Lunar Escape.

This was an astounding number, but no one seemed to catch on.

It was astounding because this was tons, not pounds. They didn't get it.

Rocket scientists were used to thinking a few thousand pounds pounds,

regarding anything in orbit, around the moon, mars.

Not thousands of pounds.

Not tons.

I was talking tons.

14,400 tons.

I kept on talking, telling them about our discovery.

"Every detail," I thought when I had prepared the presentation, "I will tell them every detail." So I had every detail with me.

We had figured how much heat it would take to melt ice. This was special ice. It was stone cold, sidewalk hard, way colder than dry ice, ice. It was almost certainly stone solid permafrost mixed with moon dust.

"The ice melter heater is about like the heat sink needed for the nuclear electric generator we would set on the moon, to run lights and motors and things," I told them.

Of course they didn't get it. I had forgotten to tell them that we were going to use a small nuclear electric generator. These generators are very inefficient. To make 100 kilowatts of electricity they need to dump 10 times as much energy as heat.

It was a good thing they didn't get it because I would need 15 electric generators if I were to use them to generate that much waste heat. That's what the technical report showed.

But if they did read the technical report, they would quickly see that generating 15 megawatts of heat would be very simple if we used a nuclear water heater. The reactor would be a small thing that could fit in a large garbage can.

And besides, Dr. Mike Houts and Dave Potson just finished showing us how they could make that heater, fit it into a garbage can, and everything would be just fine.

"Melting ice is easy. Heat it and it becomes pure vapor. Condense it and we have pure water," I said.

A clever, attentive rocket scientist would have argued with me, right then and there. But I was ready, almost setting a trap for the victim.

If melting water was a big deal, then the NASA way would be hard to do. If we were to split the water we would need to melt ice just the same as using it for my rocket.

I would ask the Simple Rocket Scientist, "What is harder, melting ice, or, the NASA way, generating massive quantities of electricity, splitting water, condensing it, and turning it into liquid oxygen and liquid hydrogen?"

But nobody got cared because this was a minor detail.

Melting ice is relatively easy when one has a 300 megawatt water heater the size of a small pickup truck next to you on the moon. That's what the Department of Energy was all about.

Everyone there knew that, so they shut up.

Now the tricky part. I had to tell them how we could make a rocket powered by steam that would be any good at all.

It was technical. IT wasn't very hard. After all, it was about nuclear reactors. Nothing about nuclear reactors is very hard.

I told them that back during the late 1960's some engineers had tested the cladding of a fuel element at the temperatures we wanted, in water and specifically for a nuclear heated steam system. And I also told them that power densities like we wanted were achieved during the early 1970's.

That was all there was to it, to that part.

That meant we could make the nuclear rocket. Each ton of nuclear rocket heater would deliver something between 75 and 290 million

watts of heat, and blistering hot, 1000 Kelvin, 720 Celsius, over 1300 Fahrenheit.

That would be a bit more power than a jet engine.

Again, nobody seemed to get it. I suspected nobody would get it, because I had never met a rocket scientist who told me how stunningly powerful their little cryofuel engine was. The Rocket Scientists had an engine they used every chance they could, called the "RL-10".

Any rocket scientist excited about her work would point out to me that the specific power of the RL-10 was about 1,300 Megawatts per ton.

That would mean that an RL-10 rocket engine no heavier than a jet engine on a typical airplane would generate almost 2 million horsepower. That is a lot of horsepower.

A jet engine typically delivers something between 0.005 and 0.020 million horsepower.

A clever Rocket Scientist would have pointed out how puny my rocket was. She would pick the smallest nuclear rocket on my charts and point out how it would deliver only about 75 million horsepower per ton, not 1,300 like her chemical rocket.

But I never met a female rocket scientist. Females were typically too smart to do that sort of thing for a living.

It was a relatively simple thing to do, with the Microsoft Excel spreadsheet, to figure how much water my steam rocket could deliver to lunar escape. One had to be sure to save enough water to bring the rocket back to the surface of the Moon. It was a slight detail, but it counted.

With the spreadsheet it was very simple to simply put in different kinds of rocket engines. When I did that, I found out how much fuel each kind of rocket could deliver to lunar escape.

"Ha to you, Stan," I thought, and declared "I didn't show the liquid hydrogen rocket because it doesn't compete."

Stan's favorite rocket, the favorite of any practical rocket scientist who needs to travel through space fast, is the nuclear rocket that uses liquid hydrogen propellant. It goes fastest. But for this job, it worked not so good. So I left it out. And Stan Borowski just kept watching, somewhat bored.

The chemical rocket would deliver 2 to 3 times more payload to lunar escape than my rocket. As expected.

Any smart rocket scientist would see it. I hoped they would.

And if they would say anything, like "ours is 3 times better than yours," I would trap them. I was ready.

But no one did. I got to keep speaking.

“We calculated that the baseline steam rocket would deliver about 14,400 tons per year to lunar escape,” I declared, again, to make the point.

Nobody smirked. Nobody reacted. It was like the room was asleep.

I kept on going.

“So, how much stuff would you have to land on the moon to make the chemical rocket deliver 14,400 tons per year to lunar escape?” I asked.

This was the trap.

The answer totally surprised me, and Schnitzler, and Larson, and everyone else who figured it. That’s why we were here, to document that we found it.

After showing a complicated chart that I even had trouble understanding, I pointed out how the NASA guys would have to land somewhere between 1000 and 8000 tons of nuclear electric generator to do the same job.

If they were so stupid as to use solar panels instead, they would have to launch 100,000 tons. That would be totally outrageous.

But the NASA guys would have to launch more than just an electric power supply. They would have to launch the water splitters, the cryogenic gas liquefiers, and the heat sinks for all that stuff.

All that stuff would add somewhere between 400 and 4000 more tons.

Their program would cost more than the USA collected in taxes during 1992. Totally completely stupid thing to do.

I had to be clear about this.

“The chemical rocket way of doing this

needs to have something like

10,000 tons of stuff

to split the water and turn it into liquid oxygen and liquid hydrogen.

The nuclear heated steam rocket

needs a few tons.”

No response.

How many more ways could I tell them?

“The chemical options costs between 150 and 720 times more than the nuclear option.”

No response.

“You could send a 5000 tons space ship to Mars with that water at lunar escape” I declared.

Still no response.

They were asleep.

Or I didn’t say it right.

I went away puzzled.

I did not expect so little response.

To myself I thought “I will lobby Stan, to see if I can get him to figure it. I’ll talk to the tank guys to see what they can do. Might be worth something. Don’t know.”

I sat half asleep through the rest of the technical talks, just like everyone else.

Terrified in the Space Needle

Chapter 051.7: The Super Scary Space Needle

The clouds of Seattle were just thick enough to mask the sun. The weather was pleasant, not hot, not cold, just pleasant. We were done with the morning session, Stan gave his talk, I gave my talk, and everyone else gave their equally imaginary future for mankind in space. We were standing around in the our small conference room, getting ready for the noon break.

“Stan, are you going to lunch?” I asked, trapping him and keeping him from getting away.

Speaking rapidly in his typical way he replied “Well, yeah, uh, yeah, I’m going to the Space Needle. I have a friend here I’m going with.”

He was objecting.

“Can I go with you?” I asked, being deliberately pushy. I could see by his fidgeting and I could hear by the inflections of his voice that he did not want to go to lunch with me.

Speaking rapidly again, “Uh, well, uh yeah, I guess. I’m meeting someone at the space needle.” He was trying to evade.

“Why, uh, what do you want to talk about? I’m meeting a friend there,” he repeated.

“Just space things, nuclear rockets,” I replied. I had to think of something that would sway him. “I want your advice on how to present our nuclear rocket,” I continued.

Deliberately, I left out the word “steam”. The Department of Energy was deeply involved in nuclear rockets, so leaving out steam would open a door to something he could relate to.

“Yeah, ok, uh, we can go have lunch.” he allowed.

“Do you have a car?” I asked.

“Yeah, I, I got a car,” he said. Stan did not stutter, and his words came out so rapidly that the rest of the sentence was not composed before he started with the beginning. Stan’s mind was fast.

“Can I ride with you?”

“Yeah, well, ok.” he responded, and we were off.

“You know I am scared to death of the Space Needle,” I said.

“Oh yeah? Why?”

“The Earthquake. They are supposed to get a Magnitude 9 here, sometime during the next 30 years. It would be very scary on top of that thing.”

“Oh yeah?” he replied, without processing the comment.

Once in the car I opened the conversation about nuclear rockets.

“How could I present my case better?” I asked him.

That would elicit his objections, but in a way that would get him to tell me what it would take to convince him.

“Well, uh, you need to show the masses,” he said, as he shifted the gears of a low cost, small rent-a-car.

“What do you mean?” I asked. I thought I did calculate every single mass, and that I showed whole categories of masses.

“Well, you gotta calculate all the masses, of the stages, of the engines. Show the masses,” he said.

He was right. I understood. I egged him on to tell me more details, so he would feel like he was giving me advice.

And he really was. It was a shallow rocket science conversation during a 15 minute ride to the Space Needle.

He was right because I didn’t tell the masses clearly. I had them, but on notes, computer printouts, buried in tables in formats that were too hard to read. I did all the work, and did not tell what I did.

That could have been why there was no response to what I said. The audience could also have been half asleep, watching me like they do the evening news.

When we calculated the masses we got such outrageous answers, wonderful, good, big answers, that we did not know where to start, where to start showing how the other guys rocket and support masses were horrible heavy and ours were wonderful light. We did not know where to start to show that their payloads were puny and our payloads were massive.

I didn’t show the masses, said Dr. Borowski from NASA.

Space Needle Parking Lot

The space needle loomed above us. The sun was behind clouds. The temperature was just right, not hot, not cold, not windy. The parking lot was more than half full. People were going in and out the base of the space needle tower..

Three massive beams reached up into the sky, almost like one beam, with a flying saucer the size of a restaurant perched on top, what looked like 1000 feet up. Each beam seemed to be as gigantic and big across as my car. Somehow they were connected together and seemed to reach into the sky like Jack and The Beanstalk.

I didn’t like it.

“What if the earthquake hit and we are at the top?” I wondered, to myself as my eyes scanned the 3 beams from the ground to the sky.

“It’s like dinner plate full of spaghetti on the end of a long fishing rod,” I said out loud. I was unaware of Stan, who was with me. Stan was not really aware of me. He was looking for his friend who was meeting him here.

“This thing would bend a bit. Probably not much. 50 feet. And we are at the top. Stranded there. Tipped and ready to slide off, all the way down to the ground.” I hallucinated to myself.

We walked into the entry area without any visible signs of stress or anxiety or impending doom. We bought our tickets like there was no danger at all. The person taking the tickets looked and acted uneducated and oblivious to any kind of life other than his mission in life to take tickets and herd people into the elevator when it was the right time.

“The architect probably planted those beams deep enough in the ground and cased them in cement, so the earthquake will not knock the tower over,” I told Stan, as we milled around waiting for the elevator and for people to get off so that we could get on. He did not acknowledge. It seemed the ticket guy was keeping track of how many people were up at the top.

“Nobody seems scared,” I said to Stan as I noticed tourists and kids and all kinds of people milling around, apparently completely unconcerned for their safety. He was unaware of me. He found his friend and was talking.

“Maybe they don’t know there is supposed to be a magnitude 9 earthquake here in the next 30 years,” I told myself, as my eyes scanned from one side of the waiting area full of people, looking at each person for a few milliseconds, checking each successive person, looking for facial signs of terror or anxiety on anyone, any anxiety.

People were just talking, milling around.

Then the elevator emptied and the ticket guy ushered us in. The doors closed. The quiet elevator acted like an elevator. It was bigger than the elevator I took 2500 feet down the salt mine in Ohio when I was a graduate student. It went faster, quieter. It took a while, as I expected, for it to get all the way up.

When the elevator got to the top, the doors opened. Nothing shook. The room felt solid. I knew we were on a 100 foot across dinner plate full of heavy stuff on the top of a long, 1000 foot long steel fishing pole, poking into the sky.

I tried to feel for slow vibration sensations coming from the floor. If I felt any, it would mean the structure was a flimsy metal cage with heavy restaurant parts on it. But the floor did not budge. It was solid.

I tried to feel for the swaying in the wind. People often told me how they felt the swaying in the wind on a high floor of a tall high-rise office building in a city.

I felt no swaying. It felt like any other big high rise business building on a regular day.

“We should get a table,” Stan’s voice boomed into my space, waking me up from a dreaming-while-awake semi-trance. I had been alone with my mind even though I was talking and walking with Stan and his buddy.

“Restaurant. Eat. Choose something,” a voice in my head commanded me.

Commands seemed to issue from somewhere in my head, telling me what to do next. We all talk to ourselves. This was not unusual. It had nothing to do with anxiety or stress.

“Lobby Stan.” The command to lobby Stan took over a bit, and fear became second, but not third or lower. I elbowed my way to sit directly across from Stan so I could lobby him.

“Stan, what are you going to order?” I asked.

“Oh, the fish. Probably real good, fast,” he replied.

I ordered the fish. Some kind of fish. There wasn’t much choice. I did not like the fish. But the other two special things for lunch looked worse.

We talked rocket science, but Stan was distracted, somewhat uncomfortable. He wanted to talk with his friend. His friend had appeared. We talked a bit. Stan talked with his friend. I ate the fish. I tried not to think about if the Space Needle restaurant would start to sway and jerk.

The magnitude 9 earthquake could happen without warning. It would suddenly happen. We would all be thrown among the tables and chairs, with nothing on the floor to grab on to. I tried not to think about what I would hang on to when it did.

We were at the top of a long pole, way up in the sky. We would sway a lot. It would snap.

I tried to eat the fish and talk rocket science. There just wasn’t that much to talk about. Rocket science was never a very deep subject.

Stan seemed to agree with me that a nuclear rocket using steam propellant could achieve a temperature of 1100 Kelvin and a power density of 3 MW/liter and that we could do so with high confidence. These were the requirements that INEEL derived in the paper. But he was not interested in talking with me.

When we finished eating the three of us walked out to the sidewalk on the outside of the 100 foot across saucer in the sky on top of the 1000 foot poles, the observation ramp.

A chest-high chain link fence kept us from committing suicide or accidentally falling off. Another chain link fence on the other side of the restraining fence was spread out like a net from under the sidewalk on the edge of the pie plate, probably to catch things that people would throw over the rail. Even normal people would throw a thing or two and watch it slowly fall, and maybe watch it fall on someone or a car 1000 feet below.

We were as high as airplanes. I saw a propeller airplane straight out from us and coming from the east, slightly above us. I saw it's pontoons. It followed what seemed like the 1/2 mile wide river below us. It turned, slowly descended below us, it turned some more and landed on the water.

I looked down at the chain link net. I was scared.

"I'll take the picture of you two," I volunteered. Stan and his friend were positioning so that the guy's house was in the background somewhere.

When we returned to the ground my horror was over. Stan and I returned to the rocket science meeting.

Life Support on Mars

"We are going to open up the room later," the conference session moderator announced, "for the guests." I did not know what he was talking about. I was attending this session because the topic was how to make air and fuel on Mars.

This conference room was deeper into the bowels of the convention center. It was the typical buried room. The hallway on some floor deep in the building somewhere had no windows. It just had more doors to more conference rooms like this one. The room had no windows, held about 20 chairs, with more chairs folded up against the back wall. The lights were flat incandescent and lit up an unceremonious collection of speaker paraphernalia, such as an industrial table, well used slide projectors, bulky green painted metal overhead projectors, a worn pull down projection screen and a felt board to write on.

Bob Zubrin walked in, slouching, his head looking at the floor. The Famous Dr. Robert Zubrin, carrying what looked like a very full and heavy backpack. It was full, full of his new book on Mars. He saw me and immediately came over and sat down next to me.

"Hey, Anthony, buy my book," he commanded in his typical way: friendly, abrupt and direct.

"Ok, how much?" I responded.

I gave him the \$20 cash and wondered why he wanted to sell his book like this. One book at a time is no best seller.

I noticed he wore a good suit and was perfectly groomed. He still had dark hair, so life must not have been that stressy since I last saw him. He was, after all, running his own space contracting business and only had himself and one or two others working on it.

The session got started pretty quickly. The moderator was clearly in a hurry for some reason.

When it was Bob Zubrin's turn to talk, he told how he would generate rocket fuel on Mars. One of the things he had to do was suck Martian air into a storage tank. That was tricky, I thought,

because there is almost no air on Mars. His motor and compressor would have to suck a lot of almost nothing to collect enough Mars air for Zubrin to turn into rocket fuel.

His viewgraphs showed pictures of him with some real hardware. It looked small enough that all the parts and pumps and pipes might fit in the trunk of a car. It looked like it would actually make rocket fuel. I was impressed.

Did Zubrin figure how heavy the hardware would have to be to make enough rocket fuel to get off the planet Mars? He didn't say.

Another guy showed how he would make oxygen on Mars. He would suck Mars air, too. He showed a picture of his little Zirconia device that looked like a white disc the size of a big checker or cucumber slice. He forced Mars air, which was carbon dioxide, on one side of the slice, hooked two wires up to it, connected the wires to a source of electricity, and oxygen came out the other side. Pretty slick.

I wondered how heavy the thing would need to be to make enough air for me to live on. He made a point of how heavy the air-sucker motor would be. I believed him. The only thing that would not be heavy would be his white cucumber slice of Zirconia. Everything else would weigh a ton.

After a few more papers on rocket science the moderator broke up the meeting. People were starting to accumulate in the hallways outside our chairs. The maintenance people opened up the movable barrier between our room and the next conference room.

And then I found out why this was going on. The next speaker was one of the guys on the team who put the remote controlled Mars robot on the moon. That little robot jammed the internet, all by itself. Everyone got on the internet to see it's pictures.

He walked in and told us about it. He looked like an astronaut type of fellow, medium brown hair, thin, athletic looking like he would swim a lot.

He only talked about his work, not about incidentals, and with pure engineering focus. He seemed to have zero arrogance and zero pomposity. I had seen his type on occasion before. Focused. All business, interesting business, robot rovers on the moon. His part was the reentry device and landing it without smashing it to pieces or getting it stuck in some Mars ditch or down some 500 foot Mars gully.

The first thing he did was to paste up a huge 3D color poster on the wall, 10 feet long, and handed out 3D glasses. We could see what the rover saw, in 3D color.

Then he told of how they made the landing device. It was a bit of rocket science. He explained why they didn't just use a parachute. He described a plastic bag ball full of air falling out of the sky.

He also showed how it could have landed in a gully ditch and never be seen again.

"We were lucky" he said. He showed pictures of the smooth landing area the on a Mars photo. Then he showed a close up, and how smooth turned into rocky riverbed with frequent, 50 foot potholes.

I had no idea he was going to talk about this, or that anyone at all was going to talk about this. It had been all over the news and someone on the airplane even talked to me about it.

After his talk I went up to him and said things to him. It didn't matter what I said. I wanted him to say things to me. It didn't matter what things. He was a celebrity. And he was handing out little stickem decals with launch and rocket and robot symbols.

He gave me one.

I scored.

Radioactive on Mars

This session that featured the Mars Lander was chaired by a NASA person, Dr. Diane Linne of the NASA Cleveland lab, LERC it was called, "Lewis Research Center." Part of the reason I chose her session was to see if NASA would use nuclear things in space or on Mars. If NASA would not use nuclear on Mars, nothing would work. Despite what the Greenies said about solar power in space, without nuclear, electronic things run out of power in a few weeks. Even though it sounded backwards, if the astronauts would use clean, green chemical rockets instead of nuclear rockets, the astronauts would get a 1% chance of deadly cancer from space radiation. Without nuclear electric generators on Mars, the astronauts would die, of cold, of freezing, of no air. Die.

"What would NASA say about nuclear in public?" I wondered.

She didn't say anything. She let everyone else bring it up.

To my surprise, several different people volunteered that the Mars Lander rover robot's legs would freeze if they didn't have those little RHU heaters. A radioactive heating unit, "RHU," was a little device that had so much fission product radioactivity in it that it stayed warm all by itself, even at cold that was colder than Antarctica, as cold as Mars. The Mars robot had these in its legs, to keep it from freezing.

Clever NASA guys. They let the others praise nuclear, and then they would get to use it.

That meant I could praise nuclear and they would encourage me to say it, so they would not have to.

Great. I would.

Greek Rocket Science Supper

"Antonio, you have to come with us to supper," commanded the loud and confident, almost boisterous, Bill Haloulakos. Dr. Vassilios E. Haloulakos, an educator as well as a Ph.D. rocket scientist, born in Greece, schooled in everything classical, Greek, and very loudly friendly. We were at lunch somewhere within walking distance from the conference and I got to meet and talk with his wife, Vicky. She felt a certain instant simpatico with me, I felt, because while Bill was getting something from the buffet, Vicky complained about Bill a bit. She only just met me 15 minutes earlier.

"My son has a Greek restaurant, here in Seattle. You must come and share a bottle of Zytrina with us," Bill demanded.

They honored me by asking. They honored me by driving. I was a guest without a car.

Late, after dark, after the last late meeting of rocket science, they picked me up for a Greek Restaurant experience, a meet-my-son experience, and a supper with intellectuals.

Presentation counted. The first thing they did was drive me across a huge bridge, and then on the other side we drove under it. Huge metal arches and supports illuminated by city lights stood out against black night sky. I could not imagine how the construction workers could be so fearless when they attached

those huge beams so high up above the water and ground. How could they not be terrified every second?

They slowly drove around a few blocks looking for a parking space, and stopped at an interesting cultural marking place, under the bridge. Other people besides me were apparently impressed by this under-view and had painted something like a shrine on the rocks to mark a spiritual location.

We threaded slowly through the uncrowded street, past a store that had a cross and some Christian church marking, past a few hippie storefronts with "CLOSED" signs in the windows, and wandered into the food place.

George and Sharon Haloulakos did indeed run a quaint Greek restaurant near under the bridge. The restaurant had the ambience of an authentic Greek restaurant. His food was noticeably different from the massive-quantities feeding lot of Idaho food. It was good, too, and some of it was just different, strong tasting.

George tried to be as boisterous and confident as his father. When he spoke, his eyes moved down and his face slightly turned away, and one of his shoulders moved slightly down, like he was signaling unworthy. It registered when I noticed it. His words said the word equivalent of "I've achieved my lifelong goal of having a Greek Restaurant." But his intonations said "I couldn't do the rocket science. I can do a restaurant." When he talked to the rocket scientists he leaked his inner insecurities.

He let us know by his unintentional expressions it was clear he was not a rocket scientist and all he had was a little Greek restaurant somewhere in Seattle down by the river under the big bridge.

Frank Meade's wife Madeleine was an egg and chick biologist. She appreciated my egg-communication, parapsychic story. She understood. Frank was listening, as an observer of the conversation.

"If you deny the facts, you will guarantee you never find out why it happened," I asserted to Madeleine.

"Why yes, that's true" she said, smiling. She knew that some kind of chemical communication was going on between eggs and the birds sitting on them.

Then Frank, sitting next to her, started to volunteer.

Frank, the Chief Scientist of the small, 30 or so person, rocket science lab at the Edwards Air Force Base, was very mild mannered. My conversation with his wife seemed to open him up.

"You know, Arthur C. Clark told us one time that nothing we are doing right now will be important," he said, prodding.

"Why?" I asked.

"Well, he said if we send a space ship to another star, in 50 years we will have invented completely new ways to travel space, and the new vehicles will pass up the old ones."

"Yeah, I guess that could happen, couldn't it," I responded, not really believing it.

In a few eyeblinks my inner self emoted the typical despair feeling, "Physics is physics. We don't have anything new. We have invented everything in physics. This is the end of the line."

"He said you can never tell what is going to be invented, only that it will far surpass what you have."

"Yeah, that did happen, didn't it?" I affirmed. I did recall the episode with Browning and Simmons and their "Epochal Events." Their conclusion was "an unpredictable invention happens every 100 billion man-years, and it changes everything." I recalled the time constant they estimated "Every 25 years now, because there are 4 billion people in the world."

But I didn't believe Frank. My inner voice was talking as loud as the people at the table.

"Why should we believe that?"

That's parapsychic stuff.

Wishing for warp drive.

Yeah, and a transporter, too."

Switching back to the us in the Greek restaurant, I prodded him with a key question.

"Do you see anything out there that's strange, new, really different?" I asked. He seemed like the kind of impractical person, intellectual, perfect Chief Scientist type, that would deliberately look for and listen to new things, even if they were half baked and just beginning. Black holes, wormholes. The stuff I had read about by Penrose and Hawking 2 decades earlier.

"Well, yes, and" he replied, I interrupted, as he took just a moment to recall what he wanted to say.

"NASA did that warp drive. I that real?" I said, before he could finish what he was about to say or start a new sentence.

"Well, yes, that's some very interesting work," he said.

"Do you know the guy's name?" I asked.

He thought a moment and said "Al cubee air, I think. I could find out."

"How do you say that? Do you know how to spell it?" I asked. He did indeed have something in Physics that was New, Different, Earth Shattering, maybe and Epochal Event in the making.

I didn't quite get the name. I started to write it on the scrap paper I always carried in my shirt pocket.

“ALCUBIERRE, I think. Could be acubear y. I’ll go find out for you,” he said in a way I believed he would.

An momentary excitement distracted me, and the emotion flashed:

“Quantum Mechanics,

new,

warp drive

NASA paying,

can’t believe that,

they must be panicking,

to be so forward looking

rational.”

He had to know about more things. I just knew it. He was the type.

“Where there’s one there’s 20,” I always said. I learned when hunting for petrified wood in New Mexico that if I found just one little piece, there would be more and bigger pieces somewhere, typically uphill. There would always be more if you saw just one. Any hunter can tell you. If you see one, there’s more nearby somewhere.

“Do you know of anything else that is new and magic?” I asked.

Before he could answer, I asked specifically about something that Ed Storms had brought to our attention at a space meeting.

“Like Cold Fusion. Is cold fusion real? I heard that some people are actually seeing something real.”

Immediately his face relaxed.

“Why yes. Many people are getting positive results,” he said, so scientifically, affirmatively, with complete candor. We were in a Greek Restaurant, and our loud, friendly, boisterous host was trying to get us to share some Zytrina with him. And Dr. Frank Meade was still talking like a perfect scientist.

“So it’s real,” I said with an emotion that communicated “neat! I like this!”

Bill Haloulakos was trying to get our attention so we could drink Zytrina.

“Where?” I asked.

“Well, mostly in other countries. Italy. Japan. They’ve stuck with it.”

“Not here huh?” I replied. Frank ignored my comment.

“It’s really interesting because they are not observing the characteristic radiation associated with nuclear reactions,” he added in a scholarly way.

He was talking like a pure scholar reciting items from a list. Credible, but like perfunctory recital of salient points everyone should know.

It had always been curious that “cold fusion” was nuclear but without the radioactivity. That would be like a dream. A dream of perfect energy. Totally impossible. Totally wonderful. Just pure, high efficiency energy for us humanoids. A gift from the civilizations that made us.

“You know they are also observing transmutations,” he added.

“You mean that’s real?” I asked. That was better news than anything I heard at the rocket science meeting.

“What kind of transmutations?” I asked. I already knew what “transmutations” meant. I had been reading about it in a technical journal “Fusion Technology.” It meant non-radioactive isotopes of things we see in nature, but in oddball abundances. I wanted him to tell me, to confirm.

If he would verify what I had been reading, then science really did come across something entirely new, different, probably extremely useful.

“They are finding isotopes in abundances that aren’t natural,” he explained. He verified it.

The rest of the evening passed like a relaxed evening with intellectual friends at a Greek Restaurant under a bridge somewhere.

Completely unexpected, I learned that we had indeed found a new energy source. Their friend Arthur C Clark was probably going to be right.

I was going to dig into the cold fusion thing first thing when I got back.

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Kostas Opa 206 633 4141 3400 Fremont Ave, North, Seattle, Washington 80103 970708, haloulakos, vickly and bill; a bottle of zytrina; haloulakos sharon and george; Ramny Adams; Peter X, Frank and madelleine mead; 970707JPropConf

Mead, Dr. Franklin B., Jr. & Madeleine, 805 275 5929, fax 805 275 5471, meadf@aol.com Senior Scientist, Advanced Concepts & Enigmatic Sciences, OLAC PL/RKF, 10 East Sturn Blvd., Edwards AFB, CA 93524-7680 [805 275 5540,

The Rocket Fuel Bladder

"Poly Ben Oxazole" at TRW

Just about every conference or convention I ever attended had some kind of exhibit place for vendors. The vendors and their exhibits were in a windowless room large enough and with high enough ceiling to park 5 eighteen wheelers in. Behind the curtain against one wall was the huge doors and the dock, where displays had been hauled in. All the booths were laid out like a city, with aisles for streets. Rich guys would buy a whole block for themselves. Poor guys had the minimum booth, only enough for a card table.

A typical vendor was Boeing, who was the official host of this rocket science meeting in Seattle. They bought a whole block. The marketing people had displayed life-like models of real space hardware, or giant, 3 foot models of rockets, airplanes, fighter jets, or cutaways of jet engines.

Hot looking ladies made up to look like the Personal Secretary to the President of the Corporation were handing out flashlights, trinkets, whatever, to passing timid engineers. When I would engage one in small talk, it became clear immediately that they were hired hands.

Missing were real lady engineers, real lady marketing people. This was typical. Ladies apparently don't choose to become the transmission mechanic who gets the transmission fluid all over the coveralls when fixing the 400 pound gear thing. Females don't typically choose to work at the tire store where they get to remove old tires and put new ones on the car. And females typically had not chosen to be rocket scientists.

One would see a real female scientist at a government agency booth, like a NASA booth, or an INEEL booth, or a Department of Energy booth.

Typically, companies who are making some kind of satellite, rocket or jet airplane want you to remember them so fondly that you tell your kids. Typically, these vendors will make up 2 foot by 3 foot posters with fabulous pictures of Jupiter, Mars, galaxies, rockets, 3 foot long green alligators. Anything that would excite children would be fair game. Anything that would excite 4th graders, 8th graders or college students would be fair game.

I always scoured the convention floors for extra copies of these prizes, so that I could give them away when I would give a talk to school kids. The kids loved them. I would come back with armloads of stuff, and give away armloads of stuff. I was on a search and collect mission.

There probably wasn't anything in this whole vendor area that could help my mission, the mission to Occupy the Solar System. But there was almost 100% chance I could find things kids would love.

Wandering about, I came across a half-block area manned by TRW. They make all kinds of space things. One of the things they were pushing were tanks. Rocket propellant tanks, rocket fuel tanks, cryogenic rocket fuel tanks. Tanks.

My mission to Occupy the Solar System depended crucially on being able to make a low weight water tank. The tank would be a water bag the size of a yard in the suburbs, like 100 feet across. The water bag would have to weigh less than a car, like less than a ton or two. I would need to store 15,000 tons of water in the bag.

A tank like that would be a miracle for my competition. The NASA guys, my competition, were using liquid nitrogen and liquid oxygen. Their tanks would typically hold 10 tons of rocket fuel per ton of tank. To hold 15,000 tons, their liquid hydrogen tank would weigh about a 1000 tons. Huge. That's about the same as 10 Shuttles.

My NASA competitors don't even imagine such huge tanks.

But I knew it was theoretically possible to make a water bladder tank that would hold 15,000 tons and weigh only 15 tons. That would be like half the payload of a Shuttle. Anytime I saw anything about tanks, I paid attention.

TRW was displaying tanks. On the table was a blurb that had some equations on how to characterize tanks. That caught my attention. I was calculating tanks. But they did it for a living. Anything they said about tanks would be worth way more than anything I would say.

The advert blurb I was reading was using something they called "W" as a measure of how good the TRW tanks were. TRW tanks had the highest "W" of all. What was "W"?

Focused intensely on the sheet of paper, I forgot to avoid the salesperson.

"Can I help you? Something you're interested in?" said a deep voice of somebody with dark hair I was trying to avoid.

“No, I was just looking at your technical, thing, here,” I said, halting, incoherently. I was focused on understanding the definition of “W” and did not want any marketing guy bothering me. I was not thinking about what I was saying. My eyes and attention were on the technical thing in my hands.

“I’m just looking at something technical,” I said, as I finally looked up at the fellow.

“I’m the engineer that wrote that,” he said.

Instantly, he transformed from Glad-hand Marketing Frat Boy to Highly Valued Resource Person.

“What is this W?” I asked, and didn’t let him answer before I asked “How do you make a super low mass tank, for water, in space?”

He described the “W” in technical terms. I understood.

“So, can you make a tank to hold water in zero g?” I asked. Before he could answer I volunteered “We are working on a steam rocket. The payload would go way up.” What I told him was incoherent gibberish. I blurted out what I wanted to do and did not give him accurate information or even intelligible information.

“A steam rocket can really do pretty well. You know Evil Knevil tried to jump across a canyon with a steam rocket,” he replied. To him I was a prospective customer. Customers were always right. He was trying to agree with me so I would buy his tanks.

“No. I want a water tank,” I said, trying to correct my error in speaking.

He didn’t hear me. He wanted to tell me his story. He started talking about how back some years ago, probably 30 years ago, some rocket guys demonstrated how a steam filled tank would make a rocket that could be used for launching.

“No no, that’s a hard problem. You have to hold hot steam. The steam has no mass. The specific impulse is too low,” I asserted, trying to get him away from his story. I had just given him a three phrase, rocket science analysis of why the plain old steam rockets were no good.

He stopped.

“All I need to do is hold water, cold, 1 Celsius, low vapor pressure, .1 psi, 7 mm mercury, like a bladder,” I said, throwing everything at him that counted, only what counted, and sounding like gibberish again. But what I said was pure rocket science analysis phrases.

His eyes lit up. He knew exactly what I wanted. It wasn’t gibberish to him.

Joe Lewis must have been either a physicist or a damn good, old fashioned engineer.

He replied in the language called “rocket science.”

“It’s all in the tensile strength,” he asserted.

“It’s all because of the high tensile strength of the wrapping,” he continued,

“new materials. Poly benzoxazole.”

A high school dropout could ask the right questions.

“How strong? How heavy?” asked a high school voice in my head.

“How strong is it and how heavy is it?” a college kid voice in my head asked. Those were the only two things that counted.

“Does it have a high tensile strength?” I asked, using “Rocket Science” language for the term “how strong.”

“Seven hundred thousand psi” he replied, looking at me and waiting for my eyes to pop.

My eyes popped. “

Whoa. Steel is forty thousand. Kevlar is 200 something. What’s the density?”

By giving him the numbers “40” and “200” I sent him a signal that I knew exactly what I wanted and that he had it. He was judging me and judging whether or not to get excited working with whoever I was with. I had to provide some positive signals. When I asked its density that was rocket science for “how heavy is it.”

“It’s got a density of 1.44,” he replied. He passed my test.

He really did have something that could change everything. He knew it. He was in the same situation I was in: he was looking for somebody who cared.

“Wow,” I said, acknowledging. Water was 1, plastic was about 2, cement was about 3, iron 7. Low was good. His stuff, “poly benz oxazole,” he called it, was good.

We talked for a while as I explained how water and steam rockets would work for running around the inner solar system.

“The steam rocket will take 10,000 tons to Mars. Jupiter’s moons,” I asserted. Then I showed him why and how, with a quick rocket science equation or two. He followed everything quickly and easily. None of what I said was hard. It was rocket science.

“All I need is a bag to hold the water. Not a tank, a bag,” I said. That was rocket science for “this is easy.”

“It won’t work very well for going really fast. You need hydrogen for that, and the NERVA type rockets,” I asserted. We all knew that. We needed to go “fast,” but we needed “heavy” as well.

I had his phone and email and address. I could contact him later. But before I left him I wanted to find out how he would make a water bladder.

“How would you make a tank with just strands of that PBO stuff?” I asked, most astutely.

“Oh yes. I would make a wrap for a tank. I’d use 5 mill weave of fine, PBO fibers. I would cover the inside with film layer to keep the water from leaking out.”

We had talked about a tank that would start out all packed into the Shuttle payload bay. I joked about how it would be like a parachute, all packed into a backpack, and then unfurled when we squirt water into it to fill it.

“How would we launch it?” I asked.

“It would be collapsible,” he asserted, assuring me he remembered the parachute-backpack story.

We were all done talking technical. He and I agreed to design a conceptual tank for a steam rocket I had asserted that I would do something about it. He gave me the tensile strengths and the thickness of the sheets he could make. That was all I needed.

“When I’m figuring how much it would weigh, what should I use?” I asked, wondering how much I could trust my own calculations relative to his.

“You can figure the weight yourself, with what I gave you. I’ll do the rest,” he said.

“You need to talk with our boss. He talks knows the head of NASA personally. They used to be good buddies. He still talks with Goldin.”

My ears perked up. My eyes probably revealed a sudden, new kind of alertness. This was a Bonus. These guys at TRW were connected.

Connections are more important than figuring, anytime.

“Is he here?” I asked.

“Oh yeah. He was over there, talking to someone just a minute ago,” he said, glancing towards the crowd in another aisle.

“Would you introduce me to him?” I asked. That’s the best way, to be deliberately introduced.

“Yeah. When he comes back here. I just saw him,” he asserted.

“What’s he like?” I asked. Knowing your audience as well as you could was most important. General Dynamics taught me that. “Is he persnickety? Does he figure thing? Is he hard to talk with?”

“You really do have to talk with Dr. Robert Sackheim. He is a most reasonable fellow. He does indeed understand far out topics. He likes them. He will get along with you very well,” he asserted.

I didn’t know if I believed him.

It was time for lunch, a prepaid lunch. Typically, on the middle day of a conference we would all be fed in one big room, on purpose. That would make it a sure thing to see, in person, at least once, whomever was supposed to be there. Everyone would converge on the pre-paid lunch because it was prepaid. It was more serious than “free food.” “Prepaid” meant “you can’t voucher for a more expensive, different meal” Since engineers and scientists are cheap, they won’t pay out of their own pocket to go somewhere else and get a real lunch, instead of the rubber chicken and plastic desert cake. Engineers and scientists are high paid migrant workers. Like farm laborers, they do labor, mind labor, labor that others can’t do or won’t do for that low amount of money. So they won’t pay for their own meals if they don’t have to. And they will all be there at that mid-conference rubber chicken, plastic desert muffin lunch.

Joe Lewis pointed out Sackheim for me. In a sense, I stalked Dr. Sackheim while he was at the noon luncheon table. I was milling around near his table. Sure enough, just as I expected of a Big Boss, he was surrounded by all kinds of plaintiffs, adoring minor managers, and an entourage. It seemed like two more people were sitting at the table than the eight people it was set for.

He was making gestures, and I noticed from his ways of speaking and emphasizing and responding that did not have that bad tasting arrogance I usually find in some bosses, like the General Dynamics bosses. He smiled, was self assured and pleasant.

I walked up to him, gave him a little elevator speech and I handed him the only copy I had of the forever dark, South Pole of the moon, a picture that Colonel Pete Worden with the U.S. Air Force and Dr. Stu Nozette of the Department of Defense took with the Clementine moon probe.

Sackheim didn’t seem to respond. Having delivered my elevator speech, I walked away. After about 5 minutes of frustration at not getting his card, not getting his phone, not getting a direct invitation to speak to him further, I reconsidered reconsidering my interaction with him. I decided he wasn’t the one who should get the only copy I had of the moon. I would work other contacts.

Impulsively, I walked up and asked if I could see the moon picture for a moment. He handed it to me, I took it, kept it, and was about to run off with it. After all, I had asked him if he would be interested, and he didn’t seem to respond, so I took it back. I needed it.

“No, wait, come back,” he said. To my surprise, his face showed he was actually sincere. That changed everything again. With the same impulsiveness that I took back the moon picture, I gave it back to him.

Sackheim then talked a bit. I got his phone, address, title, and an invitation to meet again. He welcomed the interaction with the Department of Energy. He deliberately complimented me by telling

me my steam rocket concepts were really good. What I noted as important was that he wanted to pursue the INEL connection.

He was a good contact and a thinking boss. He was The Dr. Robert L. Sackheim, friend of NASA boss Dan Gouldin, head of the TRW space lab. I would definitely follow up.

Trip Report

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19970707JPropConf AIAA Joint Propulsion Conference, 6-9 July 1997, Seattle Washington; Adams, Rammy; Andrews, dr. Dana G.; benson, daniel on a/c; Borowski, Dr. Stan; Cady, Ed; Cassenti, Dr. Brice N; Chato, David H2liquid, tanks, bladders; Clark, David L; Eberhardt, Ralph N.; Fick, Michael; Forward, Robert L; Frisbee, Robert H; Fronig, David alcubierre class warp drive; Frye, Patrick; Haloulakos, Ph.D. V. Vassilios E. (Bill) & Vicky; Hawk, Clark W.; Houts, Mike; johnson, deon; Kostas Opa; Leifer, Stephanie; Lewis, Joseph.; Linne, Diane; Maggio, Gaspere; Matthews, John R.; Mattson, Larry; Mead, Dr. Franklin B.; Mead, Dr. Franklin B., Jr. & Madeleine.; Muehler, Paul; Palaszewski, Bryan; parker, Morgan JPL Pathfinder Sojourner, Mars Patch Signed; Pelaccio, Dennis G; Perkins, Dr. David edwards afb; Potson, david.; Rice, Dr. Eric E.; Robinson, John; Roldness, David J.; Sackheim, Robert L.; Santarius, John F; Schimenti, jack; Smith, Gerald A ph.d.; Truax, Bob; Williams, Craig H.; Zubrin, Dr. Robert

Trip Report

Anthony Zuppero, Idaho National Engineering and Environmental Laboratory, a national laboratory of the Department of Energy. zca@inel.gov; 208 526 5382

33rd AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit, Washington State Convention and Trade Center, Seattle, WA, July 6-9, 1997

Dr. Anthony Zuppero presented the INEEL concept for using a nuclear heated steam rocket using water propellant derived from the lunar ice expected at the forever dark lunar south pole.

Dr. Eric E. Rice of Orbitec requested INEEL submission of a paper related to this topic at a Nevada conference and also for the Space 98 conference.

JPL's Dr. Stephanie Leifer said Dr. Robert Frisbee is evaluating the INEEL steam rocket concept as INEEL suggested, but couldn't finish in time for the conference. She also said Frisbee is the only one with the funding and charter to do so.

Dr. Stan Borowski, NASA Lewis, presented Mars Missions powered by nuclear thermal rockets using liquid hydrogen propellant. He also described a lunar transportation systems using an afterburner augmentation with lunar derived liquid oxygen.

Borowski seemed to agree with INEEL, during the session, that a nuclear rocket using steam propellant can achieve 1100 K and 3 MW/liter with high confidence. These are requirements that INEEL derived in the paper.

NSF perceives that the scientist community only wants to consider nuclear [thermal rocket?] propulsion for Mars missions and is cool on any alternatives. "They know the answer." said

Person_?name from NSF. Person_?name asked Stan Borowski to come up with two suggestions for studies NSF could fund related to nuclear thermal rockets. It was not mentioned nor was it clear whether the NSF meant their interest focused entirely on nuclear thermal rockets or whether they would include nuclear electric propulsion. Stan focuses entirely on nuclear thermal.

(ask Stan who Person_?name was)

Dr. Mike Houts and Dr. David Poston, of Los Alamos National Lab, presented a "dual-mode" reactor system that would produce both propulsion and power. They could make a system for under \$100 Million and within 5 years. The system would produce up to 50 Kilowatts electricity and deliver 1 Megawatt thermal power to achieve about 750 seconds Isp at 1400 Kelvin, all for a complete system mass of less than 1400 Kilograms. He suggested they would NOT need expensive, in-pile, full scale tests because the entire system is very well characterized. The system is inherently safe when dropped in the ocean (it self-poisons and shuts down), launches with zero fission products, and could be turned on in deep space. The system does NOT scale up.

All Mars systems use nuclear electric generators.

(Several people pointed out that the Mars Pathfinder robotic rover uses RHU's (radio-isotope heaters) in its legs, to keep them warm in the Martian cold.)

Many people presented papers to manufacture rocket fuels on Mars using Martian atmosphere CO2 and Liquid Hydrogen from Earth. All such processes use nuclear electric generators. This process requires between about 15 and 100 kilowatts of electricity. Presenters included D. Larry Clark of Lockheed Martin Astronautics (Denver) and Dr. Robert Zubrin.

Stan suggested there was a strong US. State department interest in keeping the former soviet union nuclear scientists working on useful nuclear projects like nuclear rockets for space, rather than bombs. He just returned from France with a meeting of the Russian rocket scientists where he accompanied Steve Richards (NASA, Deputy Director, Advanced Space Transportation Office, Marshal Space Flight Center) and Lew Peach NASA, Director of Advanced Projects, Office of Space Flight, Code MP). They apparently explored options for using the Kazakstan site for in-pile and engine tests.

Stan had earlier specified the INEEL site in his recommendation for the in-pile tests (INEEL Advanced Test Reactor, ATR) and for the full scale engine tests.

JPL's Dr. Robert Frisbee presented a paper on a solar sail for mini or micro missions. A solar sail can compete with cryo and nuclear because the propulsion has no minimum size and because the sail areas can have sufficiently low mass per area. The same sail can provide solar thermal rocket propulsion because the power per mass can compete: The sail will very likely achieve a specific power of .04 kg per kw at 1 A.U. from the sun. (this is about 25 Megawatts per

ton; a nuclear rocket can achieve 300 MW/ton)

Zuppero had a snack supper with Frisbee before an evening session and discussed possible joint papers to use inflatable solar collecting devices and RHU/RTG powered rovers to investigate lunar and near-earth comet water resources.

Solar Thermal Rockets (STR) were represented by both Dr. Clark Hawk of the University of Alabama and by Patrick Frye of Rocketdyne / Boeing North American. These compete with nuclear thermal rockets when system masses are less than about 1500 kg because nuclear systems have a minimum mass. However, no papers were presented on this topic.

Dr. Robert Sackheim wants to talk more with us (INEEL, Zuppero) about the lunar ice / nuclear heated steam rocket concept. He was intrigued by it, given of course that lunar ice exists. He is on a commission that speaks directly with Dan Goldin, Administrator of NASA, and said he could suggest appropriate actions, depending on the conversation. Sackheim was (is still) good friends with Steve Lanes (DOE NE) and is well acquainted with the enabling elements of space nuclear systems.

=====
• ACTION ITEMS

leifer, stephanie says jpl is doing check on ineel work
frisbee is only one with resources to do so
micro missions are in favor

nice to meet you in person, hope your cold is better.
you did not look like you had malady.

hope to work together to focus doe efforts performed at ineel
used most quickly
early application of our work
energy for earth
where nuclear makes sense, we would use it,
fast trips to mars, nuclear thermal rocket

Frisbee, Robert H 818 354-9276 Robert.H.Frisbee@jpl.nasa.gov
Bldg: 125, Room: 221, Org: 3540, Jet Propulsion Laboratory
4800 Oak Grove Drive, M/S: 125-224, Pasadena, CA 91109-
8099nock, kerry; Hoffman, nesmith, bill; 970331; 970421; ;
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send posters of space resources.
email of space resources description
solar thermal rocket for mini-missions
RHU/RTG powered mini-missions to characterize ISRU water resources.

Sackheim, Robert L. 310 813 9304, fax 310 812 5979
Robert.Sackheim@TRW.com Manager, Propulsion and
Combustion Center, TRW Space & Technology Division,
Space & Electronics Group, 01/2010, One Space Park,
Redondo Beach, CA 90278 ; Lewis, Joseph; golden, dan;
send message that he can take to Dan Goldin
if water ice on moon, dramatic cost reduction for all missions in space
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doe interest: cost reduction low enough for space solar power beaming
satellites,

Maggio, Gaspare 212 239 8510, fax 212 239 8512,

gaspare.maggio@cpx.saic.com Advanced Technolog
Division, Staff Scientist, Science Applications
International Corporation; SAIC, 7 West 36th Street, 10th
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Clark, ben
get going on prepare for lunar prospector
Clark, david l

Frye, Patrick 818 586 0363, fax 818 586 0579
patrick.e.frye@boeing.com Member Technical Staff,
Systems Engineering, Engineering, Rocketdyne Division,
Boeing North American, Inc., Boeing Defense & Space
Group, 6633 Canoga Avenue MS IB-57, PO Box 7922,
Canoga Park, CA 91309-7922 str demo; shoji, jim; jacox,
mike pgm mgr STR; june 2001 fly; 970707JPropConf

email hello
jacox
web

Lewis, Joseph, 310 813 9433, fax 310 814 8290, Senior Project
Engineer, Propulsion & Combustion Center, TRW Space
& Technology Division, Space & Electronics Group;
Building 01, Room 1080, One Space Park, Redondo
Beach, CA 90278 tanks TRW intro to sackheim, robert ;
ackheim, Robert L. ; 970707JPropConf

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parker, Morgan JPL Pathfinder Sojourner, Mars Patch Signed;
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thank for patch, remind meeting, how nightwalker on moon?

Zubrin, Dr. Robert & Maggie & Rachael & Sarah, Elliot Gagnon,
work 303 980 0890 Home 303 697 0315, fax -7033,
zubrin@ix.netcom.com; Home: 303 697 0315,
President, Pioneer Astronautics, PO Box 273, Indian Hills,
CO 80454; [303 971 9299, fax 303 977 3600, old: FAX
303 977 1893, temp: 303 971 5655 @9/28/92, old:303
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thanks for book;
mini-missions

Forward, Robert L. Ph.D. @24hr ans serv 805 983 7652; 360 579
1340, forward@whidbey.com; @mail reship servidce:
PO Box 2783, malibu, CA 90265-7783; Tethers
Unlimited, Partner and Chief Scientist; 8114 S. Pebble
Court, Clinton, WA 98236.; [805 983 7652, PO 2783,
Malibu, CA 90265-7783 USA, Ed., Mirror Matter
Newsletter, de Dolan] mcsdc95; landis, jeff; Hoyt, R., ;
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what is equation hoyt used to specify how much tether mass one needs
for a given material strength?

- **Schnitzler's steam reactor**

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An Old Time Water Heater, Epochal Event

It was already late in the year. I was loosing track of time, but I knew it must be late in the year, 1996, because the sun was setting before I left work, the freezing cold had been here for months already, we already had thanksgiving and it wasn't Christmas yet. I was focusing on a wind generator document, sitting at my desk, lost in distracted concentration. I was in Concept Space, but not the one I liked.

The national lab where I worked was moving farther and farther from anything I came here to do. The lab was washing dirt to extract an almost unmeasurably small amount of radioactive waste out of one acre of dirt in a 1000 square mile military reservation. That one acre of "Pit 9" was a designated to be a dump for low intensity, dilute radioactives. It was deliberately located in the desert and designated as low intensity dump where no humans could get to.

But we were still washing politically correct dirt.

The lab was also trying to get Congress to pay us to make a wind tunnel to test houses in a simulated hurricane. This was Idaho. The houses were in Florida and South Carolina. The insurance companies and home builders there were wondering what hurricanes had to do with a U.S. Navy nuclear reactor test site in freezing Idaho.

The lab was also focusing on politically correct training, instead of doing real work. This work environment was so mind-numbing that skilled key technical leaders were leaving the lab and taking their real-work contracts with them.

Terri and I were starting to despair, realizing we had become trapped here in Idaho. We had only come here because of the nuclear rockets to take people to Mars. And that dream had been collapsed for several years now. I was the only one left who was doing any nuclear rocket work, and it was definitely only being done on the sly. The Vice President in Charge, Bill Guynot, told me personally that we were not interested at all in that nuclear and space work. Both "space" and "nuclear" were still bad words to the Clintonites.

A silly, ear to ear grin, like he had just played a joke, startled me as I looked up from my desk and to my right. Silently and suddenly he had appeared there in the entryway to my cubicle. Bruce Schnitzler, Ph.D. nuclear engineering and science, standing there, smirking. At least his expression looked like a good-omen wince.

"Why are you smirking like that?" I asked.

I stood up. One more time I noticed that Bruce Schnitzler was shorter than me. It was the first thing would I always notice when I

met him. It was a politically incorrect thing to say, about someone's height, but that's what I felt, and I never said anything to anyone.

He smiled hard and shook his head like he was about to stutter before he spoke.

He always grinned more than me. I thought he was smarter than me, too. I was sure of it. Every time he said something, it was right. He would not say much and would not volunteer much. He would check and recheck whatever he was about to say. After that, he would present it. He was smart enough not to go out on a limb all the time, like I did.

He would often smile with a wince like that, as if he knew about a prank about to happen. Typically his grin would be about some technical-political antic someone else, typically a manager of higher stature, was playing and that he saw through and would tell me about.

"You know the cladding was already tested," he replied.

"Yeah?" I responded, not knowing what he was talking about.

"Back in the 60's they tested some cladding material for a super high temperature steam generator."

"How hot?" I asked instantly, with a reflex action of the brain, suspecting he might be talking about a nuclear heated steam rocket fuel element.

Bruce had been working with me on the steam rocket from the time I started at the INEEL. He loved excitement. Space was exciting. He had told me once that he "would even live in New Jersey to do that work."

He knew that I needed a nuclear reactor that would heat steam to a temperature hotter than about 500 Celsius (about 930 degrees Fahrenheit). That would be very hot for steam. Steam that hot would make the steam pipe at least glow red.

"About 1000 Kelvin," he answered, with his typically soothing tones.

Shocked, I saw instantly. Instinctively I added 273 to my need for 500 Celsius and got 773, my goal in Kelvin temperature units. That meant that Bruce's "1000 Kelvin" was hotter than what I needed, hotter than my 500 Celsius.

"Well, I was poking around," he started, smirking, boasting and smiling, completely aware that he found something really good.

“And I found these references to some cladding work with superalloys,” he said.

The “cladding” is the coating they put around a nuclear fuel material, like the shell around a nut, to protect the nut inside from the bad things outside. Scalding, rusting furiously hot water would be such a bad thing outside.

“They were trying to make super hot steam,” he said.

The electric generator for an electric power utility would operate much more efficiently if they could operate it with super hot steam, especially as hot as 1000 Kelvin hot. I understood completely. I empathized. It didn’t work for them, but it was a nice try.

The problem with super hot steam was that it would instantly ruin the pipe. It would rust the pipe. Water, also known as di-hydrogen monoxide, two hydrogens and one oxygen, would usually not ruin thing much when it’s colder. “Colder” water to Bruce and the nuclear reactor guys would be, for example, furiously boiling water on a kitchen stove.

But super hot steam, that’s dangerous. The oxygen in the water would attack the metal of the steam pipe. That would instantly make blistering, glowing red rust, otherwise known as steam-pipe oxide. The left over material would be hydrogen gas. That would otherwise be known as “dangerous as hell.”

“Yeah?” I said, acknowledging. Bruce knew I knew that they wanted some super alloy to resist rusting where mere mortal alloys would just blister, rust and generate hydrogen gas.

“Wasn’t very neutron friendly,” he said. Only a nuclear engineer would get that comment. A nuclear reactor runs on neutrons. A neutron burns a fuel nucleus. Two or three neutrons come out of the burned fuel. Most are lost. All but one remains to burn more fuel.

If something in the reactor would be Not very neutron friendly,” it would eat neutrons that should be burning fuel. “Not neutron friendly” meant “POISON.”

I understood that buzz phrase well. It meant that the envelope they were testing as a coating around the nuclear fuel would eat neutrons, become annoying radioactive material, and keep the neutrons from burning the fuel. It meant the super alloys they were testing were somewhat of a poison to the nuclear fuel.

“Didn’t last long enough to put into a reactor,” he said, huffing a laugh to let me know that all those bad things didn’t matter at all to Bruce and I.

Again, nuclear engineer jargon. A reactor is supposed to last for at least a century. The fuel elements are supposed to last for a century. Anything less can be “not enough.”

“How long did they last?” I asked. His huffing laugh signaled that I would like the answer. I needed the reactor to run for 10 or 20 hours when coming back from a comet. I needed it to run 5 minutes

at a time on the moon. I needed a few hundred hours of run time, total.

“Couple thousand hours in the test,” he said, laughing.

“Wow,” was all I could say. Everything I was doing at my desk came to a complete halt.

“The tests showed it would be ok in a reactor for years,” he added, as if to heap insult upon injury on the demons who would try to give us bad luck.

“That means it’ll work,” I blurted out, not knowing what else to say in my excitement.

He smirked with an “umpf.”

“Is this real?” I asked, knowing it was but needing him to tell me the story again. I wanted to be sure it was not just a joke.

“Not good enough for a commercial nuclear reactor,” he replied. “They want it to last 30 years.”

We didn’t need “30 years” to initiate the Human Occupation of Space. We didn’t need “30 years” to start an Exodus. We both knew it. That’s why he was grinning so much.

I followed him back to his desk, about half a football field away and on the same third floor of the building as my cubicle. His small cubicle on the sunny side of the building had enough room for a small window and primitive computer and was jam packed and stacked up with papers, technical papers and reports on every surface.

“Some of it’s a bit hard to read,” he said, as he handed me a Xerox from the Uhlig book.

“I couldn’t really read the publication date,” he said, “but it’s clearly 1960 something,” he said as he handed me a Xerox.

I found the date a bit hard to read, too. But the data seemed to be there, clearly there.

“But that’s not all,” he asserted, this time just smiling.

“The power density we want has been tested. And the ATR can almost do it,” he said.

The “ATR” was our very own test reactor at the INEEL, one of a very few in the world.

“What?” I responded, smiling in disbelief.

“I found a some work by Katscher,” he said, handing me another Xerox, “where they electrically tested 3 megawatts per liter.”

Again, I instantly knew what it meant. I needed the nuclear reactor to heat water with a power of about “3 megawatts per liter.” If I could get that much power, the rocket would be able to

take off from the moon with a useful payload. With that much power, a rocket ship could come back from Mars with a space ship as big as an aircraft carrier.

One had to put the numbers into perspective. A car generates about 100 horsepower in a 300 pound motor using about 4 liters (quarts) of piston volume inside it. Bruce Schnitzler's rocket heater would generate about 4000 horsepower in 1 liter. Stunning.

"You know the ATR can do 1.4," he stated, flatly, almost like a lawyer. He meant 1.4 Million watts per liter.

That was politically correct news. Our own laboratory owned the "Advanced Test Reactor," the ATR. Our own reactor could almost get to the required power density. If we got the money, Bruce could actually do the work here. Our own managers would get credit for the work.

I did not expect this. He took me totally by surprise. I didn't ask him to look up that stuff. He just knew.

The data was rather clear. Sparse, but clear. We did not need reams of data. We needed clear data. It was all there, summarized in only a few pages from only a few places.

It meant that the rocket I came to frigid Idaho was so testable that Idaho could have made it during the 1970's.

This was epochal, to me.

The next step was clear: get the word out.

Meteor Bomb UFO's

19960603space96+++ Albuquerque Hilton 1-6

Scene name time:

Scene: Cliff Jacobs gives me a copy of the declassified curve of the energy in a meteor we saw with the spy satellites

Expected: Sandia would not be friendly to me at all; I would not be given any data

Unexpected result: Cliff Jacobs gave me the real spy satellite data; I never gave the weird, meteor data any thought because we didn't care about it at all.

Color: Gary Masters was friendly, and very very thin. he did not have any money or a department

His reaction: he had a canned declassified guide line, and he was happy to give me the data

My reaction: I was happy that we actually were declassifying it

What I decide to do next Tell stories about it. He gave me just enough to make a really good story.

It was a sunny day when Cliff Jacobs and Dick Spalding let me back into the spy satellite area where I used to work. I expected to see the wooden portable buildings with the decaying wood steps. I expected to see the cramped old office cubicles with no door, crammed with books and papers and within tens of feet of younger technicians making real hardware, with steel pieces and electronic parts and wires sticking out and oscilloscopes connected. But they had moved out of the cramped spaces I had known.

Instead, they took me to a brand new building that looked like some kind of high tech workplace in Los Angeles. Offices were new and some even had windows with a view. Clean, unscratched walls painted a pleasing light tan, bordered with at least one window on the outer wall and a door on the inner wall. The hardware guys were somewhere else, not here.

Cliff was still tall and thin, still wore those big-eyed glasses, still had dark hair, still smiled a lot, and was still alive. He had surprised us and himself during the 80's when he woke up one day in front of a multiple-bypass operation.

Dick Spalding was still dark haired, still thin and shorter than Jacobs, and still sharp. During the 70's he was known to have worked day and night for more than one year on end, sleeping in his camper instead of going home. When I asked him about it during a meeting because I was curious how one could be that dedicated and live that way, he boasted that it made for easy and very convenient affairs. I think he knew I believed everything and was putting me on. But his smirk made me think could have done that.

Cliff Jacobs and Dick Spalding were looking at some meteor-flash data and making notations and figure captions that they could certify were unclassified. This data was just one of many that the government had just declassified. It was one of the bright meteors the spy satellites had been reporting during the last 40 years.

Even I had helped program the spy satellites and their software to ignore the meteor data. The spy satellites were looking for atomic bombs, not meteors. But the data was still recorded somewhere. When I was there, all that data was somewhat of an annoyance. We had to store it on 1 foot reels of tape that didn't hold very much, compared to a floppy disc. There was too much of it. It filled whole floors of expensive older buildings.

But now, both the news people and technical people all over the world were interested in killer asteroids and near-Earth-asteroid stories. Jacobs and Spalding had some recent data, the data of bigger meteors that hit earth. Someone had convinced the secretive spy satellite bosses to release the data. That the Berlin Wall fell and that Russia was no longer an enemy played a big factor.

"Would you let me talk about the meteors?" I asked. Jacobs and Spalding both immediately, separately and at the same time said "sure," "yeah."

I knew what that meant and I liked it. It meant "You can talk about big flashes in the sky." But it also meant "You can talk about some cleaned up generalizations and non-specifics so we can be sure nobody can figure out how well our satellites can spy or where our satellites are looking."

I did not know how big the flashes were. I did not know how often they happened. When I was working on the ground station software, I could care less. No meteor flash was ever interesting, in the old days. Every one of them could get me into trouble if my software were to report it to the Pentagon as a bomb in the sky instead of a rock from space.

“So, what can I say?” I asked, as they handed me my very own plot of the light output of a meteor that came smashing into Earth.

“ ‘About a dozen times a year a meteor hits the atmosphere and releases between 1 and 100 kilotons of energy’ is the official statement,” Spalding said, authoritatively.

Spalding was the kind of engineer that would state things like a lawyer. He was precise. Jacobs would state things like an engineer. He was precise in a more friendly way.

I had a clearance, and Jacobs told me the story like an engineer. That meant he told me what the sensors really picked up and reported, with any secrets that might accidentally be attached. To my surprise, it was just like Spalding said. They weren't hiding anything.

Or, maybe they were hiding something and they didn't let on, and were very good at it.

Already hallucinating about what I would tell fourth graders, I wanted to make sure what I said was accurate.

“So, a dozen times a year, like an atomic bomb, and between 1 and 100 kilotons of radiated energy, is that close enough?” I asked.

Already in the 4th grade classroom, I saw the smirking faces of a few boys fooling around in the back and the intense focused stare of a few of the girls as I started to point into the sky and tell them what I had just learned.

I heard the words of Professor Benade, telling us about how Fermi would teach it. “Always relate it to something they know.” “Something they know” would be somewhere in the sky.

I had no idea where in the sky these big meteors would be. I knew they couldn't be near the ground or CNN would have reported a dozen horrific news stories every year on it.

“How high up are they?” I asked. They might be so high that no one would really care. That thought burst the hallucinogenic bubble of me being in any classroom telling exciting meteor fantasies.

In the two or three eyeblinks of time that Jacobs and Spalding took to start telling me the answer, I recalled how about 6 years earlier Dr. Ted Fay surprised me by saying that meteors would typically blow up before they hit the ground.

Fay told me how “the comet fragment” called “Tunguska” hit Siberia on 3 July 1908 and leveled 1000 square kilometers of frozen northland. It blew up 6 km above the ground (about 20,000

feet, almost as high as jet airplane) and released the equivalent of in excess of 5 megatons worth of high explosive energy. More probably 15 megatons, Fay said.

“You can say 25 km and higher,” Spalding the engineer asserted, breaking my daydream, and sounding like a lawyer.

That was it. That was all I could say. But that was close enough. The air itself only goes up to about 50 km. That “25 km” was a little more than 2 times higher than an airplane flies.

I was back in the classroom, hallucinating the story to the 4th graders.

“Twice as high as an airplane,” I exclaimed loudly, to the kids in the class, as I wildly waved my outstretched arm and pointed with my finger, painting a path across the sky, showing how the meteor would be moving about as slow as an airplane far off in the clouds somewhere.

“Whah, light!” I exclaimed, as I suddenly opened both hands and moved both arms out and outstretched wide, with as sudden a surprise as I could emote.

“It's bright, as bright as the atomic bomb over Hiroshima.”

“Silent, you don't hear a thing. It looks like a basketball of light. Maybe a plate. Maybe a dish. In the sky. Ringed underneath with red lights moving.”

This was exactly what those old guys at Sandia told me. Those old guys were there and watched the atomic bombs. They described what atomic bombs looked like when they detonated them high in the sky. So, I knew that part of my story was accurate.

“Well?” Spalding asked.

Silently, I look down at the graph of light output versus time that Jacobs handed me. It had no intensity calibrations on it, no spectral information and had a time axis that was so coarse nobody could learn any more than “it flashed for a while, 10 or 30 seconds worth.”

“Nice,” I replied. “Thank you much. This is neat,” I replied

This was plenty enough UFO data for me to work with.

The rest of the day was a walk down memory lane, talking with former coworkers, wandering through their nice new offices, and noticing that only a few had the windows with the nice view. I wondered what my office would have been like. I wondered if I would be still be sane if I had stayed there.

I wandered by Gary Masters's office. I suspected he would be unfriendly. I always thought he didn't like me. Something I did. Some mannerism I had.

He was so thin. He had a nice office with nice paintings. But he controlled no money. He had no people working for him.

And he was so friendly to me. I could not figure it.

As I left the Sandia Lab complex, with the bright sun beating down as it always seemed to in Albuquerque, I started to daydream again. I was back in a classroom, my favorite place. That was where excited 4th graders focused on new concepts. The 4th graders were too young to be driven by the hormones of distraction I noticed in the eighth grade classes.

I was telling them stories with exciting, new, just declassified data. I had told them similar stories before, but I never knew that something as bright as the atomic bombs over Hiroshima and Nagasaki were hitting earth a dozen times a year. That was stunning.

My feet stepped over a sidewalk. Nameless people walked past me, on their way to the parking lot, on their way back, all just noise. I was daydreaming while awake.

I was back in my old office cubicle in the big room with 10 other people. Dave Henry was talking to me. The only time we cared about a meteor was if it got through our reject-it filter.

Dave Henry's deep voice echoed his mandate to me "A meteor is not an atomic bomb, and we only report atomic bombs."

I saw his crooked nose, his coarse and strongly communicating facial expressions and his beaming confidence in me as his colleague to make sure it would happen that way. I never bothered about meteors. No meteor ever got reported because none ever got through our reject-it filter while I was there.

Talking to myself almost audibly in the hot sun, walking slowly, my head rocking back and forth with each step because of the damaged neck C5 vertebra I got when I was 4 months old and my mother found me screaming on the floor instead of the crib, I told myself "And now, now I can tell people that a dozen times a year, something comes in from space, with no warning at all, and blows up in the sky with a force like that of Hiroshima, like an atomic bomb."

The Featured Evening Speaker, Me, after my exciting talk, and some intensely curious, intelligent people walk up to me and ask me about the meteor bomb. I tell them authoritatively "Some atomic bombs yield 1 kiloton of energy. Some yield 100 kilotons. Hiroshima and Nagasaki were between 10 and 20 kilotons. That's a hell of a meteor. That's damn scary."

I got scared thinking about it, as I walked past cars.

All kinds of UFO stories started to make sense. The hallucination quit. I went into an analytic mental state, Concept Space. Everything around me suddenly became as non-relevant as the sidewalk under my feet.

I pictured it. I chuckled out loud. The description sure looked like a UFO description. The meteors would come into our atmosphere from space. They would glow. They would take a somewhat curved path across the sky as they came in. Sometimes they would take a sudden turn because they would bounce off the air. They would skim off the atmosphere like a rock skimming on water. But they would move like a UFO. Sometimes the bounce would break them up in to two pieces, many pieces. Now we would have a squadron of UFOs. "Wow" I muttered aloud as I walked through a parking lot in the beating bright sun.

I was still in Concept Space, calculating the physics of it all. The meteors would be silent because they were too far away when we see them. Friends at this atomic bomb weapon lab told me they could see the white glowing light of an atomic bomb from a thousand miles away, when it was high enough in the sky.

"How high?" I wondered. Probably something as high as what Spalding said I could reveal. Something "25 km and up," he said. Any meteor that high up would be visible from 10 times as far away as it was up. That would be 250 km away I figured in my head.

"The whole state of New Mexico could see the flash," I mumbled, as I walked between cars parked in the hot pavement of the sprawling lot.

"But only a few people would be close enough to hear the boom," I muttered.

It was a physicist who asked me the question after my talk as the Featured Evening Speaker. No, maybe it would be a real estate agent. They're smart.

As we stood near the table I told him that the exploding meteors would typically be so high up in the sky that they would almost never generate a sonic boom.

"All you would see would be a bright thing moving across the horizon, as fast as an airplane," I told him.

"Then it would stop and get very bright," I added. "It's a hundred miles away. The sonic boom takes 5 seconds to go a mile. That's 500 seconds, almost 10 minutes. By that time it's all over and you went somewhere else," I told him, somewhat rehearsing what I would tell him, imagining what I would tell him, as I looked up and noticed I was walking aimlessly in some parking lot somewhere on the east side of the Sandia laboratory. I could not remember where I parked the car. It took me a long moment to recall what color my rent-a-car was.

I was in the wrong parking lot. Realizing somebody that had known me might recognize me by my rocking head walking

pattern and might be watching me from their window on the 4th floor of their new building, I tried to act like I knew exactly where I was going. I repointed myself, recalled exactly where the car should be and reset the automatic pilot.

Is my UFO picture right? People will listen to everything I say. I have to make sure everything I say is exactly right. Every detail.

I imagined, half calculated, how a meteor would spin so fast it would break apart. Or that it would slam the air so hard it would fly apart. Either way, pieces would then silently and suddenly each take a different direction. Each piece would glow. Each piece would silently travel across the sky, fast.

“How fast?” an engineer would ask. “Ten times faster than an airplane, ten times farther away. Sometimes closer, sometimes farther,” I answered, would answer, would answer authoritatively.

Deep in Concept Space, I checked what people had told me about what they had personally seen for themselves. Many people told me they saw things in the sky like that. Not one ever mentioned a sound. Nobody ever talked about sonic booms or sounds when they talked about UFO's. I specifically asked about sounds.

Several different people I knew personally told to me what they saw. The meteors from space seem to fit perfectly. Barry Short at the INEEL wanted to get rich by collecting one. He told me a whole story about how he saw it land “just over the hill.” He swore it landed just over the hill. He didn't hear any noises or booms, but he said he got some friends and went back there to try and find it. “They're worth more than gold. You could retire on it,” he exclaimed, smiling.

My sister Cathy's boyfriend the Chiropractor Homer Wall saw one. He described perfectly what I would see when a meteor would simply explode at higher than 25 km. He told me about a somewhat dull, glowing orange basketball in the sky, and how it slowly faded away.

Nancy my sister saw the light of one when she was younger, during 1970's or 1980's. She got scared and didn't tell anyone. The light from above her car lit up everything around her on the lonely farm road, “like someone had a searchlight shining on all the trees and fields and road around me,” she said.

Captain Sarraino saw one. He told me when he visited Livermore CA, circa 1976. “We saw it move across the sky. And then it took a sharp turn and went a different direction. We didn't hear a thing.”

I looked up and saw the water tower in the parking lot. My rent-a-car was there somewhere.

I pictured the meteor again. It was a dark rock in space headed right for Earth. How big?

This time I quickly calculated in my head how big a rock. “20 times less mass than the explosion. Rule of thumb. 100 kilotons means 5 kilotons of rock. Density 3.”

I stopped in my tracks, fumbled through my pocket, took out the calculator, punched in ‘cube root of 5000 divided by 3.’ The calculator read 11.8 meters. 35 feet.

“Size of a house,” I thought.

A rock from space about a big as a house would come racing in from space and hit the air. It smacks the atmosphere, like a high diver belly-flopping. Except that it's going so fast it's like a rock hitting a rock. Sparks fly. But it's going so fast the spark is white hot and as big as an atomic bomb.

All I had to do to figure the brightness of the meteor bomb was imagine what it would look like to watch an atomic bomb going off. Many people right here at this Sandia Labs had told me how they saw and felt what the light of an atomic bomb was like.

The light would sometimes be so bright that the people on the ground said “it lit up like daytime.” It would not need to be as bright as the sun to be like daytime because most of the atomic bombs were set off at night. Their eyes were completely adapted to night.

Sometimes a dull orange red fading fireball of a smaller one would look like a glowing basketball, bigger than the sun or moon, sometimes not moving at all, sometimes with lights around the outside. Some technicians who watched the old atmospheric tests at Frenchman's Flat at the Nevada Test Site told me of the lights on the outside of the fireball of an atomic bomb.

The event would not look anything like any meteor most us have seen. It would look like a big fat UFO.

These bomb meteors are rare events. Only a dozen per year hit, spread out over the whole world. Since 3/4 of the world is ocean, less than 4 per year hit over any land. There are 7 continents, so less than 1 hits a continent every two years. Rare events.

Some would look exactly like an atomic bomb, in the sky, far away. Almost exactly like a UFO.

I looked up from the pavement. I was still a bit lost. I had told myself to go to this parking lot. And here I was. The car was here somewhere.

“Where's the car?” I asked. I asked myself and that would trigger me to go find the answer. After I wandered around for a moment, I remembered what color the car was and where I had parked it, and I drove out. I was still composing a story for people.

Someone in the audience raised his voice and asked me “Why did we keep this a secret?” I knew that answer.

With a laugh and a smile I shouted back “We didn't tell anyone because we didn't want any Commie Pinko Rapist Atheists to know how well we could detect them, or that we were even watching.”

I had tried that “commie” line on a couple of different audiences. It typically didn’t work, and I did not really know why. Maybe I wasn’t saying it right.

Not everyone appreciated the humor of “Commie Pinko Rapist Atheist” punch line. It seemed that only those who remember the 1950’s seemed to catch it. The Soviets were “atheists” then, and in those days, that was very bad. Our side put “under God” in the pledge of allegiance, to combat those evil commie pinko atheists. There were a lot more atheists now. Maybe that’s why the punch line didn’t work.

The bad guys were “commies,” and commies were like the Nazi’s that got away. My audiences forgot that “commie” and “pinko” were epithet nicknames for our Cold War enemies. “Rapist” just sounded good.

Driving slowly out of the Kirtland Air Force Base, so I would not get a ticket, I kept practicing how I would tell the story. “Like an atomic bomb,” I declared to the audience. Drama. It’s a true story.

I would then tell them exactly why the meteor is the same as an atomic bomb, so they would understand that this is not some made-up story.

“Open the story with drama,” I said aloud, in the car

“A millisecond after the start of the explosion, the fireball is identical to an atomic bomb,” I said to the audience whose complete attention was focused on my every word.

“All the energy of motion in space is released when it smacks the air. All in one place. The energy is 10 or 100 times more than the weight of the rock, if the rock were high explosive. That’s the reason there are planets. The explosion energy is not enough to escape gravity,” I continued.

I lost them. The audience would not know what I was talking about.

“Nope,” I said aloud in the car.

“You got distracted. They don’t know what the weight of the rock has to do with anything,” I said aloud.

“They don’t know about high explosive. They don’t get the direct connection between the feeble energy of high explosives with chemical energies and the powerful grip of gravity, trapping and sucking everything tightly into giant balls like Earth, Jupiter, and the Sun,” the Mentor in my Concept Space told the Me who was speaking to the audience.

“Tell them less,” I the Mentor told the Me The Speaker.

Stopping at the main intersection with the firehouse on the corner and still inside the Kirtland Air Force base I pondered how much I should tell an audience, to keep their attention glued to me.

What would I tell them?

“You can’t tell the difference between an atomic bomb explosion and a meteor explosion. No, it’s not the radioactivity. The meteor has no radioactivity. But the radioactivity is not the killer. It’s the explosion that does the urban renewal.”

That “urban renewal” line always worked. Someone always chuckled when I said that.

“Shock em.” I said aloud, as I drove slowly towards the exit guard gate of the air base.

“If a meteor or atomic bomb actually hits a city, the city is gone, vaporized. Urban renewal happens, and a glassy melted surface appears where the sidewalk used to be. It’s the white hot blast that blows everything up,” I declared to the audience.

“The UFOs. Show them how you didn’t give a damn about their stupid hallucinations,” I muttered.

Walking a step or two across the stage, I brag, focusing my attention towards a few of the smarter ones in audience, whom I deliberately met before the talk, looking at them in a way that everyone can see. Everyone knows these are the important ones I am deferring to.

“We didn’t care what kind of UFO stories people made up. Abductions. Roswell invaders. We would hear their crazy stories on TV, but we just laughed at them. We knew what they were. They were just small asteroids crashing high in the atmosphere, 4 times higher than an airplane, exploding with the force of atomic bombs over Hiroshima.”

Then I would stop, and nonchalantly say “Besides, they don’t have a clearance.”

“That’s all bull,” I mumbled aloud, as I slowly accelerated past the guard gate, leaving the Atomic Bomb Weaponization Air Force Base behind me.

“I don’t remember a single meteor,” I muttered, realizing that I was practicing telling a lie to an audience that would believe me.

Not even once in 10 years did we make a mistake and wake the General in the Pentagon with false alarm, with some damn meteor bomb.

As I drove into the parking lot of the motel it hit me: An atomic bomb is nothing compared to a celestial object. Even a tiny one like a meteor only as big as a house.

Walking to the airplane to go back to Idaho I muttered the astonishing lesson:

“A dozen times a year, with the force of the atomic bombs over Hiroshima or Nagasaki, we get hit by meteors from space.”

1996.06.03

An Emmy

[S4 CH 053-Emmy-driver.doc](#)

Scene name time: Emmy

Scene: thanksgiving, Nov 1997, Carlsbad Inn, San Diego,

Expected: just saying hello

Unexpected result: 1997 we get an Emmy for the killer asteroid story

Color: I can't find it on internet;

His reaction: they find it for me

My reaction: I was totally surprised. we were on vacation in San Diego at our time share, on the beach at Carlsbad ca.; High self esteem happens.

What I decide to do next:

I sent them a long email from Carlsbad, and they replied that we got an Emmy.

The thing that got us an Emmy, for a TV Discovery Channel documentary, was moving killer asteroids out of the way. I provided one punch line for the show. The director and writers of the show accepted and picked up the Emmy. The star of the show didn't get the Emmy, nor did the players. Just the writers got the Emmy.

I had expected that I would get some time on camera, and that Dr. David Morrison would get most. I didn't know that Gene Shoemaker was the star of the show, at all. I went to Las Vegas and did the show because they asked, and paid my way.

Only the star of the show got more on-camera time than me. I did not expect that I would get that much time. the INEEL guys said I got 8.5 minutes out of the show. "that was a lot" she said to the senior fellow at the INEEL public relations.

We got an Emmy for the work. And because of Bill Guynot, INEEL is not mentioned anywhere.

I had moved from technologically advanced San Diego to that god-forsaken, ugly, crude and frigid desert called Idaho, to a rather backwards and ineffective reactor test site posing as a national lab.

I left San Diego for one purpose and only one purpose: make rockets so that Humans Could Occupy the Solar System. Electric rockets. Thermal rockets. Any kind of rocket.

I discovered a way to make space ships as big as ocean liners, with nuclear rockets and space water. The Idaho facility had the only charter, the only government money and the only facilities to do it. But Lockheed Corporation, the new contractor, wanted nothing to do with it, and told me so.

VP Guynot Forbids Use of INEEL Name

I recalled the horrible pain, the start of the end, the interaction that signaled Terri and I were headed for some rough times.

When Ultrascience had called me for their TV doco shoot, it was thrilling, exciting. I would get to publicize INEEL to more people in one shot than all the school presentations and Kiwanis clubs that I ever did for INEEL. I could talk to the whole state of Idaho all at once, the whole Western Rocky Mountain States, the whole USA. The Public Relations department would love it.

I had asked Peta Newbold, the Field Director, to ask the President of the national laboratory, John Thensome, to bless my participation in the shoot.

All excited, I went to tell the Vice President of Research at INEEL, Dr. Bill Guynot. I told him about the TV doco and our role. I told him how INEEL would be able to lead the research and development of the premier propulsion system that would enable *Humans To Occupy The Solar System*, and how we at the INEEL had invented it. I told him of the recent discoveries of rocket fuel, water, in the space accessible to humans. I told how both the DOD and the DOE funded us for a key workshop.

And he said if I wanted to go do that I would have to pay my own way. He said he did not want to pay for my time and that we didn't need the publicity.

My email explained it when I tried to decline a speaking engagement:

Date: Wed, 22 May 1996 06:42:41 -0700
To: SIA
From: zca@morlock.inel.gov (anthony zuppero)
Subject: regret cancel Utah State space engagement
Cc:
Bcc:
X-Attachments:
Hi Ali,

Unfortunately, I can not go to Utah State and must withdraw my talk.

Bill Guynot, the Vice President of the AEDL, expressed strongly unfavorable desires relative to using the INEL name on space nuclear propulsion or space related activities at the INEL. He disavowed the Space Exploration Initiative work as "4 years old," and therefore not relevant. He said there was no program, no money and no plans to become involved in this topic, relative to INEL management. If anyone should ask about it, INEL is not interested.

Guynot's action was prompted by a request from an Australian TV production company to give INEL, through me, some free exposure on a Discovery Channel / Learning Channel on a program about asteroids and comets and the possible effects of a collision with Earth, and the technologies which may be available for deflecting or removing the threat. The Producer / Director, Peta Newbold, asked John Denson, President of Lockheed Idaho Technologies Corporation, for support to let "Dr. Zuppero to travel to another location," and to ask for help with the video from Lockheed Martin.

I asked John Martinell, a Director in the Business Development group to clarify, and he said that INEL management had agreed with the DOE to tightly focus its activities and to act according to the principle of a "Osystem of labs." The direction for the INEL is to be a "national environmental engineering laboratory," and this apparently excludes space-nuclear related activities.

I indicated to John that I could agree to not mention INEL or to represent the INEL in space nuclear activities, and that my further involvement would be as a hobby or as a personal professional interest.

To go to Utah State would consume at least one of my Personal Leave days. The current employment down-spiral here at the INEL would suggest that discretionary, Personal Leave be reserved for mortgage-critical activities.

I thoroughly enjoyed talking about space with students. The topic seems to draw interest inversely proportional to age. The more you expect to live long enough to see it affect your daily life, the more you want to hear or be involved with space. I had a very good audience of 650 children two weeks ago at the Sunnyside Elementary, grades K thru 6. Forty years from now they expect to be just getting started. In sharp contrast, four years from now a significant fraction of INEL personnel expect to be not employed here, and fourteen years from now a significant fraction of INEL management expects to be retired and waiting to die.

The time constant for interest seems to dominate. My time constant seems to be getting shorter, too. I took a risk by coming to the INEL. I gambled my professional future on this very isolated laboratory, and that the INEL would be able to provide a space nuclear propulsion future. This gamble has turned negative.

I hope that some day we can find something in the space beyond GEO that can be more profitable than doing the same thing on Earth.

Thanks, Ali, for your continued interest.

Tony Zuppero
22 May 96.

Maybe I made a mistake. Maybe I should have had the Public Relations office go ask him instead of me, or have them go with me. The Public Relations Office had been paying my way to talk to people since 1991.

Maybe because of my mistake, I went away mad and not even realizing there might have been a way to get the complete and enthusiastic support of the lab.

Guynot's repeated ineffective behavior on past occasions was the real reason I kept the INEEL name off the program. It was a fitting payment for gross mismanagement, although it was a bad strategy on my part.

My logic was that since Lockheed Martin, the contractor in charge of INEEL, had a manager who could not see any value in its scientists publicizing the INEL name, and would not support the

publicity effort, then I would not give him the benefit of the publicity.

This particular Vice President of a Department of Energy national lab had a reputation. More than one of his own, Lockheed imported managers told me Guynot was one of the less effective he had ever met in that position. Some used invectives and four letter words to emphasize "the least effective." Others I had experienced a similar fate with him before.

He had caused damage to the other projects I was on when he interacted in Washington with heads of huge government agencies, such as FEMA, and with heads of major insurance companies, like the President of State Farm and several of his equals of other, major insurance and risk assessment companies. He thoroughly embarrassed us with his ineffectiveness and with his botching of major strategic moves for the INEEL.

I decided to deliberately leave off the name of and all references to the INEEL, and only because of the principle that one can not reward incompetence. He reported to us, the taxpayers.

My decision was also ineffective.

However, we workers, creators, physicists, engineers, we do choose our bosses. They better not forget that.

The moral of the story is that when a company comes in and takes over, they take 5 years to learn.

So, go somewhere else.

By the way, Lockheed Martin lost the contract because of the continuous bungling they did. Bungling the magnificent positive exposure I could have brought was small compared to the other things they screwed up at the National Lab.

John Thensome bragged one day "Lockheed does not loose a contract. Once they get a contract, they keep it."

He was the first to loose one, and a big one, too. His bungling management caused them to loose several hundred million, *out of profit*, on a clean-up, INEEL contract.

One time he was supposed to go visit an astronaut and the Insurance Commissioner of Florida, to seal a deal for a project. Instead, he got drunk in Atlanta.

That was Lockheed-Martin in Idaho.

They wasted the PR of the Emmy.

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Steam Rockets Deflecting Killer Asteroids

The three brown horses in the 5 acre field to the north of the parking lot were chasing each other again. The clouds above them in the whiteish blue sky were thin, ill defined, wispy. When I stared at the horizon, the concept of Eternity seemed to come up. The mountains towards Yellowstone National Park made the horizon jagged with a grey outline. The huge lake that had been here and burst not more than a million or two years ago seemed to appear like a ghost. And the black space beyond the horizon stretched beyond the farthest galaxy, to Infinity.

Sitting at my desk, daydreaming out the window, I was getting ready for a gig, a talk, a presentation to non-technicals. I would be the featured evening speaker with an audience of adults. The person responsible for getting speakers imported me to entertain them. They were not rocket scientists at all.

Everything had finally come together. I wanted to tell someone. But Gene Shoemaker died, and everything came together too late.

How could I get that audience to ask me to tell them about it? Silently I rehearsed a ploy I could use. I would start the talk with a question:

“I give you a choice. I can tell you about

-- how NASA and the Department of Energy would go to Mars,

-- or about killer asteroids
and how we could be heroes and deflect them,”

Which story do you want to hear?”

“Killer asteroids,” someone would volunteer.

The way I would inflect my voice when I gave them the choices would send a subliminal message that I wanted to talk about killer asteroids. Often enough, audiences readily took such a hint. This ploy almost always worked.

“Great. You are like the 4th graders. They always want to hear about killer asteroids,” I would say. They would laugh a little, and I would entertain them with my choice they helped choose.

But Gene Shoemaker died. I still could not get over it. We had been working together on a scheme to use comets to deflect killer asteroids.

Gene loved comets. He loved the idea that we could use comet water for something, for anything. Nobody else cared.

I would use comet water for occupying the Inner Solar System, from Mercury to Saturn, with my nuclear heated steam rockets.

At the time, we were trying to figure out a way to move killer asteroids out of the way, out of a collision course with Earth. It was a popular topic. Hollywood released three movies about it during the last two years.

Gene was like the technical guru of the near Earth Asteroid group. Famous, he was a space geologist who trained every astronaut who went to the moon on space geology. He was one of the choosers, one who picked who got to go to the moon. Everybody listened to Gene.

One way to knock a killer asteroid out of a collision with Earth would be to attach a rocket to the asteroid. For example, idiots would suggest we just land a steam rocket on the asteroid and just have the rocket slowly push the killer asteroid out of the way. I told that 1992 meeting on killer asteroid deflection, at Los Alamos exactly that, and nobody was smart enough to call me an idiot. There were plenty NASA guys there would have done just that, if they were smart enough.

Unfortunately, landing on a random asteroid would be rather difficult because *we would have to land on it*. How would we do that?

Only Hollywood could do that. They made a movie where some macho hero landed a shuttle on a comet. His Shuttle bounced around and bonked on space rocks. If that would have been my car, it would have been totaled. But not the Hero's Shuttle.

In fact, the Shuttle with the Hero would smash into the comet so hard that it would never get a chance to be blown to bits. It would vaporize instead.

That's how Gene and I and Bill Tedeschii of Sandia found out how to move celestial bodies without using atomic bombs.

We were clever.

We knew that if you were in one orbit around the sun and something else was in another orbit, and your orbits crossed, and you timed it just right, you would meet up with the something else in that other orbit. And, if you or the other guy didn't put on the space brakes, you would crash.

Your crash speed would be huge, so huge that when small things crash into big things, the small thing mostly disintegrates

completely. The energy of the collision is like inside the fireball of an atomic bomb 5 milliseconds after it detonates.

Nearly anyone could calculate that. Gene did, a decade or two earlier.

Gene had calculated the "velocity mismatch" between any two typical orbiting things one might find in orbit in the Inner Solar System. The things could be asteroids, comets, planets, Earth, Mars, or a space probe.

The "velocity mismatch" was the speed they were moving past each other when they almost crash into each other. A rocket or a landing craft would have to accelerate and change its speed by that much velocity to stop and land. Gene's equations showed it was most often between 5 and 25 kilometers per second.

Well, "5" was a lot. Nobody knew how to get "25"

The way I get to land on and use near-earth comets is to find one where the landing speed is 1 or 2, not 5. We found many like that. Most would take between 5 and 25.

And that is how we won the game.

"How about if we just crash into it?" I said to Gene. That's what Johndale Solem told a whole room full of us during that 1992 meeting on killer asteroid deflection, at Los Alamos. It was not a very original idea for us. Johndale said it first.

And that was the first Eureka. It was instantly obvious. It would work. We were both a little surprised at the obviousness of the answer.

"Crash into the killer asteroid with a heavy payload. From a comet. A near Earth comet."

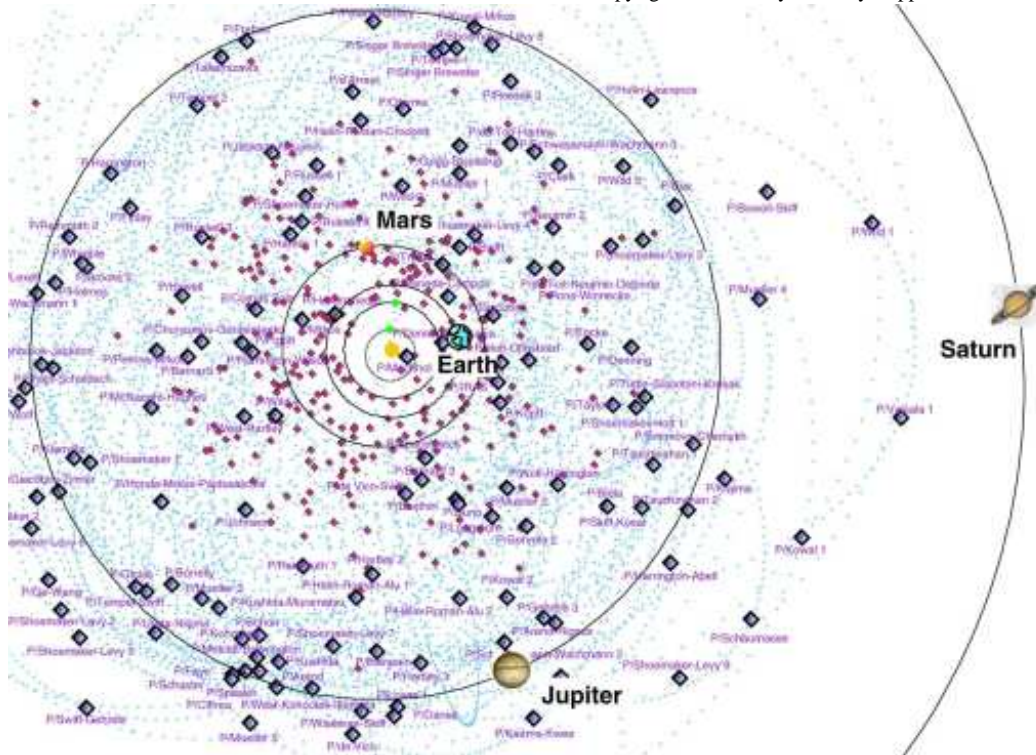
It was a brilliant idea. No one person invented it.

It was obvious after everyone's puzzle piece was on the table.

But implementing it was only obvious to Gene and me. Gene and I both knew that there was a swarm of near Earth comets between Jupiter and Mars. We knew of about 150 of them. With 150 to choose from, we would nearly always be able to find one with a convenient orbit.

We knew that I could land my steam rocket on some small, reasonable fraction of them. Gene knew it because he had calculated the "velocity mismatch."

Nearly everybody else didn't even know that they were there. The remaining few only knew there were many of them. Only a handful of people in the world knew *exactly* where they were and how convenient they were. Gene and I both had data and pictures. As far as we were concerned, they were "everywhere," accessible and approximately in the right place.



One can almost always find a comet in the right place.

Water stations. Water was my rocket propellant. Comets were the ice balls.

Gene knew I could shove 10,000 tons of water ice back to Earth orbit for us to Occupy the Solar System. He checked the calculations. But he died.

Gene died.

Smashed in a car wreck. In Australia, on a trip to look at a meteor crater somewhere in the outback. On a narrow crossroad. Driving on the wrong side of the road, for him. They drive on the wrong side in Australia. Probably not paying complete attention. Caroline was with him. She lived. He died. Big truck hit him. Blood everywhere. I wasn't there.

Nobody paid much attention to my bringing back 10,000 tons of water ice to Earth orbit, either. Nobody was seriously going into space, and nobody was even planning to Occupy the Solar System. So, nobody needed the 10,000 ton, 2 million gallon water tank out there.

I didn't help the situation, either. People quickly concluded my schemes were a bit outrageous when I would show them the calculations.

To deliver 10,000 tons of water ice or oil shale to Earth, I would have to use up to 300,000 tons of comet water as propellant. That was a huge amount, completely outrageous. Fanciful. Completely insane.

That's why Gene and I won.

"That's not so hard to do. The comet is made of ice," I would say about my 300,000 tons, defending myself.

"It's only a chunk about as big as a football field," I would say, visualizing a nuclear reactor about the size of a full size pickup truck, with a 100 ton bag attached, to hold the water.

Eyes would roll. Rocket scientists would suddenly stop asking me questions about it. They would just say "oh," and politely wander away to talk with someone else.

"They never did the calculations," I would complain, to explain to friends and believers.

"They" never did. If "they" would have done the calculations they would have seen that melting 300,000 tons of hyper-frozen, black-space cold ice would not be that hard if you had a nice, compact nuclear reactor with you.

(Rocket Science: it would take about 50 megawatts of heat for 6 months to melt the 300,000 tons of hyper cold ice and to vaporize it and re-condense it to separate it from dust and junk. Running one of the nuclear rocket engines at "idle" would do it. The engines would typically run at 300 Megawatts. The engine size would be about like that of a full size pickup truck.)

We at the Department of Energy had just such a nice, compact nuclear reactor. In our minds we had them. If you would pay for one. Nobody had paid for one of those space reactors since the 1960's, early 1970's.

But Gene knew. And Gene calculated.

Bill Tedeschii at Sandia knew. He calculated.

Tom Larson at the INEEL knew. He calculated in detail, careful detail, meticulous detail.

Gene liked my story on how I would use comet water to propel a bag of comet dust to knock a killer asteroid out of the way. Gene agreed to write a paper with me on the scheme, with Bill Tedeschii as a co-author. One of us would present it. We didn't care who. We were working on it.

But Gene died. I looked out the window again. I was still not over it. Infinity was behind the white-grey-blue sky at that northern horizon, up by Yellowstone. Infinity was past the horizon, deep in the black of space, extending out forever, farther than ever.

Almost as soon as we had said "just crash it into it," crash into the killer neo, crash the whole 300,000 ton bag, Gene and I both realized what the result would be. It would be huge, wonderful, unmatched. We would make an order of magnitude more difference compared to the other guys schemes, what our colleagues were proposing.

If we crashed a 300,000 ton space ship into a killer neo at the typical velocity that Gene's equation showed, the result would be almost as much as hitting it with a 100 megaton bomb.

Nobody ever made a nuclear bomb that big. Not even the Russians.

"Yeah, we should write that up," Gene said. I agreed.

We all had other things to do, to make a living. That is why neither of us did much on it. In addition, nobody knew of any killer asteroid headed for Earth. We all knew that the chances of a killer headed our way were less than once in a 100,000 years to get hit by one.

Even if it did hit, it would probably hit some other continent, not ours. That was just the way probabilities turned out.

We would figure out the details of our comet-water, Earth-saving scheme in our spare moments. It wasn't that hard. It was rocket science.

Looking out the window, I saw the jet airplane coming in for its scheduled afternoon landing at the Idaho Falls Airport, from Salt Lake. It reminded me of when I had done this calculation before.

Calculating on an airplane, for diversion on a trip to somewhere a few months earlier, I had imagined we were docked on one of Gene's near Earth comets, picking up a load of water. And also, we agreed to sign a minor, one time contract to toss a bag of dust at some near earth asteroid, to knock it out of the way.

In my mind, we told the NASA guys how we would load up a few of the big payload bags with comet dust instead of water. A million tons of comet dust.

"We would pump the bag full with our left-over mud slush, left over from our water vaporizer, condensing purifier machine," we told them.

"No, that would not work," I thought. The comet dust would cake up. I wanted something that could disperse into a dust cloud.

I was imagining the conversation and had to make up something that would work.

"We would fill the bag with a megaton of ultrafine comet dust," we told them. They liked that.

Then we would launch away from the near earth comet and aim the bag of dust at the killer neo. It would fall from way out by Jupiter's orbit.

We would explain to NASA how the bag of dust would fall under the Sun's strong gravity from out by Jupiter all the way to near the killer asteroid. The dust bag would gain 8 or 9 km/s of energy, just by falling towards the sun. Huge.

When the dust bag got close to the killer neo, just before it would crash into it, we would burst the bag and make a small cloud of dust. A mile across. A kilometer across. The cloud would be about the size of the killer neo.

Then the cloud of dust would smash directly into the neo.

"Advantageously," as patent people would say, the cloud of dust, moving at a relative velocity between 5 and 25 km/s to the target, would smash into the neo like a blanket of hand grenades. The 1,000,000 tons of impacting dust would knock asteroid as if it were hit with 10 to 100 megatons of hand grenades.

It would knock the killer asteroid a little, enough to miss Earth.

"A million tons?" I thought. I had used 1,000,000 on the airplane, instead of 300,000 in front of me on my desk, because it was easier to figure. That was three times more mass than I had presented to Gene and his near earth asteroid buddies at that 3 July 1990 conference.

"Oh Well. Not that big. Ship would be 500 tons, or 1000 tons. Not that big," I thought.

Sitting in my airplane seat, I had also calculated how much. How much would it move it? How much would a million tons of dust smashing into a 1 kilometer asteroid move it?

Suspense. Would it be enough? Or would I have to try something else?

The pocket calculator displayed my estimate of how much we could move a killer neo. It was enough. Barely enough.

But it wasn't quite enough. If the velocity mismatch happened to be at the lower end, or if the killer neo were bigger than a kilometer across, as many are, it would not be enough.

Sometimes the killer neo would still hit Earth. People would die. Babies would be smashed. Maybe all the people on a continent would die. Bad.

Oh well. If we made the payload a bit bigger, maybe that would work. Gene and I would only do this in our spare time.

From my desk at the INEEL, occasionally staring out the window, I quickly repeated the calculations I had done on the airplane. This time, I used a spreadsheet on the computer in front of me. Everything appeared to work.

My computer screen displayed some notes I took when talking to Tedescii. A few months earlier, while talking with Bill Tedescii of Sandia Labs, I asked him what would happen when hypervelocity dust hits a target.

He was doing just that kind of experiment for the Pentagon, the Defense Department. Tedescii's task was to find out the physics of space interceptors hitting the bad guy's bad missile headed for my home and my family.

One of the questions that needed an answer was what happens if the good guys would just throw a cloud of sand into the sky and at the right place in the sky so that the bad guy's missile would fly through it, into it. Would sand grains wreck the bad guy's missile?

"It multiplies," he exclaimed, excited for some reason.

"It multiplies," Tedescii repeated, "the momentum multiplies," he said, clearly excited that someone cared about what he found.

"What do you mean?" I asked.

"The dust grains hit the target surface and make the target surface explode. The dust grain blasts a tiny hole in the target. It dislodges some mass. The dust is delivering energy. The momentum multiplies!" he explained and exclaimed.

That was interesting. The dust was delivering energy. Not just momentum, but energy. It was making the target become its own high explosive. The dust grains were moving so fast they made little sparks when they smashed into the target. Sparks with 10 times the energy of high explosive. Not so little. Easy calculation.

Instantly I saw what he was talking about.

That was the final Eureka.

"How much does it multiply?" I asked.

"An order of magnitude," he replied.

Wow.

After I asked him some pointed questions, it turned out that we could reliably multiply the momentum, the shove, the push on the killer asteroid, by about 5. Maybe we could get 9 under some conditions.

I realized immediately that my megaton of dust would act like a Gigaton bomb. And we would never need to launch any nuclear bomb at all.

NO bombs at all.

What was even more intriguing was the fact that we would not need to care what kind of target it was. No matter what it was made of, our dust would explode its surface and knock it out of the way a bit. The killer asteroid was just like the bad guy's missile.

My competition, the other guys were proposing to use an atomic bomb to blast the killer neo out of the way. They discovered that if the killer neo was hard, it would definitely be harder than they liked. If the killer asteroid was a stone meteor or worse, a metal meteor, then the bomb would not blow up enough meteor to shove it enough out of the way to miss Earth. It would only be enough if the killer asteroid were crunchy, like dried clay.

The other space researchers would need a much bigger bomb to knock a hard asteroid off course than to knock a soft one.

Not us.

The bad news for them was that the atomic bomb approach would need the biggest bomb we could imagine, a "Gigaton bomb," like Dr. Edward Teller said.

But not us.

"We don't need no bomb," I thought, chuckling to myself as I imagined what I would say to the audience.

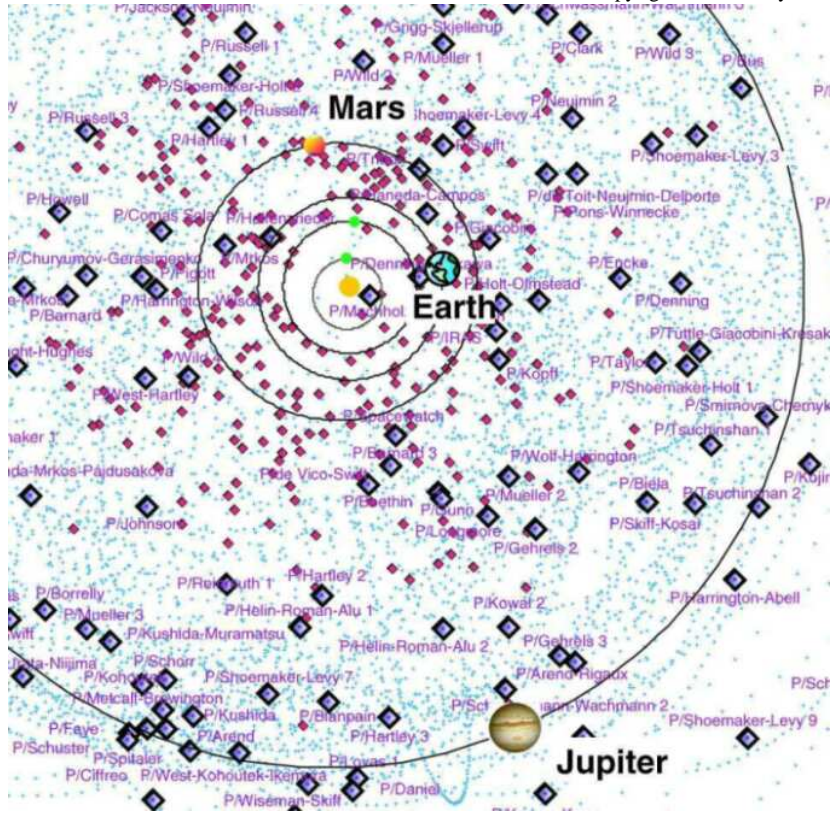
I had told Gene how the lights went on when Bill Tedescii at Sandia told me how the momentum multiplied.

When I calculated it, I realized that the million tons of dust would act almost as good as a billion ton atomic bomb.

I was elated. Gene was elated. But Gene died.

I was staring out the window. I was still not over it. The feeling was as if he were alive and just asleep in a hospital bed, just not awake.

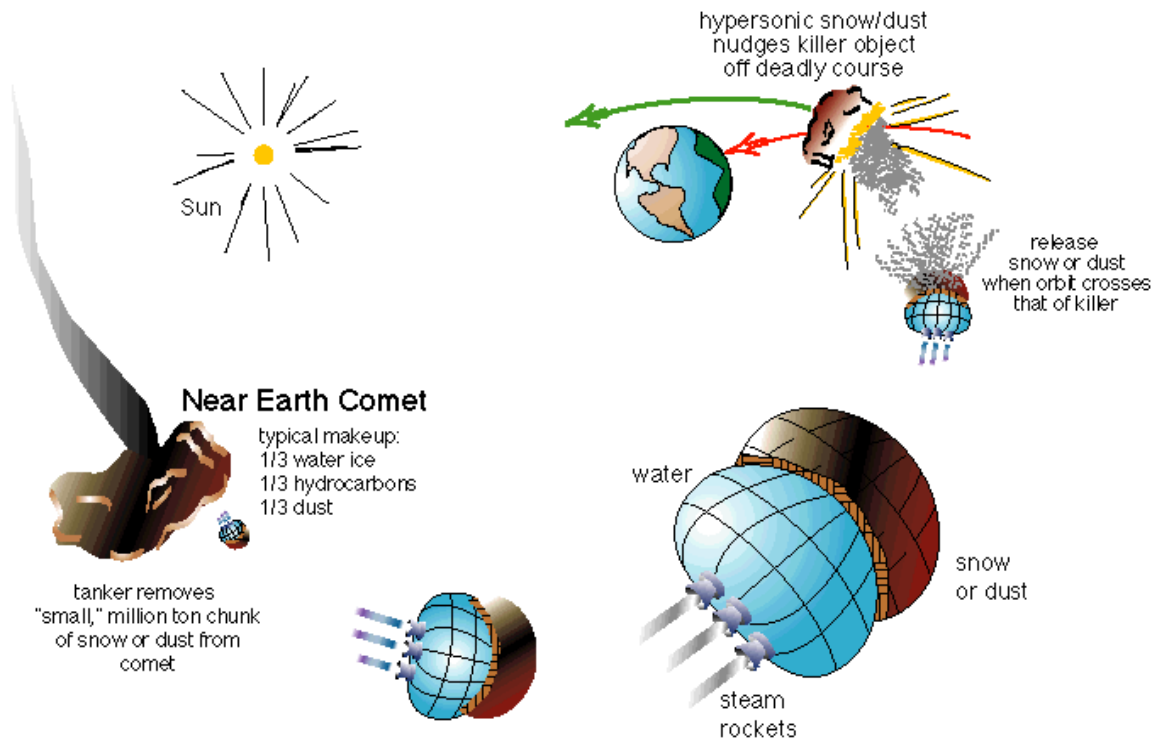
Trying to focus, I prepared a talk. The first part was the usual story, the scary story, the one where I show the picture of how Earth is in the middle of a killer asteroid swarm.



Earth in the middle of a swarm of potential killers

The rest of the story would be us as heroes, saving the world.

Deflect Celestial Objects by Leveraging NEO Resources



if it accidentally blows up on launch.”

Mars Nazi's

When I would talk to groups interested in space there would always be a strong Mars contingent. We called them “Mars Nazi's.” All they would ever do was shout “Mars, Mars, Mars, Mars.”

For them I would volunteer
"this is no more expensive than
going to Mars for no damn reason.”

Shock would always wake up an audience sedated by a big meal. I had a ready shocker to jolt them.

“An atomic bomb is the
cheapest way to move small asteroids.

"You need a Gigaton Bomb.
That's a 1000 Megatons of bomb. "

After only a short pause:

"Blow up all of Florida all at once

Another twist, slightly shocking would be:

“We hope the big ones don't hit,
because we just can't do anything much about it.

Even if we have 5 years notice,
all we can do right now
is store food and
evacuate the continents it will hit.”

I had tried that one on test audiences. The silence of the audience and their wide open eyes let me know they got the joke, or the reality, of “evacuate the continent...”

I was ready to talk about it. I was not ready to write a paper about it.

Nobody really cared.

And anyway, Gene died.

Lunar Prospector

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The era of the NASA Lunar Prospector tbd

prospector

Ice on the Moons

The era of the Lunar Prospector

Scene name time: L P Launched

Scene: on the phone, trying to get data from the LP team

Expected: I would find out, so I could plan

Unexpected result: nobody says a word, no leaks

Color:

His reaction:

My reaction:

What I decide to do next:

Alan Binder actually does launch the lunar prospector. We had been waiting it and him to win. Without water in space we are done for. We would go away.

I fret, persevere that:

it's too far to go to even the near earth asteroids to hunt for water.

Cooking them would work, but the missions are too long. they all have to be manned.

Even to the moon is extremely expensive.

Late 1997, we try to pry data from Binder. He won't budge. No data at all. I call Feldman at LANL. He won't budge. I call Blacic at LANL. He won't budge either. There is just no way to know what they found. We have to wait.

I had only met Feldman once. I have had frequent meetings and conversations with Blacic.

Scene name time: 19980226LMPaloAlto "LM Palo Alto Cooologia"

Scene: spkr at Lockheed Martin Palo Alto Colloquia, on moon ice;

Expected: I would get flack from LM people, all experts

Unexpected result: they like it very well

Color: lights went out. could not have supper with Maximowciz

His reaction:

My reaction:

What I decide to do next:

Scene name time: 19980226LMPaloAlto KCBS AM 740 News radio

Scene: KCBS AM 740 News radio spoke 3 minutes on San Francisco news radio KCBS AM 740

Expected: I would do as well as I did in Boise, Idaho

Unexpected result: I stammered

Color: (fucked it up)

His reaction: cut off communication

My reaction: dissapointment

What I decide to do next: practice more

Scene name time: 1998, a day with Alan Binder

Scene: 19980227missioncontrol Alan Binder, Lunar Prospector Mission Control, NASA Ames, Moffet Field, next to that big wind tunnel, with Cathy C. C. Culver and David Swanson

Expected: cold treatment

Unexpected result: he was so friendly and like a colleague; he told me the real story

Color:

His reaction:

My reaction:

What I decide to do next:

The Real Story He had been planning the lunar prospector for a long time, many years, with Gregg Maryniak and others, as a private mission. NASA hated it. it was not NASA.

He submitted an unsolicited proposal to NASA. They sent a "no, don't want to" letter, but then realized that they were legally required to consider the proposal. So they did. They assigned a budget type person to it. When Discovery Program AO (announcement of opportunity) was announced, he decided to decline to submit, until a friend of his said he had to. So he did. Because the choosers were an outside panel, he won. He had said "if an outside panel were the decidedrs, he would surely win. And he did.

The mission control has a Sun terminal (I think) with lots of windows on a big screen monitor. This is Alan's screen it has the propulsion and power windows highlighted. This is a simple satellite. No on board computer. No tape drive to store data. Cathy Cutler

complex missions

Scene name time: circa Feb 1998, Lunar Prospector Announces results

Scene: Just before the announcement of the Lunar Prospector results, at my house, by the satellite TV receiver, Schnitzler and I agree on how much it takes for us to be happy. How little it takes for us to be mad. I think John Rice was there, but I can't remember. We say "300 Megatons" would make us be undecided.

expected: binder will announce either trace water ice or huge water ice.

this is the decisive moment. We will know for sure whether we should go forward with full force, or stop.

unexpected result: Then Binder announces on satellite TV, 300 megatons. Exactly the amount that we said would be indecisive.

color:

my reaction: frustration

what I decide to do next: instead of planniung a media event or abandoning it, we must go back to the drawing board for strategy.

Why was I so dumb?

I could have had a media event just waiting, one that would show how the DOE and INEEL would take 1000 people to mars every month with the ice. Even 300 M tons would do it.

But no. All I did was silence. Not enough balls. the failure was that I thought too low, too weak. I had all the pieces to make it just work like crazy. Even an emmy.

Scene name time: 1998 Jack Schmitt

Scene: Last Astronaut on the Moon, Dr. Senator "Jack" Harrison Schmitt says to me over the phone. 1998 early on, Lunar Prospector just announced 300 M tons, then ups it to 10 G tons. what they say is there: 1% of the dirt is ice. or, 1/9 of 1% is hydrogen.

expected: Jack Schmitt will say water changes everything. He will support steam rocket.

unexpected result: he denies what they see is water, just like NASA is doing. He refuses to believe or admit there might be water.

color:

• **his reaction:** "boil the dirt for its Helium 3 and hydrogen" his favorite and only answer is to hunt for fusion reactor fuel so he can save the world by supplying it with unlimited energy. Then says there could be 1% hydrogen.

my reaction: If that 1 % is true, we don't have a moon of any value. I calculate that if the water is only 1% of the dirt, my steam rocket can't use it much because you have to heat 100 tons dirt for 1 ton water. to get a mere 10 000 tons you would need to move a cubic football field. That is too much. And 10 000 tons of ice is not enough to do anything.

what I decide to do next: Abandon Jack Schmitt as a reasoning person.

I also decide not to pursue moon ice with vigor.

Scene name time: Early 1998, York Films starts "If we had no moon"

Scene: telephone with Discovery Channel people, York Films.

Expected:

Unexpected result: the Discovery channel guys want me to say if we had no moon we would be screwed

Color:

His reaction:

My reaction: I can't say that because I don't believe it. I can't. it is not correct.

What I decide to do next: try to find a way to say the moon is rocket fuel. compose a way to say it.

I am supposed to say that the moon is rocket fuel, and without the moon we could not go to space cheap. but the only part of the calculation that works is if the moon has water icebergs, not permafrost. it has to be real ice in big, house-sized chunks. just moon alone.

the planet mercury has big ice lakes. why is mercury different from moon? well, binder will tell me that there are lots of reasons. but there ought to be ice at the moon's poles. if not, then we have to go to near earth rocks to get water. They aren't that far, but they are far enough that it is no 1 week journey. going to a near earth rock is a major space program.

you could indeed do it solar, entirely, not nuclearly. that is a curious thing.

solar heated steam rockets may indeed work, especially because a near earth rock has negligible gravity. that's the key thing you need. no gravity. you could do the whole thing with miniature devices, miniature robots.

why didn't I think of that long ago? it would make the market and path for semi-autonomous robotics flourish. you could send 1 kilogram devices out there to do prospecting. they could fill their bags with water and come home. no nuclear at all.

no nukes

scales down

much closer than mars

always sunny

hey.

but no one cared. and I was exhausted going this route.

we need moon ice. huge glacier lakes of it, even if they are buried under layers of moon dirt.
we need lakes of moon ice. then we can occupy space with a reason.

with lakes of ice, a near earth rock, non-nuke, solar, scalable program has a reason to exist.

I need to see a reason to appear.

19980226LMPaloAlto "LM Palo Alto Coooquia" dickinson KCBS AM 740 News radio spkr at Lockheed Martin
Palo Alto Colloquia, on moon ice; spoke 3 minutes on San Francisco news radio KCBS AM 740 (fucked it up)

19980227missioncontrol Alan Binder, Lunar Prospector Mission Control, NASA Ames, Moffet Field, next to that big
wind tunnel, with Cathy C. C. Culver and David Swanson

Water In Space And the Zup Steam Rockets

The sky was deep blue, like it usually was on an April day in Albuquerque, New Mexico. It was warm enough in the morning to walk with no jacket. It was cool enough at noon to keep the suit jacket on without getting hot. Rocket scientists and Wanna-Be-Space-Cadets were converging on the Albuquerque Hilton Hotel. I was completely anxious, chomping at the bit, excited, armed with data, new data, exciting data, with all the puzzle pieces in place. "We now have everything for Humans To Occupy the Solar System." That message kept ringing as the single "focus, focus, focus" in my head.

It was an older hotel, not the smooth granite marble type that big corporations and their marketing types choose, but a 1970's type of clean, manicured, southwestern style, adobe-like, perfectly constructed meeting place, very much like a Santa Fe look. The look was a mix of Western European American, Native American and Conquistador Spanish architecture. The windows were deliberately designed so the sun would blast into big, Western European rooms painted with Big Texan, light color walls and would illuminate Spanish, shiny gold-brass, Native American symbols laced with turquoise. One could feel the proud satisfaction of the three cultures who proudly conquered this cross-road state.

This was not Mexico, but "New Mexico, USA." One does not need a passport travel in a state of the USA. New Mexico had been a state for more than a century. This was the USA.

We were at the intersection of interstate highways I-40 and I-25. Take the north freeway to Santa Fe, and get to Los Alamos National Lab, the birthplace of the atomic bomb and NERVA, the first nuclear rocket.

Take the south freeway and you go to White Sands New Mexico where the first Atomic Bomb was detonated.

Go east through the pass between the Sandia and Manzano mountains and you are on your way to Texas, and Amarillo where during the 1960's they put together atomic bombs.

Go west 100 miles and you go into a time warp where in 1.5 hours of time travel in a car you materialize in the Native American territory like it was during 1950, or 1940, or 1930, depending on how many feet off the highway you wander.

Go down a few miles under the ground and you get the recent lava that made the string of volcanoes along the Rio Grande and lining the west boundary of Albuquerque.

Go up 100 miles through the intense, clear, deep blue sky and you get to the black of space. I could see all these as we flew in.

This was the "Space98" meeting sponsored by the American Society of Mechanical Engineers.

NASA was not the organizer at all.

NASA tagged along anyway and held it's "In Situ Resource Utilization" meeting the next morning after the 3 day Space98 meeting. That way, creative rocket science and space science people would already be here.

NASA did not have any money to pay for rocket scientists to come to the meeting about the Human Occupation of the Solar System. NASA only had money for the Space Station. This meeting was definitely not about the Space Station in any way.

Nearly everyone here was here to enable the Human Occupation of Space.

NASA's Boss, Dan Goldin, had declared that the "Human Occupation of Space" was his objective. So, NASA itself had to tag along.

NASA wanted sports events in space, not "human occupation."

The meeting organizers chose a simple hotel with a dozen or so floors in the main building, with an almost completely enclosed compound surrounded on three sides by 2 story motel rooms. The sun shined brightly in the courtyard. I recalled when two years earlier I ate supper in this very courtyard with Harrison Schmitt, the last man in the moon, when they filled the courtyard with food tables at dusk.

This time, this meeting, I knew that we humans had discovered everything we needed to start the Human Occupation of Space. We needed massive quantities of something to use as propellant for the rockets. And we needed it close, close to Earth.

We found it. On the moon. The NASA space probe Lunar Prospector measured how much water, even if it did not know in what form. I was hyped because I knew it and knew how to use it.

We needed a rocket to use the water. We found it, in Idaho. A steam rocket. A rocket heated by a nuclear reactor. A reactor in many ways like the ones used in nuclear submarines. All the key pieces had been tested. The facility to test a full scale nuclear rocket was there, at the Naval Reactor Test Site, "NRTS".

I could test a nuclear heated steam rocket at the NRTS. I had left San Diego 7 years earlier to work at this Idaho Nuclear Energy Lab, "INEL", and for that very reason, to build and test a nuclear heated steam rocket for space travel.

The government guys in Idaho Falls in charge of the INEL changed the name of the lab to INEEL, "Idaho National Engineering and Environmental Laboratory." A bit out of step with the times. This is the dot.com era. This is a new world. This is 1998, not 1978. "Environmental" is a hippie word. The attempted political correctness of it all just proved that Idaho was still in the early 1970's.

We needed thousands of places near Earth to go to that were interesting and useful. And our "near earth asteroid" astronomers found them. They found a swarm of mountain sized places to go. The swarm stretched all the way from the planet Mercury out to the planet Jupiter. And some usefully large fraction of them seemed to have hydrocarbons strikingly similar to dirty oil shale. Apparently there would be enough dirty oil shale out there to fuel air pollution and global warming for the next 15,000 years, plus or minus a hundred thousand years.

We needed a billion places to go. The astronomers had just found them, just beyond Neptune. Places we could get to, not as far away as the

nearest star, places with hydrocarbons, because we are a hydrocarbon life form. We found them.

We *humans* did. I had to remember avoid making it sound like I was part of the “finding” of any of these things. I was just a rocket man, neither astronomer nor astronaut. School kids mistook what I said to mean I was one of the discoverers. That misinformation would be excusable. But to let it pass in a technical meeting would be the end of my credibility. I had to watch my words carefully. “Practice being careful,” I repeated to myself.

The vast swarm of the billion places starts with the biggest comet, the Pluto-planet at the start of the Kuiper Belt. It extends out to farther than we could travel in a human lifetime in any spaceship we know how to make today. It ends an eights of a light year away, at the edge of the Oort Cloud.

The Kuiper belt seemed to have a billion objects similar to comets, and what statistically could be millions of objects as big as the biggest asteroids. Apparently, most of them would be rock-solid, hyper-cold, frozen hydrocarbons, with liquid or frozen air gasses for atmospheres.

Trying to calm myself down, I deliberately repeated what we were here for.
NASA asked me to come here to tell them about the Iceship.

That was my excuse to come here. I was one of about 30 selected “rocket scientists” who were supposed to have innovative, new, creative ways to use resources already in space. NASA was looking for ways to use whatever is on Mars so we could live on Mars. They were especially looking for anything on the moon we could use as a way to live on the moon. That would change things, fast, if it were simple.

The huge quantities of resources like hydrocarbons did not mean much to NASA. The huge stores of water in some form did not mean much to them either. NASA was flyboys. Like Olympic antics, somersaults in space, kids flying rocket ships.

NASA just did not care about hydrocarbons. After all, what kind of glory is there in digging dirty oil shale for a living, in deep space, with a porta-potty for a house and mush-paste for food? That’s what living in space would be like, and that’s what working for a living would mean, mining hydrocarbons from space.

NASA scheduled their meeting to be right after the Space 98 meeting here. That way whoever went to the Space98 meeting could stay an extra morning at their own expense to be at the NASA meeting. And NASA would not have to pay anything at all. What a deal.

However, NASA did indeed pay one thing of exceptional value: the 30 of us would be officially recognized as “Experts,” and our concepts “Specially Selected.” That was definitely better than money.

I was hyped. This was my chance to speak in public at a real space conference about both my steam rocket and my iceship. I had all the pieces for Humans to Occupy the Solar System. The rocket fuel (water), the rocket (a nuclear heated steam rocket), a cheap spaceship (the iceship) and, a real number, “millions” of places to go and millions of worlds to conquer.

To me it was just incidental that friends and colleagues were supposed to be here as well. Random friends and close friends were still living near here, in Albuquerque. Two said they might stop by.

But the only reason to do any of this was to enable the Human Occupation of Space. It wasn’t just an all-expense-paid trip to old friends and rocket science. It was 100% about Making a Vision happen.

The nuclear heated steam rocket was a Vision, a vision to enable the Human Occupation of Space. The rocket enabled us to afford it. I could

prove we could afford it, if we would only use the water we recently found on the moon.

Now even NASA knew that the moon was definitely a source of water. The Lunar Prospector, a NASA satellite, confirmed what the Clementine Mission’s Department of Defense satellite found. Water in some form was trapped deep in the forever-dark craters at the north and south poles of the moon.. Barely enough water to make it interesting. But enough to start the Human Occupation of Space.

I had practiced my talk about the steam rocket many times. I practiced at Kiwanis Clubs, every 4th grade that would let me, high schools, professional society meetings, Navy Reserve meetings, geek meetings, space conferences, Washington DC meetings, Jet Propulsion meetings, NASA meetings, even on TV, the Discovery Channel, The Learning Channel, everywhere, often..

This time was better than all the others. I had all the pieces put together. Everything was in place. The story was complete.

This was also the first time I put the concept together with a real rocket scientist as co-author, a rocket scientist from NASA Houston itself. Astounding.

A NASA rocket scientist named Dr. George Zup sketched a small space tanker concept that used the steam rocket for propulsion. Zup designed the rocket space ship. My INEEL colleagues Schnitzler, Larson and Rice sketched the nuclear engineering part.

This time I had credibility.

Dr. George Zup was “Division Chief, Structures, NASA Johnson Space Center, Houston Texas.”

The steam rocket space tanker was the last thing he did before he retired, December 1997. Just in time for the deadline for the submission of technical papers.

This moon water steam rocket technical paper was scheduled for Monday, 27 Apr 98 at 10:20 am to 12 noon, session on Space Tourism.

The smaller room with fold up chairs only held about 30 people. Dan Yurman was sitting towards the edge to my right as I looked out from the podium, watching about 30 people pack the room. Half the people were trim and slim had their suits on, like they worked for aerospace companies. Another third were sloppy, like their day jobs were completely unrelated to space or aerospace. A few, casually dressed, looked confident, like professors. I did recognize a few professors at this meeting. One unfamiliar fellow draped across two chairs in the front row to my left was both sloppy and obese.

The room fell silent as I took command of the audience.

*“I’m going to tell you about
how we can have a dramatic increase in propellant,
rocket fuel,
in the space around Earth itself.*

*I’ll show you how you could see this
within your career lifetime.”*

That was my opening line. Only space cadets would care about having rocket fuel in space, but the room was full of space cadets. Behind me on the projection screen a colorful map of neo space cajoled them.

The map let them all see familiar things, like Earth, Mars, Jupiter, Saturn. And unfamiliar things, like completely unfamiliar, water color blue-ish diamonds splattered uniformly from Mars out to Jupiter.

They could see a danger color in the reddish diamonds. They could see completely unfamiliar things that clearly looked like the orbits of things, but dotted, making a fog. They could see how the orange color, dense fog was clearly engulfing the entire orbit of Earth around the sun.

Some of the objects seemed to have names, real names, like the names of real people, not mythology names.

It was new. It was different. It was real. It entranced.

It was something they never heard of. They were silent. Dead silent.

They were focused entirely on what I was showing. Everything I showed them was different from the NASA story. It was completely different from a couple guys in puffy suits jumping up and down on the moon.

My space map showed so many places to go in space that they could not count them. And, the places had names. The space from the Sun to Saturn was full of things. Instead of the black, empty space, of the solar system we learned in grade school, the Solar System was jammed full of places to go.

This was a trick. It was a way of screaming
*"!! We have to go to space, now !!
A zillion new worlds to occupy !
A New Universe for Us!*
without ever raising my voice or saying a word.

"I put this map of neospace up here to show you what we recently found out about the solar system.," I said.

As I described it with the most dry and bland technical terms I could muster, they saw a future. I saw they saw a future, just like the school kids, the Kiwanis Club people, the Latter Day Saints Boy Scout troops. Their eyes showed they all responded in exactly the same way. They saw the excitement of new challenges, of new habitats, new worlds.

"These are the comets you can't see," I explained as I changed the picture and put up the picture of just the Jupiter Family comets.

NASA never told them there were mountains of oil shale whizzing by near Mars, sometimes near Earth itself.

NASA never said anything about icebergs in space that were black and nearly invisible.

It was total shock.

These were rocket people, so I set up a question for them to ponder. When you ask someone a question, their mind tries to answer it. It tries and tries until it does. That is one of the properties of our Life Form, and especially of higher order animal brains. They are problem solvers.

Ask a question and whoever hears it goes hunting for an answer. It was a subliminal trick.

*"I'm going to ask you a question.
When you answer it,
it should totally change your view of
space transportation.*

Here's the question:

*Suppose you have all the propellant you want,
in space,
to use in your rocket.*

*In other words, suppose you have
UNLIMITED MASS
to work with.*

*But,
you don't have unlimited energy.
you only have
LIMITED ENERGY,*

*Your power supply is limited,
like batteries.*

*Limited energy.
Like when you are running your solar powered
rocket heater,
or your nuclear heater.*

*You are trying to collect as much sunlight as you can
for as long as you can,
running at the maximum,
to the limit,
balls to the wall.*

How should you use the energy?

*Do you focus the energy on
the smallest possible amount of propellant,
so that it gets really really hot?*

*If you do that, you are doing
what the rocket scientists say.*

*That gives you the
highest specific impulse.*

*Or,
should you heat it up only to medium?*

*Or, should you run a lot of propellant
through the heat exchanger,*

*so you just barely heat up
a huge amount of propellant?*

And eject the most possible mass?

*Which one is the right answer?
hottest?
medium?
colder?*

*The rocket science answer?
or The Physics Answer?*

I just gave you a clue."

Einstein said something like “you have to ask the right question.” I gave them the right question.

The answer would enable the Human Occupation of Space. The answer will tell them how to use the water on the moon. But no one in the room seemed to get my point about the question.

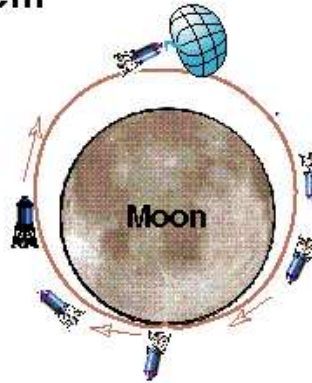
“Never mind,” I thought. I could see I was talking to blank stares on that one.

I proceeded to tell them the rest of the story. The title of the story was “Lunar South Pole Space Water Extraction and Trucking System.” I put up the first viewgraph.

Lunar South Pole Space Water Extraction and Trucking System

Anthony Zuppero*,
George Zupp**,
Bruce Schnitzler***, Thomas K Larson***, John W. Rice***

** Division Chief, Structures,
NASA Johnson Space Center, Houston TX 77058
*** INEEL = Idaho National Engineering and Environmental Laboratory,
PO Box 1625, Idaho Falls, Idaho, 83415 USA
* Advisory Scientist, INEEL, and Adjunct Professor, University of Idaho



Space 98 & Robotics 98

Space 98: The 6th International Conference and Exposition on
Engineering, Construction, and Operations in Space

26-30 April 1998

The Albuquerque Hilton Hotel, Albuquerque, New Mexico



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The little picture on the title page said it all.

"I'm going to tell you how to truck water from the south pole of the moon into space, and keep doing it, huge amounts, simply," I said.

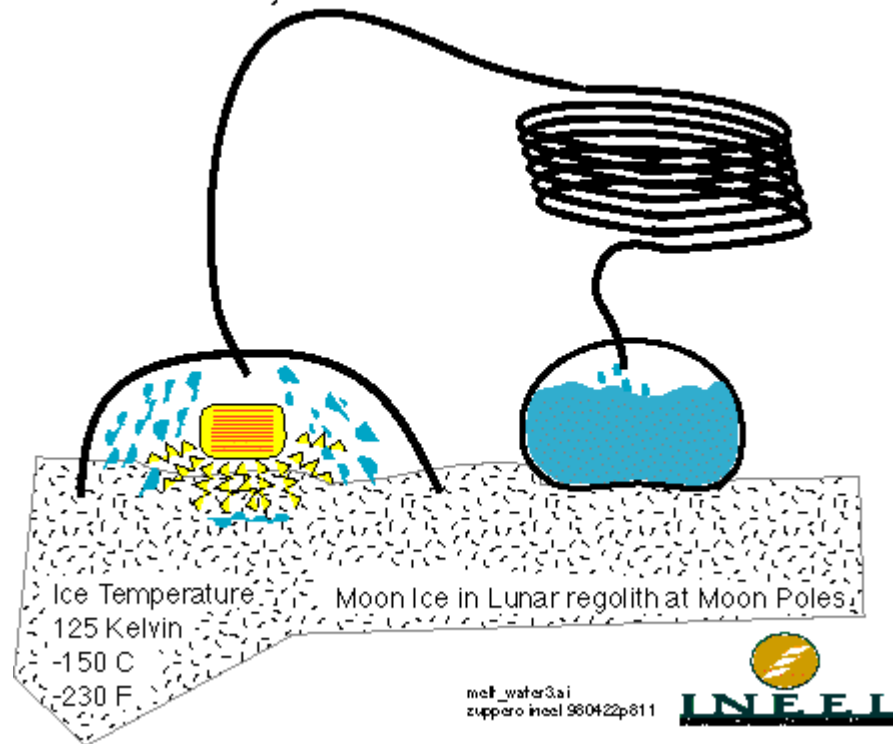
That was the message point.

With the picture and just a few words, they knew exactly where we were going.

Why would anyone care about water? They all knew the answer. “You split it and make hydrogen and oxygen,” would be their answer. Nobody had to tell them why water would be the most valuable thing one could do.

I put the next picture up.

Refrigerator-sized Nuclear Heater Can Melt 100,000 Tons Ice Per Year



“The first thing you do is melt the ice.”

The statement was supposed to imply something simple. I deliberately drew a glowing yellow brick on the ice. As I looked at it, I realized it should have been glowing red, not yellow. I should have used the color of something glowing hot like the inside of an oven. I should have been more careful to draw “red hot” like the inside of a furnace or the top of a barbecue.

“You take an 18 megawatt nuclear reactor, about the size of a refrigerator, and turn it on,” I declared.

I did not bother to tell them that if they did NOT take along that nuclear reactor, they could not do a thing. Permafrost is hard like a rock when it is cold, at the minus 200 degrees Celsius, deep in a forever dark crater of the moon.

Every time the concept of the extreme cold, frozen permafrost of deep black space came up, I thought of what Tom Taylor had said to me, and of what I replied.

Several years earlier, at another space meeting in Albuquerque, Tom Taylor complained to me about my permafrost statement. Tom Taylor personally worked on the Alaska pipeline. He and I were coauthors on technical papers on space topics. Tom carefully explained to me how really difficult it was to pierce the permafrost with heavy equipment.

“That stuff is almost like a rock. You can scrape it all day with a back hoe and not get anywhere. That stuff is not so easy to work with,” he asserted, forcefully. I didn't get it.

“But I'm melting it,” I had replied. I didn't understand. I listened to him, but I could not figure why soft mud and water would be difficult to work with. My 18 megawatt, nuclear heater would turn hard permafrost into soft mud.

Finally, years later preparing for this meeting, I realized what the problem was. The Alaska Pipeline guys had to use oil as their energy source. They only had puny motors to work with, like 500 horsepower diesels. A mere 500 horsepower was puny.

What the Alaska pipeline permafrost guys just didn't understand was the raw, Behemoth power of a tiny nuclear reactor, a reactor as small as a refrigerator. The nuclear reactor would deliver an 18 Megawatt, 24,000 horsepower heater that could run for a year without asking for more fuel. Their 500 horsepower diesel would run out in less than a day. They were stuck with fossil fuel, like diesel. Diesel fuel is about a million times less energetic than our little nuclear reactor.

The Alaska pipeline guys had a problem. I did not. It was that simple. So I didn't bring it up. But if anyone in this audience would dare to challenge, I was completely ready with the complete and total counter.

Nobody in this audience knew that much detail. Almost no one there knew any details at all about the ice on the moon. They never heard of a simple heater ice melter.

“You take a refrigerator-sized nuclear reactor and heat the ice,”

I continued, somewhat repeating myself,

“and you condense the steam into your water storage tank.”

It sounded simple. We all understood it wasn't exactly that simple. We all knew that doing anything on the moon would be a big deal. At least I thought we all knew that.

Nothing would be simple when it's deep in forever dark craters. At the bottom of craters at the poles of the moon, it had been total darkness for 2 billion years, facing the extreme cold of totally black vacuum of space.

Worse yet, gears and wheels freeze in that kind of extreme cold. It's so cold, air itself would condense into liquid on the inside windows of a waiting, lonely spaceship with its battery turned off to save power.

All known lubricants become solid, like cement. Ice becomes hard and rough exactly like a plain old rock.

Waiting for the sun, we would die, frozen solid, hard as a rock.

Nearly everyone in the room was idealistic in this way. They would not be here if they did not harbor some kind of irrational illusion about the compatibility between humans and space. They believed that whatever we wanted to do would be completely doable. All we needed was the decision to do it. Unrealistic as it was, the concept of us doing whatever we imagined was ok. After all, at least two people who actually walked on the moon were here at this meeting.

Another thing they never questioned was that I could get 18 megawatts into a refrigerator-sized box. I personally never actually did such a thing. They should have questioned it. The real size, with all the pipes and valves and shields and things could be more like the back half of a pickup truck.

It was generally known that the nuclear reactor guys did get 50 kilowatts per liter with water cooled reactors. That meant it would take 360 liters to get 18 megawatts. That would be about a third of a cubic yard. 1 foot high, 3 feet square would be about 1/3 of a cubic yard. That is smaller than a refrigerator. When it would all be in a nice package, it would be as big as a refrigerator. When connected to things, it would be like the back of a pickup truck. If anyone should ask, I had the details, the real numbers.

If anyone would challenge that we could make something as small as a refrigerator that would deliver 24,000 horsepower, I would deluge them. I knew the actual sizes and the powers. Long ago, during the early 1970's, I hugged the shell of one of those reactors that delivered 3000 kilowatts per liter, not 50. That reactor delivered about 300 Megawatts in a "jar" that would fit in the back of my pickup truck. It would be heavy enough to bend the springs and maybe hurt the axel, but it would deliver 1000 % more power than the permafrost guys could use. That rocket engine delivered 400,000 horsepower.

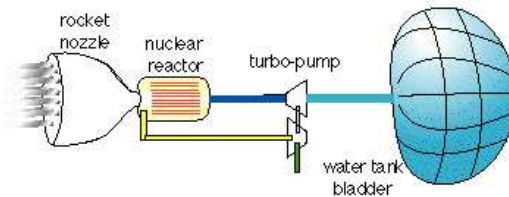
We at the Department of Energy could deliver a Behemoth heater. That was no exaggeration, and everyone knew it.

The audience paid attention like they had never heard this story before.

On the other hand, it was true: almost no one had heard the story before. NASA had been the only one telling stories, and the didn't tell this story.

I put the next viewgraph on the screen.

Nuclear-heated steam rocket



NSR12Simple.ai
zuppero@ined 980423

Pointing to the simple diagram, I declared "All we need to do is pump the water into the reactor, and the steam powers the rocket." I moved my pointer starting from the blue thing on the right, then to the pump to its left, then to the reactor thing, and then to the rocket nozzle.

Rocket science had some simple things, and this reactor seemed to be one of them. Steam-generating, nuclear reactors had to be simple, otherwise nerds with slide rules back during the early 1950's could not have made them.

"We would bolt the rocket nozzle directly on the reactor," I declared.

"The startling simplicity of this thing completely captivated me when I first saw it,

during the early 70's.

The bolts caught my attention.

The bolts attaching the rocket nozzle to the reactor.

They were big bolts, like we had on our farm tractor.

They just bolted the rocket nozzle right to the one foot wide output hole of the nuclear reactor."

"This is the water," I explained, pointing to the blue water bag balloon of my drawing.

Then, pointing to the thing between the reactor and the water bag, I explained that "this water pump pumps the water into the nuclear reactor."

I was hiding something.

The pump would be a bit bigger of a water pump than I had anticipated. For at least 5 years everyone thought the water pump would be just a small thing. Just some kind of pump. But the pump would not be so small.

We had just calculated how much a water pump would weigh. One calculation had the water pump weighing as much as the whole reactor.

I didn't tell them that the nuclear rocket that Jim Powell and I proposed and that we published would require a horrendously powerful water pump. Powell was going to run the reactor at "supercritical pressures."

The "supercritical" term had nothing to do with reactors. It had to do with steam. "Supercritical" meant a very high pressure. "Supercritical" meant something very hard to do. The pressure was 3,200 pounds per square inch.

There was always some fine print in any concept. No matter who had the interesting thing to do. Fast airplanes. Fast cars. Tiny computers. Nuclear heated steam rockets. There was always some fine print. The fine print was the place where one could find the expensive part, the embarrassing delays in the project, the failures, the cost over-runs.

In this case, the fine print was how heavy the pump would be if we made it like the diagram said. I didn't bring that up. They would just have to assume there was some fine print somewhere, like everything everywhere. This point was a bit sensitive. It was a sore point.

Bill Richins, Tom Larson and I from INEEL addressed the problem, but not in time to change the figure and the text we published. What we published for this meeting, the SPACE98 meeting, had an error. My audience was looking at a slight error. I was hiding it.

Larson, Richins and I would definitely publish our fix, someday. We had most of the figuring done. We found out we could not get a pump to run the nuclear reactor at some horrendous, supercritical water-steam pressure. We could only afford a pump that would deliver 50 or 100 psi, something much easier to do.

I was ready to answer this objection if anyone would ask. I hoped they would not. Engineers had actually solved the problems hidden in the fine print, and these nuclear heated rockets actually worked. The engineers demonstrated one during the Viet Nam war.

I think the reason nobody cared about any damn nuclear rocket during 1969, even if it could take astronauts to Mars, was that they did it just when the USA was killing my schoolmates in a damn war in some swamp land somewhere in Asia where nobody cared about, and for no good reason. And the people who lived there wanted us to get out. We were shooting them in their own land and burning them with napalm.

Can you imagine how the rocket scientists in those days wanted us to praise them because they made a nice rocket to go to outer space? As if everything were ok? No.

The reason no one cared was that we were being bad, killing the inhabitants of a foreign country. It didn't matter how many people we put on the moon or how many nice nuclear rockets we made. Our country was still killing people in their own country somewhere on another continent. Even putting a man on the moon didn't cancel what we were doing in Vietnam.

I didn't talk about that. All that was a quarter century ago.

Deliberately repeating the simple story to make sure they got it, I moved my pointer to the reactor, just past the pump. I explained that "The reactor

makes steam, the steam goes out the rocket nozzle." I made a simple motion from one end to the other.

The picture was simple. The concept was simple.

Scanning the audience, I looked for anyone squirming in their chair or shaking their head with "no, no" motions. That would be a sure sign of a fight about to happen. I was ready for a techno-fight. I had all the pieces. I knew every nuclear rocket player that counted. We had heard all their arguments and we had addressed all the objections. We knew where we fit and where we didn't, and we stuck to where we fit.

Nobody was shaking their heads "no." That was good. I must have been doing my job right.

The main objection a rocket scientist would have would be that steam makes an awful rocket. That would definitely be true. Steam would indeed make an gawd-awful rocket. I was ready for that one, but no one was shaking their heads.

How awful? How awful a rocket would a steam rocket be? That was the key. It was not so awful. It was just barely not awful enough to be awful. It was just barely good enough to be stunning.

"Nature was on our side," I volunteered. I should not have brought it up, but I felt confident because the audience seemed to be accepting my statements. Therefore, I thought, I can tell them how close or far from wonderful my invention is. They will have the real data and they will know where they can and where they can not use the steam rocket.

"Just a little bit less power, and the steam rocket would not be able to lift off against the gravity of the moon," I declared.

"We were lucky.
This steam rocket has just barely enough power to lift off from the moon.
That means we can use it."

Nobody seemed to get the clue. I volunteered another fact I should not have volunteered.

"The steam rocket will not work on Mars.
You can't go from the surface of Mars to Mars orbit with a steam rocket."

I was not happy with that result. But I told them anyway. It was a trick. Bait. I was baiting my competitors.

I was baiting any rocket scientist who wanted to use a hydrogen propellant, high specific impulse, wonderful nuclear rocket to get off Mars. Theirs would not work either. It would have too little power to lift much off the planet. The only thing that would work well would be a chemical rocket.

The only thing that can get you off of a planet with high gravity, like Mars, Earth, Venus, Mercury, is a chemical rocket. No one knows of a rocket that would be able to get us off a planet like Jupiter, Saturn, Neptune or Uranus. Their gravity is too much.

No one I saw in this audience had worked on any nuclear rockets, or a steam rocket, so none knew what to ask or how to complain. Not one of the handful of key rocket scientists of the world were in the audience. None that I knew. There were only a few in the world. It was my job to know them all. Real rocket scientists attended the Joint Propulsion Conference. I did see most of them there. And this SPACE98 conference

was not that big a deal. It had no connection to lucrative government contracts.

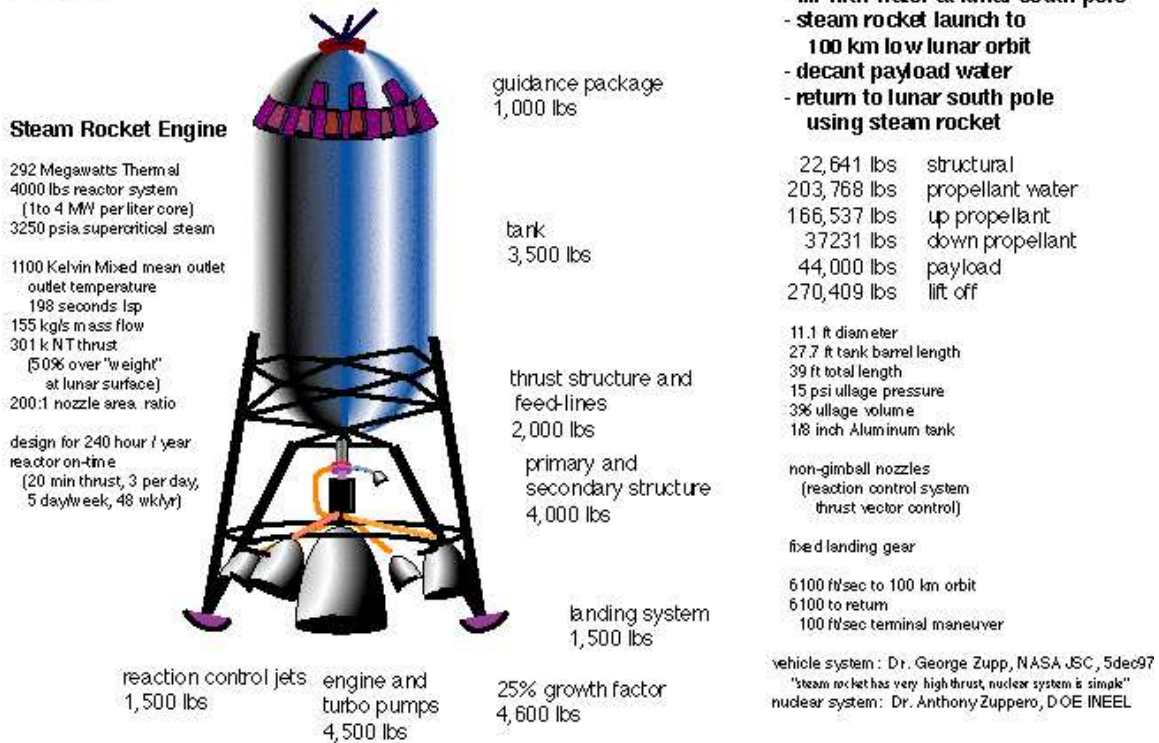
I put up the next slide, our nuclear heated, steam powered space water truck.

The audience listened as if everything was ok. I could prove that everything was ok, but they didn't ask. I was armed to the teeth to fight the objectors. I had all the data. I was the heretic, and I had all the calculations and data to back me up. But they just sat there, focused on me, listening.

DRAFT #2
RECORD OF WORK
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george zupp fax rcvrd
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NASA JSC Structures & Mech. Div
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Lunar South Pole, Space Water Truck

"Hauls water from lunar south pole to 100 km, low lunar orbit."



"Now you put the water into your rocket fuel tank," I said, pointing to a blue water tank.

The whole rocket was mostly a rocket fuel tank. They could see we were primitive artists, by our drawing. And they could also see we calculated everything, because of our detail. Every number describing the design was there. Even the embarrassing 3250 psia supercritical pressure was there, an error in the fine print.

"George Zupp of NASA did the rocket design. We did the nuclear design. George made a real heavy design because he did not have much time to make it weigh less."

I told the audience a story about how George was proud of his heavy, low tech water tank.

"This water tank is heavy," I said.

"I would have made one much much lighter. So light you could carry it.

I asked George, "Why did you use such a heavy water tank?"

"Because I can go down the street and get someone to sell me one," he said.

He laughed with a Texas accent when he said it.

He said "Anybody can do better than our design."

He was boasting.

At first when he said that I was dismayed.

But then it quickly dawned on me:

If anyone could do better than that, and ours would work, we win.

Everyone who did better would reference us.

They would brag.

We would win,

because they would have to reference us to claim they were better.

*George Zupp's boasting was a good boast.
George hoped everyone would beat us and say so real loud."*

The audience listened to the story without much facial expressions. I guess I didn't say it right.

Maybe I did not say anything of value. All they needed to notice was that the payload would be 20 tons, 44,000 pounds.

Maybe I should have been more clear. Maybe I should have paused at just the right point of a sentence and said nothing for 5 seconds, and then clearly said, in big letters using small words spoken slowly:

***"The only thing in this whole talk
that is important is that***

***every time this rocket takes off,
it takes another 20 tons to moon orbit.***

***It can take off as fast as
you can get it back from space
and pour more water into its tank."***

But I didn't. I was stupid. It was the only thing that really counted. All the rest was just technical data to back up my story.

Everything they needed to know was there. But it was my job to make it clear and point it out. I failed.

Maybe I should have said the bottom line a different way, more clearly.

***Every year this puny rocket can deliver 2,200 tons of
anything into Earth escape orbit.***

Maybe that would not have been clear enough. Not many people know what "2,200 tons" means. A typical 18 wheeler truck can carry 25 tons. The payload bay of the Shuttle can carry 25 tons. This 2,200 tons would be about 100 of them. That's what I should have said:

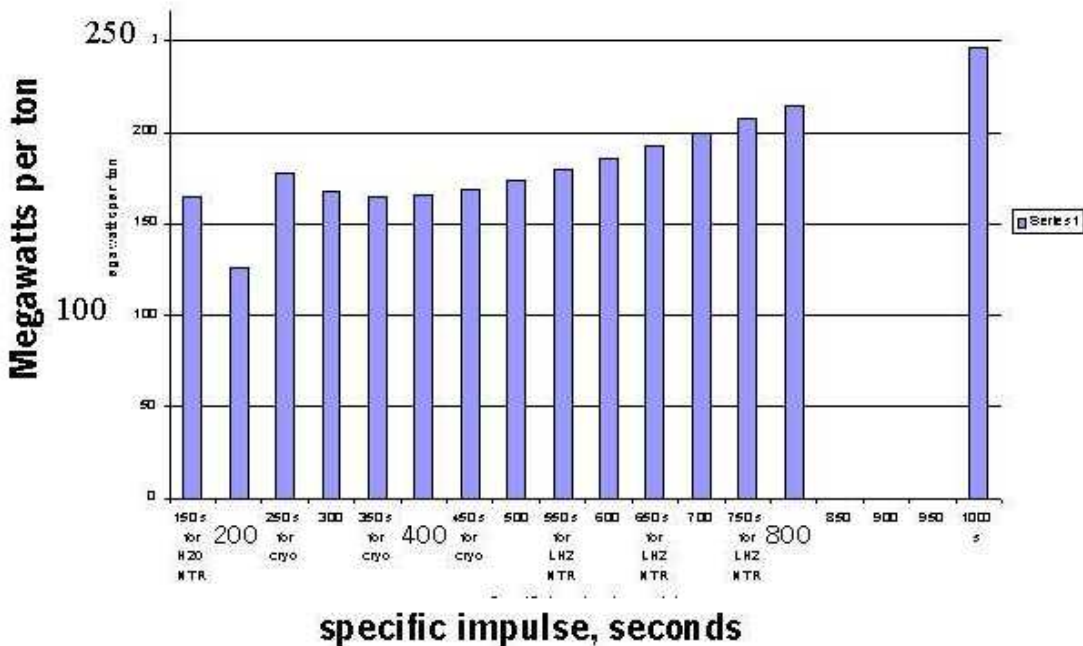
***Every year this puny rocket can deliver 100 Shuttle
payloads of anything into Earth escape orbit.***

No one in the audience knew that the fine print on the viewgraph showed how we calculated the yearly payload, 3,800 tons. We had a ship making 3 trips a day, 5 days a week, with 2 weeks vacation. Pretty easy duty. No one had time to figure how much of a 3,800 ton payload at low lunar orbit would end up at lunar and earth escape. The answer was roughly 60%. About 60% of whatever was in lunar orbit could be sent to escape both the Moon and the Earth.

We never told them any of that. I thought it would be too much. But I was the bottom line. It would not have been too much. Maybe not. They were stoic.

I placed some technical data on the viewgraph machine. I thought this was a strong piece of data. This viewgraph compounded my stupidity.

Required Launch Power-per-Mass vs Isp has a minimum



Attacking an imaginary opponent, I started into a completely obscure and unfamiliar topic.

"The problem with solar rockets

*is they can't get off the moon.
They don't have enough power."*

I knew there were solar power propulsion nuts at this meeting somewhere. I was going to attack them. I knew there were chemical rocket NASA people here. I was going to attack them, too.

I was trying to make the point that the steam rocket was special, as rockets go, in that it needed less rocket power than all the alternatives. It takes raw rocket power to push a rocket off the moon.

Rocket power is hard to come by. The guys in the audience apparently didn't know that. They almost certainly didn't figure what that "100" meant on my chart, "100 Megawatts per ton" If they would have figured, someone would have said out loud

"100 Megawatts? That's 130,000 horsepower!"

Nobody said a thing, not even with their faces.

When I had first figured the data for this chart, the result astounded me. The chemical rocket was the first example I figured. It was an astounding rocket engine. The Pratt and Whitney chemical rocket engine called an "RL-10" delivered about 292,000 horsepower. That was the first astounding part. The next was that it weighed only 370 pounds. The 370 pounds was about the weight of a car engine. A car engine delivers less than 300 horsepower. This was incredible.

The RL-10 delivered about 1,300 million watts per ton of engine. That's 1.7 million horsepower for each ton of engine. That was huge.

By comparison, the nuclear heated rockets were puny. The nuclear rocket would only deliver 300 million watts in a two or 3 ton package. If it were using hydrogen propellant, a well designed one did deliver 300 million watts in a 1 ton package. If it were using water propellant, it would deliver 150 to 250 million watts, maybe 300 if the water flow was designed right. That 300 would be "puny" compared to a chemical rocket's 1,300.

On the other hand, I was here to show that the nuclear heated rocket would still deliver plenty enough to be useful. We were Lucky. Nature was on our side.

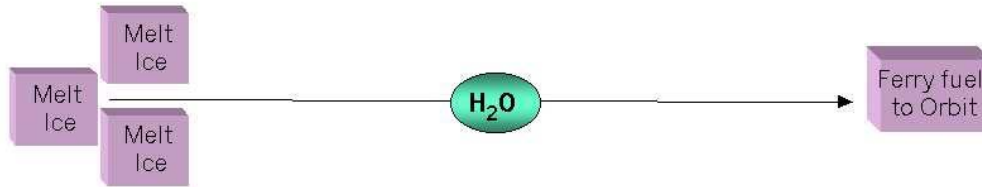
The astounding part was the "million watts" part.

The curious and unexpected part was that if they used the far superior chemical rocket, it would need a higher minimum power to lift off. It was the specific impulse that made it worse.

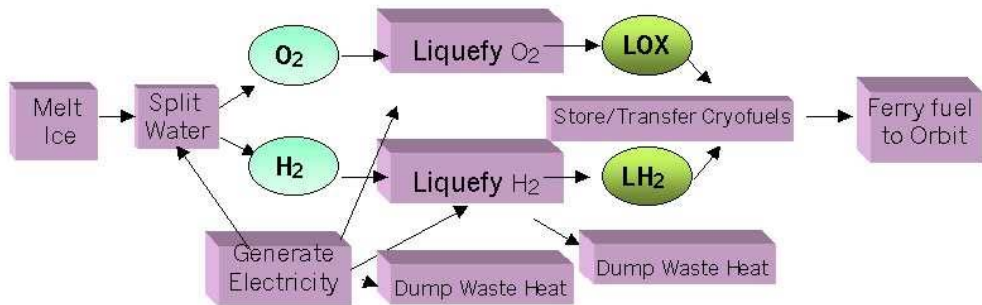
To prove my point, I showed the chart. The chart said that if they used the superior chemical rocket, it would need a higher minimum power to lift off the moon. It was a surprise, obtuse conclusion. It was interesting. It wasted their time.

Exceptional Simplicity Dramatically Lowers Cost To launch payloads such as moon ice into low lunar orbit

Nuclear-Heated Steam Propulsion, via Thermal Process



Chemical Propulsion, via Electric Separation



example ppt
fuel.zuppero.ppt#r 980314

Finally, I put up a viewgraph that said what I meant. I had discovered something, and this was one of the three key pieces of the something. I discovered that the steam rocket approach was the simplest.

Pointing to the top part, my part, I said:

*“The reason using water is
so good
is that we just use heat.”*

They were supposed to see that the top part was me and the bottom part was NASA and the rocket scientists.

I tried to use a phrase that sent the message. I had practiced this phrase over and over. It was the “focus, focus, focus” part.

*We only need to melt ice to get the stuff
that we pour into the rocket fuel tank*

The audience needed to know what the difference was between us, the heretics, and the status quo. I told them as clearly as I knew how:

*The rocket scientists would have us
split the water and use liquid hydrogen and liquid oxygen.*

*Look at this.
Look at the non-trivial hardware things you have to do
to get liquid oxygen and liquid hydrogen.*

The picture told it better than words. NASA and rocket scientists pretty much all categorically stated that we should split the water to get the hydrogen, or to get hydrogen and oxygen. It was all so simple, they said.

But they lied. Or they didn't know what they were talking about. Or, they did not mind that you and I had to pay for all that nonsense.

Pointing to the complicated things needed to convert water into liquid hydrogen and liquid oxygen rocket fuel, I told them what we discovered:

*When we calculated
how much this costs
compared to the steam rocket,
this is 100 times more expensive
than the rocket I just showed you.*

This was true. This was a shock. This was a surprise. I never expected that my way would be 100 times less expensive than their way.

To their credit, they never expected that anyone could deliver 100 times more people thru space than their way. To their credit, it was logical that if you did something using a known poor performing rocket, it ought to cost more and produce less. I was using a known poor performing rocket.

The steam rocket was a known poor performer compared to the chemical rocket. Unfortunately for the NASA guys, their Achilles heel is that the RL-10 chemical rocket needed liquid hydrogen and liquid oxygen for fuel, not water. Another glitch: the NASA and Department of Energy favorite, the liquid hydrogen propelled, nuclear thermal rocket needed liquid hydrogen, not water. Any oxygen would have to be discarded. I was ready for all those guys.

Nature fooled them, and I found out.

The known poor performer wasn't that poor. The only poor performing part was that my way would use about 3 times as much liquid stuff in the tank as their way.

The only reason my way had a prayer was that my liquid stuff, water, was plentiful.

Lucky for me, water turned out to be plentiful.

Water in space wasn't anywhere to be seen during 1988 when I left Sandia. It wasn't plentiful during 1990 when I was at General Dynamics and when we all got fired. It wasn't plentiful when NASA was planning to go to Mars during the first President Bush's Term. We only discovered water on a nearby comet during the first term of President Clinton's reign. The Defense Department (Colonel Pete Worden and Dr. Stu Nozette) discovered the water on the moon during 1994.

Water was only discovered plentiful in space near Earth during 1997 and 1998 when the Lunar Prospector verified it something with a lot of hydrogen was buried deep in forever dark craters at the North and South poles of the moon. We hoped the Lunar Prospector would find more something with a lot of hydrogen, but it did not. It just found a little bit. Barely enough.

I could have shown them pretty pictures of the ice, but I was focusing. I kept on talking, repeating the message so they would get it. I hoped they would get it.

*"If you just keep running this water truck
up to space and back,
every 8 hours,
20 tons at a time,
in a year you get
3800 tons of water in orbit around the moon.*

*"That's 3800 tons of rocket propellant,
or space ship hulls,
or whatever you want from the moon.
That's an awful lot in return
for just melting ice."*

One could figure everything I said on a cheap hand calculator. That was why I could win an argument in public. I could prove everything with a hand calculator.

This was simple.
It was just rocket science.

I was done.

Nobody asked intelligent questions.

I thought perhaps I picked the wrong meeting to give a talk. At least somebody should have asked why I was now saying "100 times less expensive than NASA" instead of "1000 times less ..." I was ready for that answer. George Zupp's design was 5 times heavier. It delivered 10 times less to orbit and I ran it 2 times less often than my original design. Nobody noticed.

A TV crew came in and started to set up cameras. People were leaving for another session. I thought the TV crew was here for me.

“OH, we made a mistake,” the lead TV person said, and the crews started to take down their lights and cameras.

Expecting not much, I went away without emotion. After all, the real rocket scientists go to the meeting with lots of government money behind it. Most of these guys are just dreamers, space cadets.

The sun was shining brightly. The sky was blue. About 20 tables and chairs were set up in the courtyard of the hotel for the noon lunch break. Cliques were starting to form little groups. Dan Yurman and I were plotting which clique to work, to penetrate, to lobby, to inject ourselves into. This was a meeting to meet people. The whole point was to meet people who could make Visions come true.

We picked a table with the two people I knew who had demonstrated some kind of vision. Some of the people at the tables had suits, and that was a key indicator. Putting on a suit meant, at the very least, that they would do whatever it takes, even to put on a costume for their cause.

Almost as soon as we sat down I realized someone had been stalking us. That was a compliment. Jim Benson had gone looking for us and sought us out. Benson had started his new company “SpaceDev” and made himself Chairman.

“Is there some way INEEL can propose some kind of mission using government or NASA money? You could buy launch services from me,” he said. He talked to me and Dan, both together and separately. He knew what he was doing.

One could tell, just like one can tell the Oscar winning actor within 10 seconds of their showing up on the screen, that he knew what he was doing and could do it. I liked his approach. He seemed to know how to be the broker and make things cost less. He seemed to know how to arrange a space contract to cost less than if the deals were standard government contracting with big, expensive aerospace companies as the only bidders.

I looked for bluffing and couldn’t find it. He was clearly not from the aerospace company culture.

This was a bonanza for meeting people. Not rocket science types with money. but connections.

The Iceship And The NASA Space Meeting

A Zuppero, reformatted 2009.07.20 from presentation at 1998 meeting

Visionaries Meet

This was an Official, Invited Speakers Only, Highly Selected, Imaginative Ideas-Only, NASA meeting.

*Workshop on
Using In Situ Resources for
Construction of Planetary Outposts*

*April 30–May 1, 1998
LPI Technical Report Number 98-01*

It was Friday, 1 May 1998, 9:30 AM, Albuquerque, New Mexico, USA. Dr. Mike Duke of NASA had put together a collection of concepts that had stood the test of time. A Visionary for every idea that Mike Duke selected was still pushing their own concept. That was a good test. It was good because good managers and leaders know that the best measure of impending success of a concept is to see the Visionary still passionately dedicating their time to it, after a long time pushing. Mike collected the Visionaries. Mike personally invited me to tell of the IceShip.

A basement room big enough to seat 50 or 80 people. No windows. Good lights. Plenty of space in the back for free coffee. A big space for the speaker, with a table and a nice podium, very wide, along the length of the room, not the depth. A limited number of chairs. A select number of people. Everyone here was handpicked.

Plenty of room for visitors, but there weren't many. Only serious visitors. Most of the space cadets had gone home already.

As we sat down and listened to the opening remarks, I looked around at who was there, who I might know. And then I scanned the agenda. I realized my presentation was nearly last and that most of what would be said here was recycled. It was chocked full of concept after concept of impractical things, useless things, untested things, old things, things we heard about many times before, and some things 3 decades old --- exactly what one would expect from those seriously planning to live on other planets.

My turn to speak was near the end of the list. I would have to wait and listen. I had no choice. I was also tracking this audience, my audience. I would have to just sit through this patiently. Something was bound to be interesting. Famous people were slated to speak.

Something nearly immediately caught my attention because it related directly to making a huge space ship cheaply.

A fellow named C.C. Allen described how to make strong bricks from moon dirt.

"Puzzle pieces. Snapped together by a machine," I thought. The building-making-machine flashed into my head. A comic book during the 1950's had a person driving a building construction machine with hydraulic arms throwing big brick puzzle pieces at a

building, tossing the pieces high into the air, snapping them together on a growing building, creating big buildings super fast. C. C. Allen was feeding the memory of that thing I always wondered about.

Allen said all one had to do was heat the moon sand till it just melted, and the sand could cast into molds to make strong bricks. "Strong bricks, better than ice," I thought, "sun heats 'em. No electric required." Those were feel-good thoughts. The "no electric" part was very good for space economics and engineering.

Four years earlier, Nancy Linarez and I wrote how we could use melted moon dirt to make a space ship. Now Allen was giving me details. I started to get excited. "How strong would it be?" I wondered.

He didn't say how strong the brick would be if I tried to pull it apart. He only said how strong it would be if I piled them up. There is a big difference. I needed something that would hold a spinning space ship together, to keep it from flying apart. C. C. Allen left me without a key piece of information.

He also said the bricks would tend to crack if they cooled wrong. Bad. Not what I wanted to hear.

I kept sitting through the presentations, waiting for something new.

Many people told of how to use the dirt. A Visionary showed how to make solar power photovoltaic cells on the moon, from moon dirt. I was tempted to ask him if he could do this at a place just west of Albuquerque, about 30 miles from here, on the desert, from desert dirt. If not, how could he do that on the moon? If so, we ought to. That would be a mean question.

None of these things were new to me.

One Visionary showed how to suck oxygen out of rocks, moon dust. Since most of the rocks on the surface of the moon are oxides, there was plenty of oxygen to work with. The only known way to get the oxygen out was to use electrolysis. He would stick electrodes into molten moon dirt lava, connect the electrodes to electricity and electrocute the lava. Oxygen would bubble off.

So, that's what the guy wanted to do? How original. I had heard about that one a decade earlier. It would be easy on paper. The concept had them electrocuting orange hot, liquid rock lava, making oxygen bubbles. I did not ask what happens when or if the container would cool. Would the result be an oxygen-maker completely clogged by solidified, rock-solid lava, and then we suffocate?

A Visionary named Jakes from the Czech Republic came to the rescue and showed a new way to get oxygen from moon dirt just using heat. That was new. He would just add a reducing medium such as coke, he said. I wonder where to get coke on the moon? The moon has no coke. The moon is carbon poor. That's why the iron specks making up 1% of moon dust are high quality stainless steel: they have no carbon. I kept listening.

At least several Visionaries talked about ways to use Mars dirt and Mars air. All the ways seemed a bit hard to do. Very hard to do. The Mars air is so thin an air pump would have almost nothing to suck.

Another Visionary fellow showed how to melt moon dirt and make igloos for shelters. They looked like blobs of melted glass dopped together, and then we were supposed to slither in there somehow, in our inflated space suits, without snagging them or cutting them on the edges of the melted glass corners, and call it home.

Should I speak up?

"Nothing in space would be better than the worst place on Earth. Even the coldest, bleakest tent in Antarctica during a horrible blizzard would be easier to live in and work in than anything on the Moon or Mars. So, *why do you want us to pay for this?*"

People asked us that "*why ... us ... pay for this*" question at the Department of Energy. Why can't we ask these Visionaries the same question?

Worry started to come over me as I squirmed in my chair. Strategically seated in the last rows, so I could catch people of importance as they walked in or out, I got up and walked around the back of the room. Several people were standing, leaning against the wall, some drinking free coffee. Somebody was peeling open the little jelly containers and eating the jelly. The free jelly was put there for the free bagels and muffins that had long ago disappeared.

Worry started to overtake all my thoughts. Living in space would be horrible.

Perseverating, pacing back and forth, I thought:

"Where are the amber waves of grain?

Where is the trickling stream?

The oak and maple tree forests of Pennsylvania?

Where are the turkeys to shoot, the deer to eat, the fertile land to grow food?

Where are the corn stalks,

and the autumn pumpkin field?"

Space was awful, barren.

"Where is a stream of water?" I planned on asking the next speaker, whoever it was, no matter who.

"Where can I catch a rabbit on the moon?" I would ask. Perhaps the audience would laugh. I would not be laughing.

"Any fish on Mars?" I would ask the next Mars Nazi.

"Is the air on Mars still poison?" I would ask.

I would remind them "During that NASA space meeting in Tucson, January 1991, half the guys in the afternoon session were talking about how they would propose to avoid dying from the traces of carbon monoxide in the Mars atmosphere".

I was there during January 1991. I heard them speak. That's when I found out that the trace carbon monoxide in the Mars air would be fatal unless very carefully dealt with.

"How much would an acre of hothouse cost on Mars?" I would ask, and then quickly, before they could answer, ask "How about on the moon?"

No matter what they would say, I would then ask "You mean it would cost less per livable floor space than the cost of an airplane?"

An airplane is a mass produced space ship found and made nearly everywhere in the world. It's cost is as low as they get. It's a space ship that keeps people alive at 45,000 feet. At that altitude, the air is thin, 75% of it not there, and the airplane could as well be floating in the vacuum of space. My airplane example would be less expensive than anything and any rocket ship in space. Airplanes would be an extremely expensive hothouse.

I learned the hard way that *outer space is too expensive.*

No. There was no way living space on the moon or on Mars would cost less than the cost of mass produced airplanes. A nice, big airplane has a size that is smaller than the hothouse on my Uncle Gus's farm, and costs about \$50 Million. That meant it would cost about \$50 Million for a house, for only as much house as one could make out of a big, commercial airplane. What kind of civilization would that be? Expensive, and at taxpayer expense. That's the kind of civilization it would be.

This was not going to work. Living on the moon would be way too expensive no matter which of the guys in this room had their way.

I kept listening, but my mood got worse.

A fellow named Ramohalli showed how to split the Martian air into fuel and oxidizer, and then use them. Unfortunately, it looked like he would take CO₂, what I exhale, and split it into oxygen and carbon monoxide. The good part was that the Mars air is mostly CO₂, so he could just suck in raw material. Great.

The bad part was that he would use electricity to split it. Once can only get a little trickle of electricity on Mars. A worse part was that he could not store very much. He was going to store both carbon monoxide and oxygen in what looked like some regular sized balloons. One can't store a lot of *gas* energy in balloons.

The meeting was degenerating, according to me. The organizer, Mike Duke, seemed to be happy. The speakers seemed to be glad that someone let them speak at NASA's special request.

Mike Houts from Los Alamos showed what seemed to be a rather exciting electric power supply. At first, it looked very good, 10 to 100 kilowatts, growing to 1000 kilowatts. 1000 kilowatts would power 100 homes where I lived, 1000 homes in Jakarta. Mike's 1000 kilowatts of electricity in space would be a lot. But then I realized this was puny. On Earth, this is only about 1,333 brake horsepower. The same power as 2 or 3 eighteen wheeler trucks generate rolling down the highway.

The Human Occupation Of Space was thinking "amber waves of grain," and "streams, fish, trees, a gentle breeze, sunshine, turkeys in the oak tree woods, long convoys of eighteen wheelers full of good stuff."

But instead we were getting "a nuclear reactor, carbon monoxide, no water, sucking the oxygen out of rocks by electrocution, melting sand to make ceramic blob igloos."

Anxiety, fantasy and reality were combining. Flashbacks to the first days of men-on-the-moon reminded me of how everyone during those days thought we were on the verge of becoming a space-faring Life Form. The first pictures that the NASA lander beamed back to Earth showed a Mars that looked just like some parts of the desert just west of Albuquerque.

"We found another Earth," Dr. Bill Bishop had told me at supper, returning for a visit to Albuquerque from his new position at NASA. It was a fanciful, fantasy conversation, and we both thought it was completely real. But that was 20 years earlier.

Reality hit me. Our species was not ready to go to space. No Human Occupation of Space.

Steve Gillette and his colleagues were describing how to use lava tubes on the moon as habitats. That was a fresh thought. I had thought about this during the early 1970's. Deep underground. Deep down in a labyrinth of caves, natural caves. Nicer caves than the ones drilled using Jim Blacic's lava melter poker. Deep in lava tube caves near moon craters. Just like the Dick Tracy comic strip of the late 1960's.

The Dick Tracy comic strip during the 1960's had it all figured out already. Dick Tracy even had a wrist TV. In the comic strip, humans discovered a pretty moon girl with little horns who lived on the back side of the moon, where we never got a chance to see from Earth. On the back side, there was water deep in lava tubes or crater cracks. They lived somewhere deep in the moon where water was supposed to be. The Dick Tracy comic strip gave me the idea.

We would be going so deep down into Mars or the Moon that the air pressure deep in the cave, miles below the surface of Mars or the Moon, would be as thick as the air on a high mountain top. Almost normal.

But when I figured it this time, in my chair among 30 space Visionaries, I found out it would be dark. Absolutely dark. Always dark deep in a cave. Probably warm, too, because it would be deep into the planet and digging closer to its hot, molten lava, closer to the core of the moon. And if there were any water above, it would develop a crushing pressure after only a few hundred feet.

Steve Gillette was now bringing us the real story on moon lava tubes. Gillette and his friends were describing how air and ice would collect deep in the lava tubes. This would have been exciting. Except that now the Human Occupation of Space would be condemned to live forever underground, like ants or moles, but 1000 feet down, maybe 20,000 feet down.

Our skin would lose color. The only light we would see would be from our flashlights. Our skin would develop calluses, permanent calluses, scales, so we could be ok with scraping against the hard rough rocks. Our skin would develop temperature sensors, so we could better feel the heat of things, like a different way to see in the dark.

Awful.

I liked the lava tube idea. I bet we would actually find them on the moon. My mood got brighter. Gillette was a mineral person who worked in real mines and real mineral extraction for real companies on Earth.

Then his team made a special point that the sticky dust that is on the surface would not be there deep in the lava tubes.

Sticky dust?

I remembered that one. Bad. The dust on the moon sticks due to static. It sticks to everything. One can't blow it off because there is no air to blow with. One can't brush it off because it sticks to the brush. It is sharp and abrasive, so abrasive that a moon suit would wear out in a few weeks. Wheels and joints get the dust inside, and it grinds them, wears them smooth, and would ruin the all the machines on the moon.

I was pacing slowly back and forth along the back of the conference room.

At least the detail of what they were describing was really interesting.

My strategy to tell them a story seemed to be a good one. By the time it was my turn, they would all be pretty bored. They were all mostly Visionaries and had all mostly seen everything before.

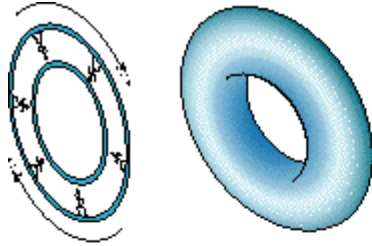
But the bottom line reality became more and more clear. The reason the Congress is not funding anyone going to the moon or Mars is that

nobody in their right mind wants to live that way.

Submarines are Like Spaceships

It was my turn. My costume was carefully adjusted and checked for specks of dust. Suit and pants pockets were both emptied of everything, of anything that could bulge. Hair was perfectly combed. Beard had been trimmed. Face washed. Tie straight. Carrying only a handful of viewgraphs I confidently and purposefully walked up to the podium. General Dynamics trained me well.

I had been watching their every move, every response. I noted what they accepted and what they did not, what they laughed at and what



Ice as a construction material

Anthony Zuppero,
Idaho National Engineering and Environmental Laboratory
Department of Energy
Joseph Lewis
NASA Jet Propulsion Laboratory
California Institute of Technology

Workshop on Using In Situ Resources for Construction of Planetary Outposts

Mike Duke, Lunar and Planetary Institute, Houston
NASA Johnson Space Center

Friday, 9:30 am 1 May 1998, Albuquerque New Mexico



Pausing for a moment and looking at them, eye contact from one end of the audience to the other, like I had seen an aerospace company president, Norman Augustine from Martin Marietta did when he addressed private luncheon meeting, I continued with a story.

“Not that you should make one out of ice.
This is only a curious Coincidence of Nature.
It lets us inflate ourselves a monstrously big space ship.”

Then I acknowledged what several of the Visionaries in the audience had suggested.

“You probably wouldn’t do this,
use ice.

You would probably use melted regolith,
like some of you here told us.

questions they asked. In the hallways and during the breaks, I had made sure I was supportive of every concept, no matter how impractical or costly. I had refrained from asking embarrassing or combative questions. I saw they responded like any smart 4th grader, and that they understood what curiosity would uncover. These were the ultimate 4th Graders, the fully matured, intensely curious, proven smart Visionaries.

Placing the picture that said everything on the projector, I introduced myself and began:
“I’m going to tell you how to make a space ship out of ice.”

You would melt moon dust
and make ceramic space ships.
Ceramic would definitely make a much stronger, sturdier,
bigger space ship.

But this is interesting.”

I turned back towards the podium and the viewgraphs.

I knew exactly how to make this ice space ship. I was about to tell them exactly how to do it.

In sharp contrast, not a single one of them knew how to make a ceramic space ship, or anything else out of melted dirt. No one knew how to reliably spin strong, miles-long fibers from molten moon dust. The fibers would have made excellent space ships.

They did not even know how to make plates out of moon lava. Plates would really be neat. One could make plates that snapped together. None of them knew how to reliably and simply make strong, foot-wide ceramic tiles from just moon dust and focused sunlight. I was hoping they would. We were all hoping. They knew this.

If I would have heard anyone who could have been able to make fibers or tiles I would have changed my speech immediately, and made us all look like heroes.

They focused on me. I told them a short story of how I asked the key question. Visionaries always want to know how one gets to the key question. They all knew that the rest of any story after the key question would be easy.

“During 1990, Ted Fay assured me
“we will get you your water.”

I figured the ice part back during 1990 with some ice data I got at UCSD.

Gene Shoemaker called me one afternoon.
“Told me about his finding water ice on a comet,
a comet whose orbit came tangent to Earth orbit once every 4.2 years

We published our result at Space 94. Nancy Linarez and I and Pat Whitman.

“Several years ago, the near earth asteroid and near earth comet people told me there was water ice nearly everywhere in the solar system.

With water on the moon and water on the comets, I wondered:
how could we use the water ice to make a space ship?

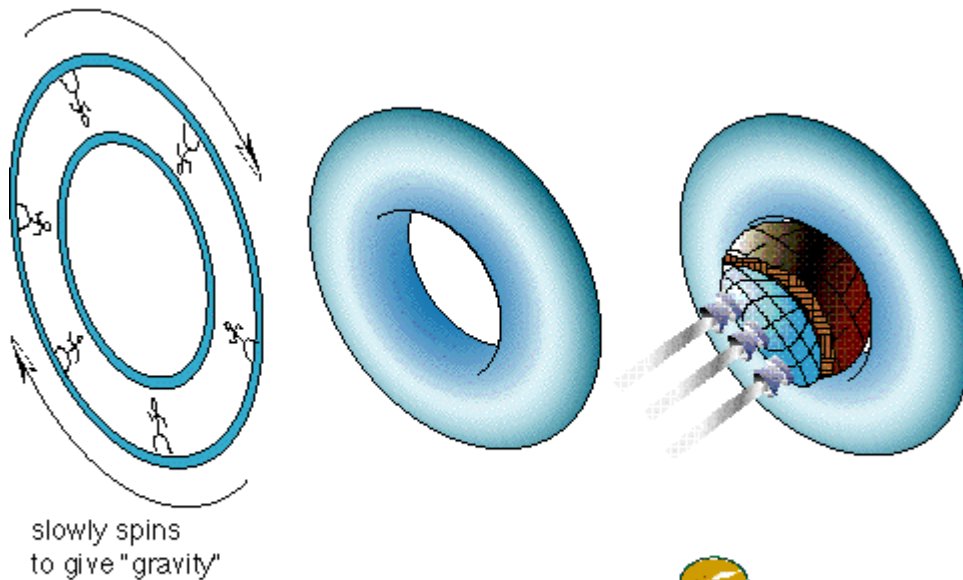
Could we use it like cement?
Like steel?

Back in undergraduate school, during the early 1960’s one of the metallurgists commented one day that
“if you freeze ice cold enough, it’s like steel.”

He lied or didn’t know what he was talking about,
‘cause it’s NOT as strong as steel.
Only as strong as a brick.
But I remembered his comment.”

I placed the viewgraph on the screen so they would see what I was thinking.

"Ice Tire" Torus Space Ship



Ice2_VG.ai
zuppero ineel 980422p1027

“We would be on the inside of a big rotating wheel.
A donut. A tube, an inner tube,

as big as a football field across.

We would spin it.
It would throw us against the walls.
Synthetic gravity.”

I pointed to the stick figures walking around the tube.

“See the picture?
There’s a guy walking on the walls.
The inside walls.”

It was obvious. I did not have to describe it in detail. They all knew that if we spun a cage, things would be thrown against the inside wall of the cage. If the cage were as big as a football field, a person thrown against the inside wall would not know the difference between that and gravity.

They only question you have is:
Will this ship rip apart when you spin it?

Would the ice hold up?
Is ice strong enough to hold together when we spin the ship?

That’s the key question.
Is ice strong enough so it won’t fly apart?”

That was the only question. From here on it was only a matter of figuring. Figuring the details. I went on with the story.

This was the same story I told 4th Graders, only this time I had every piece of the puzzle, and every number, and this made it real.

“All I had to do now was some simple figuring.
How strong is ice?
How strong do I need it?
How would I shape it?
How would I freeze it?

If everything went ok,
it would work.

‘It probably won’t work’
is what I thought when I started the figuring.

But I’m curious.”

Everybody in the audience was curious. They were all Visionaries and all space cadets. That kind of person is always curious.

This was straightforward to figure. Simplest thing in the world.

“So what’s the answer?” they all thought. I could see it in their faces. I scanned the audience again. They had that Smart 4th Grader look I had seen many a time.

“All I really need to know is
“will it fly apart?”

Well, before I figure that,
I need to know how big a ship to make
and how it is shaped.

Then I can just figure how strong ice has to be.
If ice is strong enough,
the ship is ok.

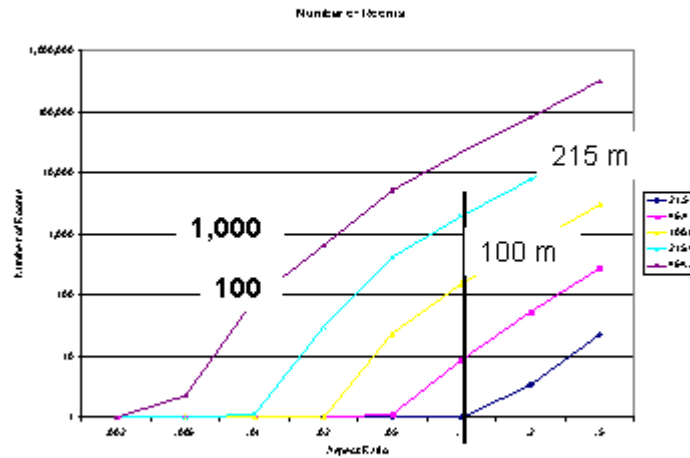
This was a trick. All they wanted to know was will the ship fly apart or not. I was tricking them into hearing every detail.

“I had make it hold enough people
or nobody would care.”

how many people to design for,
and how big the thing should be.”

I placed a viewgraph they could hardly see on the screen. All they could read were the 4, big print numbers.

Number of People-Rooms vs Iceship Size and Shape



Reference Iceship

People rooms 1.ppt
zippero line e1980423a1013

They could see “100 people” and “1000 people.” And they could see “100 m” and “215 m.”

I told them a micro-story about it.

“The United States Navy is an example.
A submarine has 150 people on a submarine.

They get that number based on skill sets.

An aircraft carrier can get away with 2000 people.

The figure shows my design could have 150 people in the 100 meter diameter space ship,
and 1900 people in the 215 meter ship.

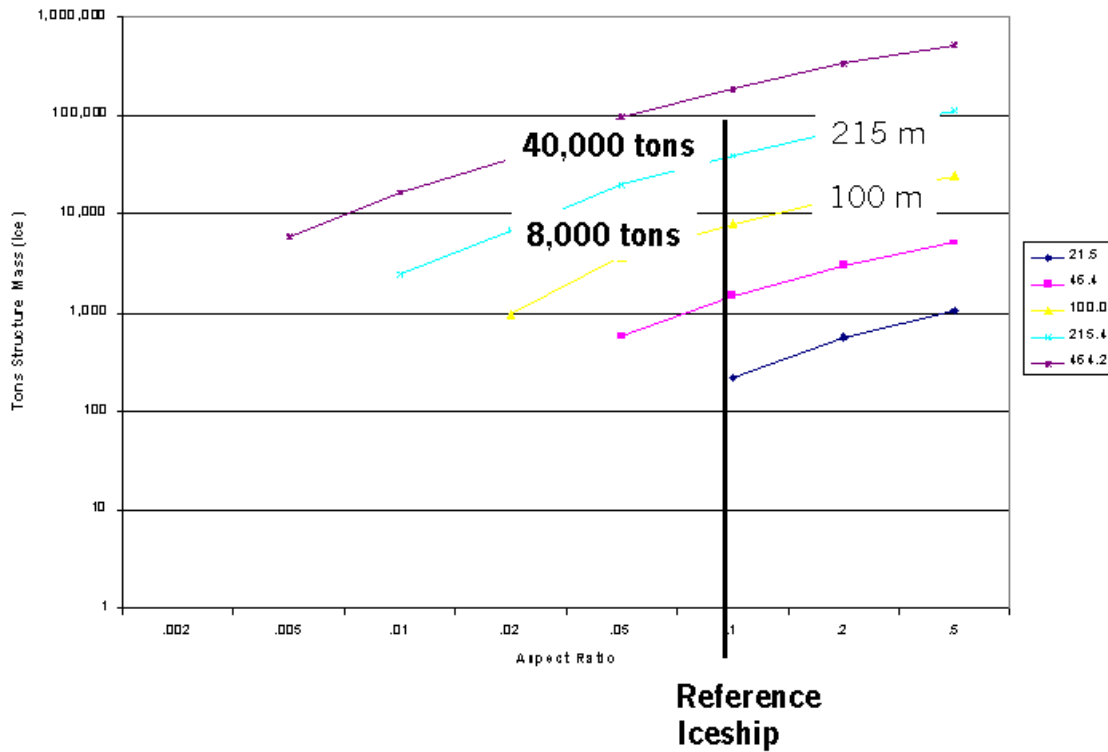
Will the ice rip and break from the centrifugal force and fly apart?

Will people be dumped into space,
blood bursting from their eyes;
pain, torture, exploding eardrums;
trying to scream but can't;
no air in their lungs?”

I watched to see if they got the joke part. The blood part. They did. They knew I was having fun figuring this. They sense I was figuring each detail in its turn.

I put the next illegible, incomprehensible viewgraph up.

Structure Mass vs Iceship Size and Shape



Structure.ppt
zuppero inee1 980423a1022

“Now we have to figure what shape to make it.

If we make the ship thin,
like a bicycle tire,
thin,
then it ends up with no room inside.
Too thin.

Astronauts.
Living cramped in a porta potty tube.
Bad.

Bicycle tire shape is the left part on this picture.
A big old doughnut or a bagel is the right hand side of the picture.”

They just wanted to know if the thing was going to fly apart.

I should have put little pictures in there. Bagels, doughnuts, bicycle tires.

“If we make it like a racing tire, like a really fat doughnut,
fat,
it is unstable and starts turning about the wrong axis,
like a coin flipping through the air,
like a tire flipping end over end instead of rolling.
Bad.

I picked a shape that was something in between.

This viewgraph shows how much it weighs.
You pick what it looks like
and how big across it would be.
The spreadsheet tells you how much it weighs.

If we make it too big across, it weighs too much.
If we make it too small, like a merry-go-round,
it’s so small that
everyone gets sick spinning so close to the axel.

So, I have decided:
Each person gets 100 cubic meters of space.
that is the volume of the biggest motel room in Idaho Falls,
the one for Moose hunters.

I decided to make it somewhere between
one football field and two football fields
across,
It will hold between 100 and a couple thousand people.”

“Then I calculated how heavy,
how much mass
how much ice the ship would be.

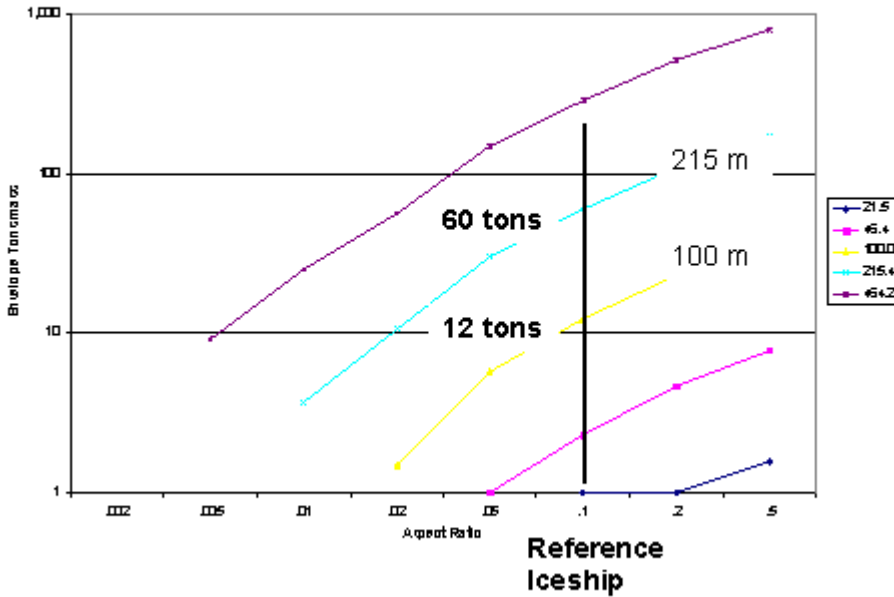
The mass came out between 8,000 and 40,000 tons

from the moon.
Maybe 50,000 tons.”

Anything under 50,000 tons
is ok.
We can get 20,000 tons of water,

I put the next viewgraph, still not telling them if it was going
to fly apart or not.

Required Envelope Mass vs Iceship Size and Shape



EnvelopeMass.ppt
zuppero lie1980423a1039

“How would we actually make this ship?” I asked the audience?

“How in the world would you make a torus, the inner tube of an automobile tire, 100 meters across, and with 1 meter thick walls, walls of ice?”

Waiting deliberately for their response and judging from the look on their faces I could see it wasn't obvious.

“You put a plastic bag around the outside of the tube to keep the water in, you put a plastic bag up against the inside of the tube, to keep the water out of the tube, and you freeze the water between the two bag.”

I knew this was so unclear that it needed to be repeated.

We would launch a bladder, some plastic bags, and inflate the space between the bags with water. The walls become the walls of the space ship.”

It wasn't clear to me that they got the picture. By now, having told this story so many times to 4th graders and rocket scientists alike, I realized it didn't matter. They just wanted to hear the story. So I asked them the key question about the plastic bags.

“What really matters is what we launch, the weight of the plastic bags, the mold, the thing we inflate with water.”

I wanted them to understand that it's dollars that count, not so much how much the ship weighs.

“How much would the plastic bag weigh?”

That's the only thing that counts, 'cause we have to pay for launching it.

If the water's out there, we have to launch the bucket to carry it.

How heavy is the water bucket?
How heavy are the plastic bags?”

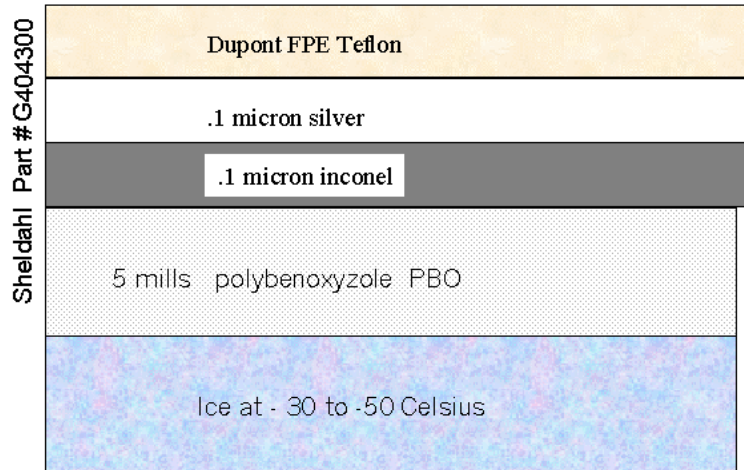
Maybe we launch them on the Space Shuttle.
25 tons is the Shuttle payload.
Anything under 25 tons would be ok.

What you see on the chart is what we launch.
That's what's important.
How much we have to launch.

120 tons is the Shuttle itself.
Maybe launch the plastic bags instead of the Shuttle.
Anything under 120 tons would be ok.

The plastic water bags would weigh
between 12 tons and 60 tons.
Not so bad."

Thermo Optical Surface Materials Provide Cooling to Very Cold Space



thermoOptSurf.ppt
zuppero inconel 980424

I still wasn't done. If we would have to take a refrigerator along to freeze the water, this idea would not work.

Joe Lewis at TRW saved the day. He knew exactly what to do and how to do it. A decade earlier, I had learned how to calculate how to paint a space ships to make it either freeze or heat up. Space is cold, minus 450 Fahrenheit. We want our space ships to stay warm, not freeze up. So we usually go the other way. But Joe Lewis knew in detail how to freeze the ship.

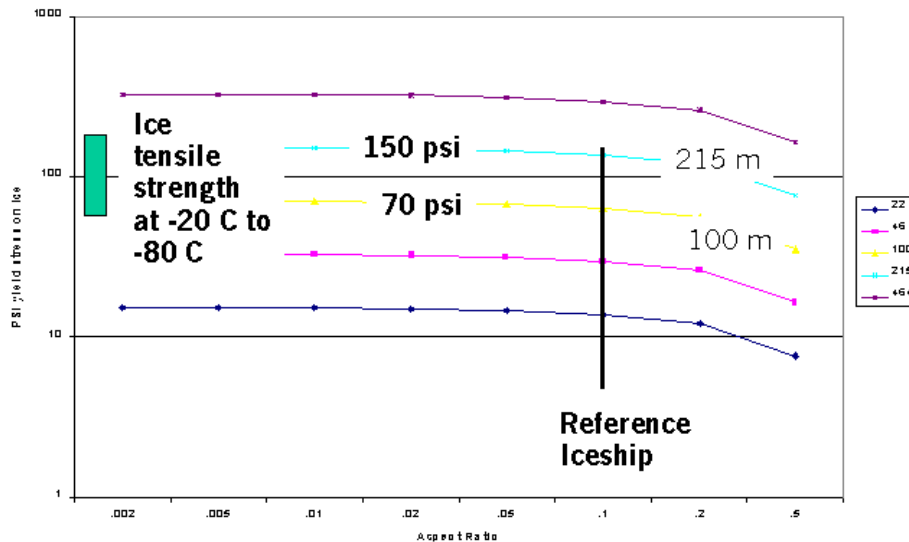
Joe Lewis at TRW would coat the plastic water bag with a commercial coating that would make bag radiate heat away. He identified it.

"Sheldahl Part Number #G404300," he bragged.

It would be like an anti-blanket.
Anti-thermal underwear.

They now had all the pieces.

Required Tensile Strength vs Iceship Size and Shape



Tensile strength.ppt
zuppero ineel 980423a1034

“Well, this says the ship won’t fly apart.” I said, as I put the last viewgraph up.

“The only data I could find was about river ice. Dirty water ice,” I declared, with a bit of exasperation.

“River ice with no bubbles and low salt has a strength of between 70 and 150 pounds per square inch,” I stated, dryly.

“That’s about half or a fourth as strong as a red brick.
Not very strong,
But plenty strong enough.”

“The big ship needs the stronger ice, 150 psi.”

I was done. So I summarized it:
“So, it won’t fly apart.
Seemed interesting to know.”

Now I waited for questions, killer questions.

If they would kill my concept, I would give up and use space bricks.

Or, I would give up and use a cage held together by steel cables. I had figured that one out, and it worked perfectly ok.
A little heavy, but ok.

The ship would be made of whatever they wanted,
and would be held together by steel cables.

They could not ask me anything I wasn’t ready to answer. I was prepared.

It was just like Mike Griffin told me 5 years earlier,
“they can’t ask me a question I can’t answer.”

“All water has bubbles,” somebody volunteered.

“Of what?” I asked,
“Carbon dioxide? Air? Nitrogen? Oxygen?”

“This is space water.
There ain’t no gasses in that water.
But if there are,
great,
I’ll use them,”

I declared.

Then I decided to toy with them.

“You know, ice is plastic if it’s a little warm,” I volunteered.

“It creeps,” I said, as I looked around the room, with a bit of a smirk on my face.

They all knew what that meant. I saw several of them start to chuckle. It meant it would slowly flow, a bit like silly putty. It would just slowly stretch and then snap.

People would be dumped into space. Gasping for air. Eyeball blood vessels bursting. Choking but nothing to choke. Ear drums bursting. Blackout. Arms and legs stretched out, slowly rotating,

moving away from the space ship, floating forever in the black of space.

A shower of little chunks of ice slowly spinning and reflecting sunlight where a space ship used to be.

“Does that kill it?” somebody asked.

“We wondered how to keep it from creeping. Actually, you could use duct tape. You could make duct tape strong enough to keep it from creeping.”

Even Mike Duke, the conference leader and funder chuckled when I said “duct tape.”

“You would probably use a role of steel cable,” I declared, sending the message that this whole scheme would work.

“Are the astronauts going to freeze to death?” somebody asked, laughing, waiting for me to answer the obvious question. He acted like he knew I was ready for the question and that he was my plant in the audience. He was smirking.

“Awh, heck no.

They don’t freeze.

They just put on their igloo suit instead of a space suit,” I retorted, taking my cue.

“These guys are Ice-tro-nauts.”

After the chuckles quieted down, I added

“It would be a bit like sitting against your refrigerator, the ice cube part.

A little bit of insulation and just like Eskimos,

ice on one side,

and you, comfortable, on the other.

- **JSC NASA Johnson doesn't care**
-

nasa jsc trip report
11/19/98 2:21:41 PM

NASA Johnson Doesn't Care

- JSC doesn't care
- intense frustration with bureau--crapse
- the Marines were telling something to the Army (nasa)

I replied to Ralph Bennett's question when he asked in the NASA JSC lunch room, "how did the trip go, on a scale of 1 to 10" "the trip went 3" I replied "oh, that's not so good." he said.

I elaborated. "it would have been 6 if we could have obtained a mandate to "look at this carefully", but I only got a door open to phone Lewis Peach to ask for more conversations."

John Martinell said I had unreasonably high expectations . But John had a good plan to follow up and felt comfortable asking Doug Cooke for help to get our management to put \$\$ on the topic. He was satisfied.

I asked them to give me the top 3 issues I need to address. their 5op 6 are:

1. near 0 Kelvin operations
2. reusability : launch RATE , number per day
3. water purity, not minor, difficult,
14 day hot, 14 day cold, the freeze cycle is not good.
4. ice?
5. economics: infrastructure cost
6. space solar power is a cascading miracles problem

> ASK Jeff George what name of person asking number of flights questions is.

We were at the jsc meeting in building 17, as planned.

Here is what the Kiwaniss Clubb representatiive would say about this meeting....

The NASA people were forced to sit and listen to this steam rocket story as a courtesy to Lewis Peach, and they had their minds made up strongly against considering lunar ice before the DOE bureaucrat scientist walked into the room. We need to thank JSC for being so courteous. The INEEL DOE scientists knew the audience would be hostile before he came to talk. And now we can all agree with the objections of the NASA JSC audience. Now we have data to be against lunar ice. We must deal directly with the reality of the harshness of the space environment.

NASA states that they can not have 700 trips per year per vehicle off the surface of the moon. Today this is indeed true. This will keep the cost of space transport 700 times higher than we taxpayers can afford.

NASA states that we don't know how to work at zero Kelvin. The basins are at 50 Kelvin, but the result is the same: we don't know how, so we can not expect to use chunks of ice there because it is too cold.

NASA's Dr. Dave Bartine says that we can't make the water pure enough for a reactor because purifying the water is not small ordeal. Further, he says, the 14 day hot and then 14 day freeze cycle just ruins the operations. We can see is objections. This means that we can not use the resources of the moon to lower the cost of space transport. Costs will remain at something like the current levels. These are too high for us to afford at this time.

The entire NASA JSC contingent does not believe that there are 10 Billion tons of ice. So there is not enough resource there to be used to lower the cost of space transportation. This means that we must launch most of the resources from Earth. Or, that we must liberate oxygen using rock electrolysis on the rocks of the moon. All of these options are too expensive.

The objections are that the infrastructure cost to put people on the moon to do Operations will be far greater than acceptable, and make this architecture no good. It doesn't matter whether this is for lunar ice or whatever. the manned lunar ops cost is too much. I agree. And the cost of a Mars ops is bound to be an order of magnitude greater than that. These are all unaffordable options at this time. We must do something smarter with our taxpayer's money.

The solar power satellite is indeed a hard thing to imagine. We won't need such a frail, expensive electric generator for centuries. Nuclear and coal and oil can all supplant the SPS. One errant atomic bomb from one errant nation, a small bomb, only a megaton, weighing only a ton of mass, can completely wipe out the 5 GW power station. In fact, it can completely disrupt a whole string of them, all at once. it could put the earth out of business in one sweep. DOE should get out of this topic, as should NASA.

I am also against using taxpayer money for a field trip to Mars at our expense. We can do this any time we choose. Why do we need to waste this money now? Our children can go there when technology is better, when there is less fear of nuclear power in space. They can start fresh, without the stigma of a space station.

Bret Drake, kept asking questions intended to debunk the whole idea.
he asked "where you want to operate?" ... in the dark and cold?
I thought he didn't like me operating in the warm. instead, he said we had no experience in the cold

and later he asserted: "we don't know how to work at zero Kelvin."

Doug Cooke said "we have several issues we have to look at yet." as he tried to shy away from me and the topic.

Lyle Jenkins tried to tell me how to fix the presentation, and thought there were ways to make solar power satellite topic acceptable.

Lyle will send me an email to connect us again.

Lew Peach pointed out that the "it" in "tell us to look at this more carefully" was the issue. I transmitted the wrong "it." I focused on the solar power satellite. and this is viewed as a "cascading miracles" topic.

Lew Peach indicated that it was not clear, even to him, that I meant we would put the SPS struts and girders up for \$5 per pound. He said "How will they ever get \$200 per pound to orbit?"

Lew articulated a path stating that the new associate?? administrator stated he wanted to consider:
other destinations than Mars
cooperative work with other Agencies
and something else I can't remember

>John Martinell will contact him.

Bartine said the purity of the water was a serious issue, because a regular nuclear power plant has a problem. He implied that it was not solvable without great infrastructure penalty.

I agreed that if there are hydrocarbons in the ice, we will not be able to distill them. This will be a problem with the comets. they are 1/3 hydrocarbons. you can't distill hydrocarbons mixed with water. You can distill minerals and salts. I said I learned this in college when I made whiskey. There is an azeotrope that prevents it. Bartine shows so obviously and plainly with his involuntary facial expressions that he doesn't want this steam rocket and doesn't like it and won't work on it. Bartine relays a difficult interaction, even when I met him half a dozen years ago.

Bartine also asked "you are going to use a bladder tank?, is that it." and he started writing, transmitting with his face "I got you now. you are using a bladder tank that won't work."

I then told the story of how a bladder tank in "crushing lunar gravity" made "unarmored" would hold 3000 tons of water in a 1 ton tank. But I said of course, Unarmored, it would leak. So you loose an order of magnitude, and we should make a tank with tankage an order of magnitude better than cryo tanks.

I mentioned the 6 mm Hg vapor pressure.

There was a laugh of approval in the audience when I mentioned that one can collapse a bladder tank. You can pack it like a parachute in the back of the shuttle bay.

Brett Drake won't work with ice because of as many reasons as he can think of. The first is that he won't work at zero Kelvin.

I forgot my calculator at the podium. It is the radio shack one they don't make anymore, the one with the hohman transfer and the interest rate equation I programmed into it.

Darel Branscome didn't say a word or ask a question. He just listened.

I told Susan Serna that the talk went horrible. she didn't know what to say.

joyce carpenter didn't say a word or ask a question.

doug cooke didn't ask a question. he sat at the important position, the head of hte table.
to his right were darrel branscome and lou frasenata.

Bill Eoff kept asking good questions, but I forgot what they were in detail. he asked about the first step, the 1% of the infrastructure size.

Eoff also asked who was doing the solar power thermal rocket work. I said "hawk at huntsville U of A."

Sadly, no one wanted to talk with me after the talk.
Lew Peach got cornered, Jeff George said hi just for grins.
Joe Nieberding or someone near him asked how much payload for a fast trip.

Zubrin's friend said "700 launches per year? We can't do a few" I should have said "NASA better get to fix that"

Instead, I said "I'm not going on an airplane until the probability is very low of something bad happening." I mentioned that Aldrin felt it was ok to sit on something big that would explode, but I won't."

My example was that the submarines came up, all but 2 times in 50 years, as often as they went down. so I could do that many cycles.

Bartine, Dave
Branscombe, Darrel
Call, ??
Carpenter, Dr Joyce
Cooke, Doug
Drake, Brett
Eoff, Bill
Frasenetta, John
George, Jeff

Jenkins, Lyle
Mandell, Hum
Nieberding, Joe John
Peach, Lewis
Serna, Susan in office
Yell, Beverly, in doug cooke's office
Zubrin's buddy who is the alan alda person with him on tv

Ralph Bennett

Residence Inns
281 486 2424, fax 281 488 8179
Residence Clear Lake,
525 Bay Area Blvd,
Houston, TX 77058,

To: Anthony C Zuppero/ZCA/LMITCO/INEEL/US
cc: "MANDELL, HUMBOLDT C. (HUM) (JSC-EX)"
<humboldt.c.mandell1@jsc.nasa.gov>, "SERNA, SUSAN (JSC-EX)" <susan.serna1@jsc.nasa.gov>
Subject: Presentation at JSC Nov 19

this space stuff is just not worth it.
anthony

day before, with ralph bennett, at lockheed martin:
J. D. Frick

John Martinell
La Quinta Inn, 15 miles from here,
9902 Gulf Freeway,
713 941 0900

he got stranded in atlanta coming back from belgium
he got into the hotel about 11 something pm
belgium:
phone 32 2 725 10 00
fax 32 2 725 11 55

Anthony Zuppero

Nassau Bay Hilton And Marina
281-333-9300,
FAX-281-333-3750
3000 NASA Road One,
Houston TX 77058
CONFO-P10382

We have reserved conference room 2065 in building 17 for your presentation to the Exploration Office and members of the NASA exploration team on Thursday, 19 November 1998, beginning at 8:30.

Please contact Ms. Susan Serna directly at 281-483-3843 so that we can arrange to have badges available for you and your party at the JSC main entrance and badging office.

A map to JSC and hotel information is available at:
<http://inspection.jsc.nasa.gov/map.html>

Joyce Carpenter
Deputy Manager, JSC Exploration Office
281-483-5229 (phone)
281-244-7478 (fax)
joyce.e.carpenter1@jsc.nasa.gov

19981119JSCnasa factor 1000 and steam rockets zuppero, anthony;
martinell, john; bennett, ralph 5 minutes; ; Bartine, Dave;
Branscombe, Darrel; Call, ??; Carpenter, Dr Joyce; Cooke,
Doug; Drake, Brett; Eoff, Bill; Fransenetta, John; George, Jeff;
Jenkins, Lyle; Mandell, Hum; Nieberding, Joe John; Peach,
Lewis; Serna, Susan in office; Yell, Beverly, in doug cooke's
office; Zubrin's buddy who is the alan alda person with him on tv

- icemoons work, and so do Shoemaker's nea's
- TBD ... to be done yet
-

Twenty One New Worlds To Occupy tbd

Scene name, time:

Twenty One New Worlds To Occupy

Scene:

sitting at my desk in the office in Idaho,
with the Idaho snow weather visible out the window to my left,
in my mind feeling the chill of the cold.

I was out on my own. I had quit space. Space looked too dismal.

I was not employed by INEEL anymore. I left. "Retired" so I could get 70% of what I would if I retired at 65, but only \$500 a month. I was really on my own. I had just changed my main career path to my secondary one, my backup plan, the one I had worked on since the early 1970's. It was not related to space at all.

As a diversion for a moment, I do that calculation again, the one that is always fun to do. I calculate the lift-off payload for a steam rocket. It always works out that it just barely works just fine. The calculation is always satisfying to do.

Expected: .

The payload is going to be no good at all for the ice moons of Jupiter. I had done this before with a couple moons of Saturn. Long ago, when I visited UC Santa Barbara with Alyson, for a parents day, in the little cramped dorm room they gave me, I calculated the payload for Iapetus and Hyperion of Saturn. I forgot the details, but the mission was too hard to.

This time, I had a better spreadsheet to calculate steam rockets off the moon than I did then. I had refined it so that it would give fairly reliable estimates of performance. It was good enough to pick a fight with NASA, *and win*.

I fully expect that the answer will be that the moons of Jupiter are just a bit too big for the steam rocket. Mars is definitely too big, too heavy. The planet Mercury is too big, too heavy, and harder to get to than Jupiter.

I remembered that 5 or 6 years ago when I did this, Ganymede and Callisto were too big, too heavy. Not by much, but too heavy. The steam rocket would not be able to lift off with a big enough payload to be astounding.

Did not matter. I was taking a 10 minute rest from the other, full time work I was doing. This was relaxation. If the answer were bad again, it would just affirm that my decision to leave Rocket Science and the INEEL laboratory was precisely correct.

So I put in the most recent data I had just gotten off the internet for the moons of Jupiter. I started with the biggest moon of Jupiter, Ganymede. I used the steam rocket I have been using for the entire time I have been at the INEEL, and for the time I have been at GD. No changes in rocket performance. Everything the same as before. I knew what would happen. The payload would be 20 tons instead of 30,000 tons. The only useful payload is 30,000 tons. The only way to get 30,000 tons from a 20 ton payload is to take "30,000 / 20" trips, which would be, 1500 trips. That would be ok. 5 trips per day for a year.

If the answer came out like our own moon, it would be ok. But it isn't going to come out that way.

The gravity is too high on those big moons of Jupiter. I know it. I expect the answer to be junk, bad, no good, worthless. Space is worthless. I know it. I just abandoned a whole career because space is worthless.

Unexpected result:

Ganymede: it is about the same as our moon. A bit less payload, but about like our own moon. And there is water ice everywhere, not like our moon. And, it is on the surface in the light. That makes it much easier. On our moon the water ice is only in the dark, forever dark, deep craters at the poles of the moon. Ganymede's ice is everywhere.

"Hey!" I thought.

The internet had just yielded a at least two sites that had the data for just about all the moons of the solar system. Pictures of the moons. Data for the moons. This was marvelous.

Instantly, during the next hour, I explored using each and every moon I could get data for, for each of the big gas giant planets, Jupiter, Saturn, Uranus and Neptune.

Every one of them worked out. They were all either as good as Ganymede or better.

They were as good as water on our own moon, except out there.

His reaction:

"Hey Tom Larson. Is that you?"

"Hey, guess what? The steam rocket would work on the moons of Jupiter."

"You should have stayed here," he replied.

My reaction:

"Naw. But if we ever get serious about space, we could go to the moons of Jupiter and the steam rocket would work like crazy."

What I decide to do next

I would calculate a few variations of the moons to see how well we could go from moon to moon, once were occupying Jupiter's moons. I would calculate the alternatives, using water splitters.

Then:

Tell everyone about it whenever I talk.

Every time I talk, show pictures,
of the 21 water moons humans could occupy,
new worlds,
in our Solar System,
close enough for us to get to in our lifetimes.

How Ice could do it.

yes. no, don't. yes, do. no, don't do it.

Ok. I would show how splitting water would work once we are occupying the places. Then we would use LH2 NTR's and go faster. But the payloads would be less.

No. I decided that I would not get into space and try to convince the world that we should use liquid hydrogen nuclear rockets to do anything.

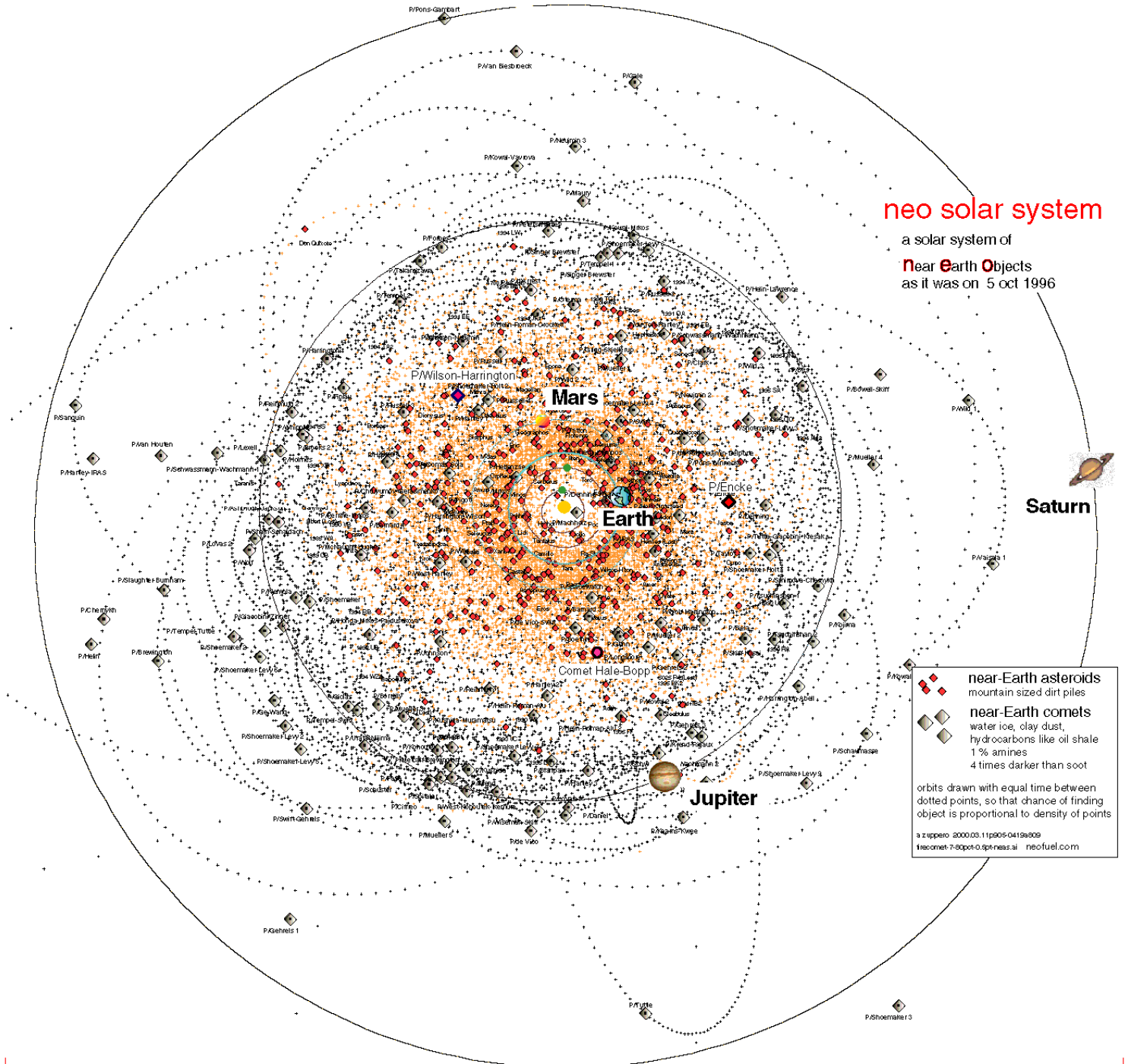
No. I would not even try to convince anyone we should do it with steam rockets.

Yes, I would only show pictures of the moons,
and tell them of the performance,

and let them figure it for themselves.

No, I decided to get out of space,
and that's that.

To Inhabit the Solar System



neo solar system

a solar system of
Near Earth Objects
as it was on 5 oct 1996

Saturn

Earth

Mars

Jupiter

near-Earth asteroids
mountain sized dirt piles

near-Earth comets
water ice, clay dust,
hydrocarbons like oil shale
1% amines
4 times darker than soot

orbits drawn with equal time between
dotted points, so that chance of finding
object is proportional to density of points

z.zuppero 2000.03.11 1995-04198309
firecomet-7-80pct-0.5pt-neas.ai neofuel.com

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It all comes together (too late)

"A trip to the nearest star" wrote Dyson. That is how this story started. Freeman Dyson was a famous physicist. During 1968 I read what he wrote about an atomic bomb powered starship. Believing his calculations, I followed,

trying to make it so. Like most scientists, I dissipated an entire career's lifetime trying to get where some other, inspiring Visionary pointed. His Vision pointed to being able to make a starship that could take us to the nearest star.

I did it because it was fascinating. I ended up poor because nobody is going to space. I ended up poor compared to my brother-in-law the construction worker, or my brother-in-law the probation officer, or my neighbor the carpet layer. But I had a trip, a marvelous adventure, and I really did find a way for us to inhabit our new solar system.

A new solar system for us to play in is what the others found, one little planet at a time. Little Planets were everywhere, it seemed. All I had to do was permit us to say in public that something as small as a mountain, going around the sun like the Earth does, is a planet.

Little planets are planets, too. They just aren't as big as Earth.

Most of what they found were so small they were almost ashamed to talk about them. They called them "objects" instead of planets. The objects seemed to be everywhere in the space near Earth. They called them "near earth objects", or "neo's".

When I listened to them carefully I heard them describe objects made of water in some form. This was new to me and somewhat new to them. They had just learned more about the water ones. Some objects were comets, made of ice and dust and something very much like oil shale. Others were asteroids no bigger than a mountain, but made of a clay, not rock, that would give off steam when you heated it in a kitchen cookie oven set to "self clean". Others were whole moons made of rock and ice, and unknown things. Even the planet Mars supposedly had water. Mercury had ice deep inside forever dark craters at its forever dark poles. I thought it was quite strange that Mercury had poles with deep craters that never saw sunlight. Water was apparently everywhere.

All I cared about was the water.

When I found out about this waterfull neo solar system, the "near earth object" solar system, neospace, the Vision became irresistible and totally captivating.

That original starship idea of Dyson's was way too hard to do, to send a thousand people to the nearest star. But sending us to inhabit somewhere in the solar system was only expensive. It was only quite hard to do. And, it was *not too hard* to do.

Each time I looked at the problem of making a big space ship, I would find another something that would stop us from inhabiting neospace during my lifetime. Some horrible problem would burst out of the deep details. Then, after a week or a month of despair, sometimes a year or three of despair, I would find something else that would counter the problem. That would light the flame again.

The Rocket Scientists would reject me often, because I boasted I could use the water directly. They said it would not work as well as their high performance rockets. I failed to point out exactly why it would work and that my way was the least expensive. Their way got us there the fastest, but mine could haul 1000 times more payload for the same money. I never explained it clearly. I was not smart enough to communicate it. So, I went away sad and they often went away as fast as they could.

I grew a Vision in my mind of us inhabiting the new solar system, the solar system of near earth objects, the neo solar system, neospace. I thought it was real. Many others still do. Those rocket scientists who actually calculated what I said, they agreed with me. But it is too late. It came together too late.

Inhabiting neospace is too hard to do now, right now, and I am now too old.

Part of my own failure could be that I was diagnosed with Asperger's autism. My genetic breed of human focuses hyper-intensely, often displays completely inappropriate behavior, and takes people literally. We are sometimes called "Aspies".

Most of us Aspies are a bit like Spock, of Start Trek. Aspies typically have a 130 IQ. This weird combination of inappropriate behavior, smarts and focus makes me and Aspies like me sometimes hard to follow and a bit difficult to work with or understand. I was an Aspie and it showed.

But that was not all.

We are the wrong species to inhabit neospace. We breathe. We walk. That's the wrong species for neospace. We are like sea clams who think we can just go live in the forest, where there is no water to breathe, and where our clam's foot does not work.

Part 02: The Starship



Nuclear explosions, to power a Starship

Long ago, when we discovered and detonated the atomic bomb, it released a Virus Of Change. It infected us with visions of really leaving the planet, and not just as ghosts. For the first time, we thought we could someday inhabit space. The energy released was extreme.

How could we use this? Could we make cars that never need gas? All cars need gasoline. Could we make airplanes that just keep flying and never need to refuel? Could we heat our homes without ever needing to chop wood or shovel coal into the stoves?

When I heard of the atomic bombs, I was little, 7 years old, and had to shovel heavy coal into buckets and carry them in. My father had to lift the heavy buckets and dump the coal into the mouth of the pot belly stove in the dining room. Could we use nuclear heat to escape this?

Could we use the atomic bomb energy to make rockets? The Germans used rockets to send bombs to England during World War II, to kill civilians, on purpose. Both the Russians and the Americans were making rockets that

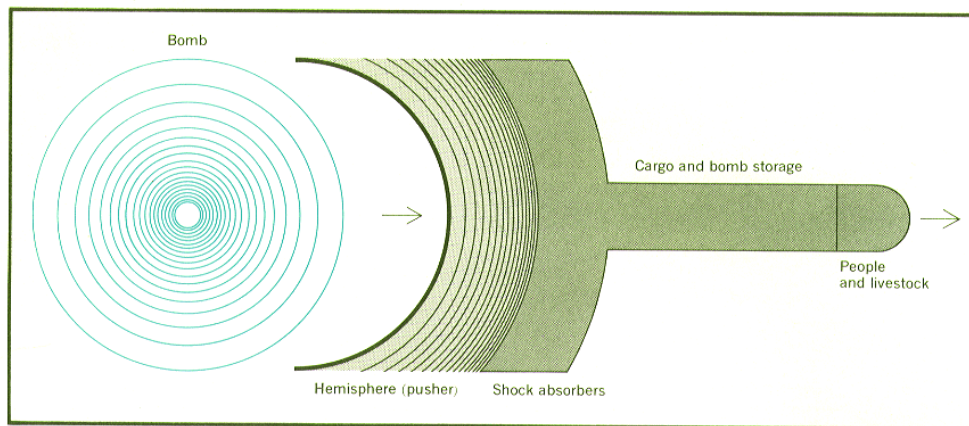
would kill all the civilians in the whole city all at once, on purpose.

If we would use the nuclear energy to power the rockets, could we go to Mars or Venus, instead? Flash Gordon went to Mars in the movies.

It had been a dismal time, a dark and stormy time, a confusing time when I was 23 years old, a graduate student in Physics. Blacks were Negroes and had to sit in the back of the bus. People shot the Kennedy's and Martin Luther King. The Democratic Parties of Chicago and Kent State beat us up and killed us because we did not want to go to Viet Nam to kill Vietnamese for them.

That was when I read my copy of a technical trade journal for physicists, October 1968. It had the words:

*".... take a town the size Princeton New Jersey to the nearest star
..... cattle and livestock "*



BOMB-PROPELLED SPACE SHIP. Debris from the exploding bombs transfers momentum to the shock absorbers and hence to the payload section of the ship. Mission velocities for this primitive design would be 500–10 000 km/sec; the upper limit is similar to supernova-debris velocities:

Freeman Dyson would propel our spaceship to the nearest star by pounding it with repeating atomic bombs. It was atomic bomb blast propulsion.

Freeman Dyson's article with title "Interstellar Transport" was the first event, a start for me, 40 years ago, on *a Vision to Inhabit the Universe*.

I did not know it was fanciful. "Fanciful" can mean having a curiously intricate quality, or it can also mean unreal, not based on fact. This one, single, fanciful article inspired me to spend an entire career trying to make and power the space ships for us to inhabit outer space. I stuck with it even when it would not work like Dyson said. I even stuck with it when "space" would only mean the space near earth.

Little did I know that we would be the wrong species, or that I would get old before we could do anything.

I learned the puzzle pieces one at a time, not knowing it was a puzzle with missing pieces, and pieces that had to be found, pieces mixed in a box of other puzzle pieces.

So naive, I thought everyone would want to go to space if only we had a rocket ship that could do it. For about a dozen years after that I kept figuring ways to use atomic bombs to make an atomic bomb powered space ship to travel the Solar System. The atomic bomb rockets seemed to be so powerful, so Almighty.

However, no matter what I did, the figuring always gave the same answer:

"needs too many bombs."

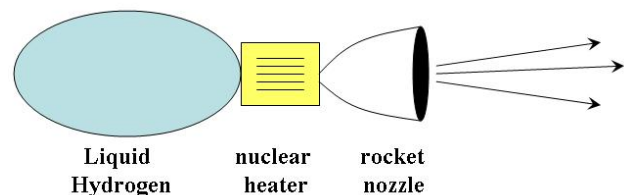
Part 03: The Nuclear Rocket

The next piece of the puzzle to Inhabit the Solar System was the NERVA rocket. Dr. Mell Merrit, who was in charge of some atomic bomb testing at the Nevada Test site took me there and showed me. He boasted "this

rocket ... would take people to Mars."

And there it was, a nuclear rocket that was supposed to do just that. So simple: a nuclear reactor super-boiled liquid hydrogen, which expanded directly in an attached rocket nozzle. Simple. The sign said it was radioactive. Mell Merrit could not stop me fast enough to keep me from running up to it and trying wrap my arms around it.

Simplest Rocket Ever



President Nixon, a newly elected Republican, had just killed the program. Mell Merrit, a Democrat, said Nixon the Republican killed it because it was President Kennedy's program, and Kennedy was a Democrat.

Two decades later I learned that Nixon killed it because NASA told him it would cost \$40 Billion to go to Mars with that rocket, and there was a huge recession going on. In today's money that would be like about 1/2 Trillion dollars.

That was how I learned that all space programs
"need too much money"
 and
"space programs are political"

If I could only figure a way to transport 1000 of us through the Solar System, everyone would want to send space ships to Venus and Mars, and maybe to the moons of Jupiter and Saturn, and we could inhabit the Solar System. All we needed was the space ship.

That's what I thought.

The NERVA failed my quest because it
"needs too much liquid hydrogen".

These Bad Things kept appearing.



A small nuclear reactor powered the NERVA rocket. NERVA used liquid hydrogen propellant and could have taken us to Mars during the 1970's.

Part 04: Space Dust and Water

"If I could only figure a way to transport us through the Solar System," I repeated to myself, "then everyone would want to send space ships to Mercury and Mars"

I thought, naively, that we would want to go to the planets and to the moons of Jupiter and Saturn, and we could inhabit the Solar System.

"All we need is monstrously large space ship and a way to power it." I thought.

That's what I still thought. I would not give up.

Then one day a colleague, Dr. Jere Harlan, told me about a spark exploder that could explode anything, dirt, space dust, to high speeds. He told me to try that as a rocket.

What a concept, "use space dust as rocket propellant," I thought. There was plenty of space dust in space, so we could have as big a space ship as we wanted.

I figured and calculated, and calculated and figured, and got another kind of bad answer:
"needs too much electricity."

It turned out that no one could make much electricity in

space. That was completely unexpected.

I could not make a good space ship using space dust and spark propulsion because nobody could make enough electricity to power the sparks.

But I did not give up.

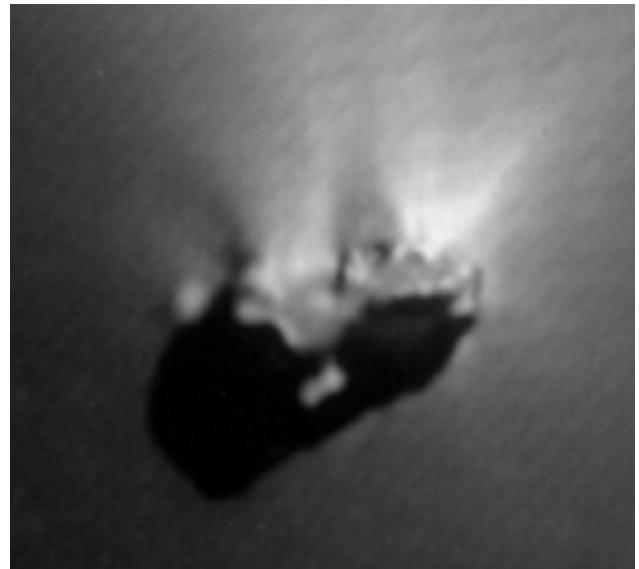
If I could only figure a way to get some propellant that I could boil, and use it in a rocket like the NERVA, everybody would want to go to space.

That would do it, I thought.

One day Dr. Marsha Neugebauer visiting from NASA's Cal Tech Jet Propulsion Lab told an audience about the plasma vapor in the tail of comets. As I sat in the audience listening, I calculated how water would work in the NERVA type rocket. That would be a steam rocket. It seemed to work a little, just barely enough to be interesting. Who would know about the water in space?

After her talk, I ran up to here as fast as I could and asked her if she knew any place in the solar system where I could get water, real water, not just water locked in the rocks as mineral hydrates.

"Of course, right here" she said, pointing to the just discovered water frost on comet Halley, as she pulled out her personal, only copy of the European satellite picture.



"water fog" from the comet Halley, from a European satellite picture

She totally shocked me.

From then on, I was looking for water and only water, in the space near Earth.

If I could only figure a way to transport lots of us through the space, I repeated to myself, then everyone would want

to send space ships to Mars. I somewhat gave up on going anywhere but to Mars.

And, if there were any water in space, then that steam rocket would surely work. When I evaluated steam rockets I found they would just barely work. Not wonderful, but ok.

One person tried to tell me to get back to work. Don Summers was a mathematician working on a project I led to point telescopes for our spy space ship. We were doing this for another space agency of the United States. When I displayed loud excitement at finding the steam rocket, he came up to me, right up to me, poked his index finger into my chest, and poked while he told me, point blank:

"The Conquest of Space
is going nowhere
until there is a
Clear Profit."

I never forgot his words. I went back to work, but I did not stop calculating it.

On a ski trip to Vail Colorado, April 1987, I was relaxing and calculating space ships. I was riding in the back seat of the car with our daughter driving. On the long, 8 hour trip I wondered just what would be the best kind of rocket. I finally got the equations into a simple form.

The next day, during the short, 15 minute time when our relatives were making coffee and mixing pancake dough, and making fun of me for calculating while on a ski vacation, I solved the simple equation.

Astounding! The equation showed that steam rockets would take a huge payload to Mars, bigger than a NERVA rocket.

That made me so bold, I ignored the next person who told me I "could not do that and work here."

Not so bright a thing to do. That guy was my boss's boss. However, I agreed with him and I was so hyped that I abandoned my perfectly secure, high pay job as a rocket scientist in a highly secret government job.

Part 05: " Rocket Science "

Sticking with it, I went to work as a Program Manager at General Dynamics, Laser Systems Lab. We would make space ships with powerful communication lasers for another space agency of the United States, a branch of the U.S. Navy. I brought along a complete, personal, Secret, Hidden Agenda, a Vision for us to leave the planet.

I had to bootleg my steam rocket space ship using my Hidden Agenda. Dave Nickerson, from the Space Defense Initiatives Office was elated when I leaked my Vision to him. He quickly found me some space-topics money to evaluate the steam rocket.

To my dismay, Dr. Bruce Jokell from another part of General Dynamics got the money and got to be in charge. He completely ruined the whole concept and made the study show how we could get liquid hydrogen and liquid oxygen from Deimos, a moon of Mars. He used a nuclear electric generator and an electric water splitting device and an electric refrigerator. He screwed it all up. It showed how he could make about 20 tons of rocket fuel.

I was completely unhappy. If he would have done it like we intended, we would have delivered about 5000 tons of water for the steam rockets. Bummer.

He was happy, but screwed it up. He was completely unhappy with me, and should have been. I was too much autistic with Asperger syndrome to realize I was not communicating properly. And, stubbornly, I would not give him the clue to make it work because then he would get the credit. Everyone went away mad.

Right after that failed study, the Cold War ended and nobody cared about space ships with lasers or space ships at all. Everyone was out of work.

Having a lot of time on my hands looking for work, I looked for any kind of work. But there was none, not for high paid Program Managers in southern California just after the Berlin Wall fell. There were 100,000 engineers and scientists looking for work.

"The war is over. Quit shooting people and go home" was what they wanted us, the Cold War Warriors, to do. Nobody cared about anything any of us were good at.

Having a lot of time on my hands, I called many people in the field of near Earth asteroids, and went to several near earth asteroid meetings. There, I found to my surprise, they told me about whole swarms of ice objects, mostly almost completely dark and invisible, lurking between here and Jupiter. Dr. Ted Fay, an astronomer at McDonnell Douglas promised me he would find me my ice, and he did.

These were gas stations in space. Amazing. They were made of dirty water ice.

When I calculated how accessible they were, to my great surprise again, I found the steam rocket could get there and back, and bring huge, monstrously large payloads back, more than the mass of 100 Space Shuttles.

I was hyped, and out of a job.

With even more time on my hands, I also found out that ice could be strong enough to make a spinning space ship. I would save that one till later.

Not many people would believe me because steam rockets

were so much worse than the NERVA rocket and worse than the NASA rockets, and worse than the powerful Russian rockets.

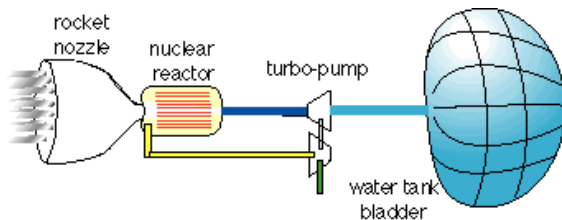
Part 06: The *Real* Rocket Science

Marland Stanley at the U.S. Department of Energy in Idaho hired me when I drew my steam rocket on his chalk board. He hired me to make nuclear rockets to go to Mars. Marland understood immediately.

Still, almost nobody else anywhere believed you could use a steam rocket. So, Marland and I and his crew worked on NERVA type rockets and nuclear electric generators to power space ships and other things. We were cooperating with yet another space agency of the United States, the Star Wars guys in the Pentagon. We also worked with the NASA guys to test the nuclear rockets for the Mars mission.

All this time, nobody at NASA would believe anything any other space agency would tell them. A NASA Manager said "we are the Mercedes Benz of space agencies." Our nuclear engine and our version of the space electric generators were always under scrutiny. Their versions were untouchable. We could prove theirs would not work like they said. But they were "the Mercedes ..."

And, NASA seemed to have no vision at all. Their only goal was to *visit* Mars. Ours was to *occupy the Solar System*.



Steam Rocket: heat water using a small nuclear reactor. Connect a rocket nozzle directly to the heater.

NASA's main goal, it seemed, was to do somersaults in a space bubble, plant flags and brag. NASA seemed to want a Field Trip to Mars, At Our Expense.

I had a very hard time, even though my steam rocket was now main stream and accepted at the Idaho National Lab.

All that turmoil forced me to compare space trip expenses, theirs vs. mine.

That was a jolt, a total surprise. The steam rocket space transport might lower the cost by factors of hundreds. It would be 100 times less expensive than what the NASA rocket scientists were doing.

Mine was less expensive because I used **zero electricity**. All my rocket science competitors would have to use electricity, huge amounts of it, to make rocket fuel from water in space *and haul the same payloads I could*.

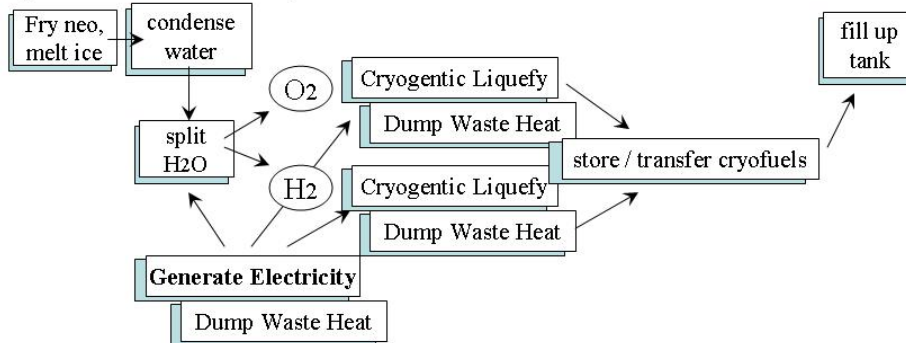
All I would need to do is heat the space things, to fry the neo's, or melt the comet ice. Lucky for me, I would not need to heat them so hot the rocks would melt. That would really clog the pipes when the lava got cold. I would just collect water and use it directly in my rocket.

Simple, simple, very simple.

inhabit neospace:



expensive visit to neospace:



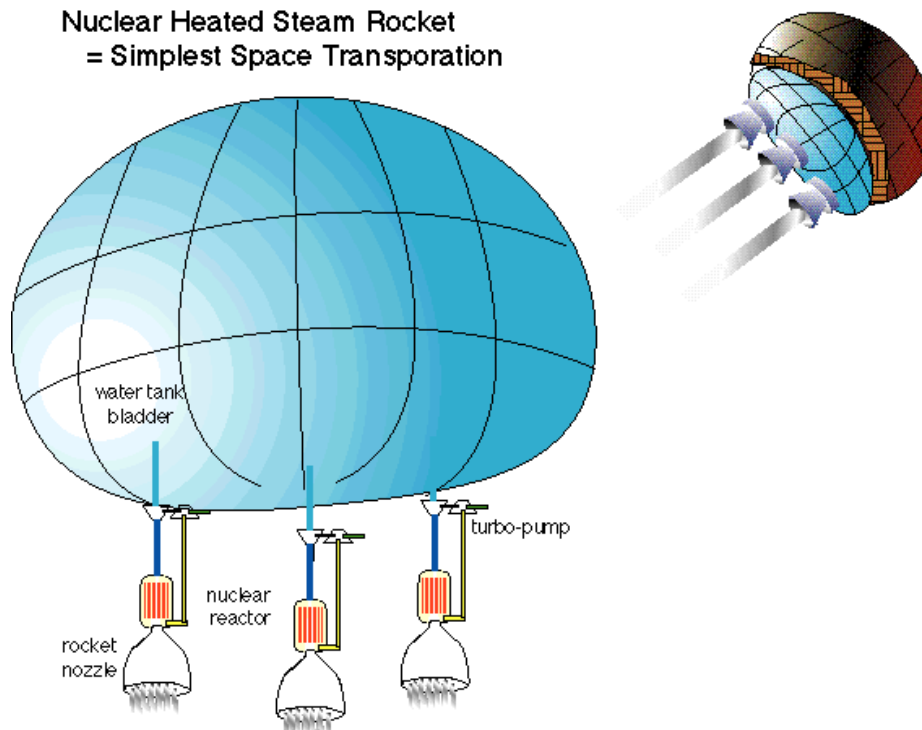
See how simple the top part is compared to the bottom part? Nature surprised me. Nature gave us a gift (the top part). We can use the water directly, straight off, in a simple steam rocket. We do not need to go to the trouble of making rocket fuel from water (the bottom part). Getting rid of electric generator and other hardware in space results in lower cost, by a factor of about 100.

Part 07: Space Water Hard Times

However, I still needed huge amounts water in space to fuel a steam rocket. I needed 1000 times more water than the other guys. One could almost see it in my illustrations. Rocket scientists said there wasn't much water out there, and that I was wrong anyway because steam rockets were so much worse than regular NASA rockets. Even though they were wrong, I learned that my steam rockets *"need too much water"*

It was a dark and stormy time. Another recession hit the technical people because the Berlin Wall fell and the Commie Pinko Rapist Atheist Russians were now friends. A few even went to Church.

Nobody cared about space or space ships or planting flags on Mars to show the Commie Atheists that our way was the better way. Suddenly, we saw they were people just like us. And we did notice that their space ships carried lot more payload than NASA's.



A steam rocket would use water stored in a very large bladder. Nuclear reactors heat the water, boiling it into super hot steam. Rocket nozzles use the super hot steam to propel huge payloads. It makes the simplest complete system in space.

I looked for anyone who would know where water would be in space. Almost no one knew. This was not a popular kind of astronomy. Almost no one did it. The problem was to find water or ice in space, and near enough to get to and accessible enough to be useful.

There is no glamour in finding rocks and ice cubes in the solar system.

At first, I did not get it. After all, I worked for *another* space agency of the United States. We did not ask NASA for their opinion about our satellites. When we launched, we did not ask them first. Instead, we told them where our rockets would be, so they could not crash into our expensive payloads. But I asked NASA anyway, this time.

The young NASA expert was right when he told me how it really was, over a very cold, very big, full quart jar of

beer at a Space Experts Party at my home, 1992.

"A young kid doesn't say 'When I grow up I want to be a space rock miner.' Kids want to be an Astronaut and go to Mars. It's all about excitement."

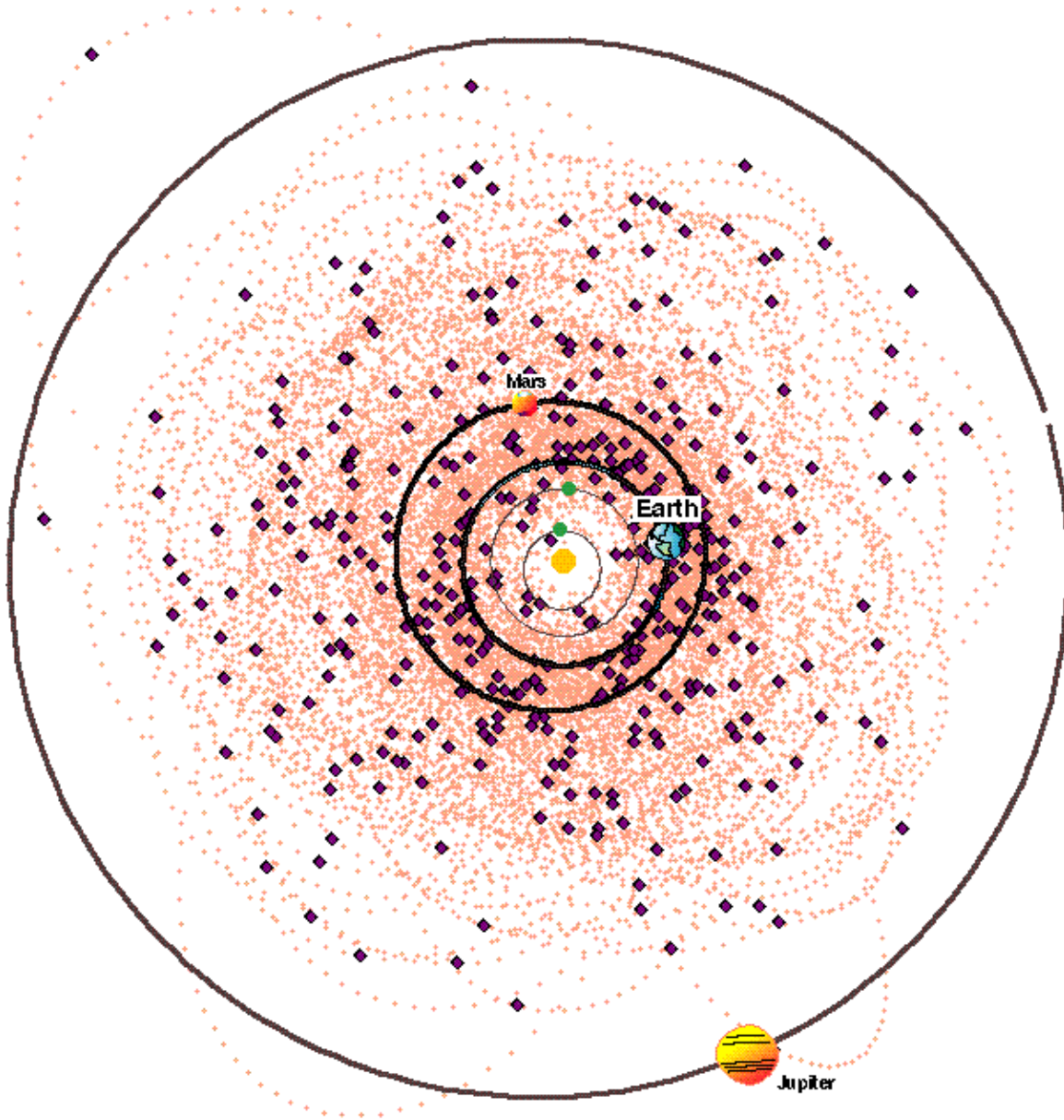
It was a sad time for me, because he was right. I learned:
"there is no excitement in being a space rock miner"

Meanwhile, my *space rock miner* colleagues found a swarm of mountain sized objects in orbits that come scary close to Earth.

Mark Sykes, Tom Larson, Pat Whitman and I plotted their orbits and where they were. The dark diamonds are the "near earth objects", **neo's**, and the pink dots were the orbits. We could see with our eyes it was scary.

I was looking for water, and all they found were rocks in space and how the sky was falling.

NASA spun the rocks-in-space story into super scary



Asteroids smashing into earth!

Hey!
Almost "The End Of The World!"
Hey!

Of course, they did not say it that way. They used professional vocabulary and phrasing.

NASA wanted space survey telescopes to find all the killer asteroids. And then they wanted missions to push the killer asteroids out of a collision path with Earth.

This was fun.

It was a great story. I would tell and retell the scary story to grade school children in Idaho, to Rotary clubs, to the Kiwanis clubs, to Senators, the Pentagon, The White House, the Discovery channel, to anyone who would listen. They all did. Eagerly. Fun!

I would describe vividly how it happened many times during geological history.

This was quite seriously fun.

A mountain sized, near earth object would hit the Earth. The whole sky would ignite, on fire, over a continent.

The blast would create 1000 foot tidal waves. Higher than tall skyscrapers. Each time the global catastrophe hit, The End of the World as we knew it happened.

I would describe how it was before our Life Form was even fish. Long ago, when we were just slime and microbes deep in the dark, hot Earth, killer neo's would hit, and we would change our bodies a little, improve them a little to thrive in the recently cleared rubble.

We were primitive then. At that time, we were still mostly just slime. We never saw sunlight and did not need it. Our name was "Archaea Bacter". Some of us still live down there in the deep hot.

After each "End of the World" we would evolve up a little. And then we would prosper, as a Life Form. It was survival of the Lucky, those lucky enough to be in those places where the catastrophe did not clear.

Eventually we became fish and crabs, and then lizards and dinosaurs, and eventually, mammals, and then humans and everything alive on Earth.

Each time, it was Survival of the Lucky.

Sadly, there was no water in space for me, so I was ready to give up. You can't make a living telling space stories.

Part 08: Tiny Planets Gushing

Just in time, some colleagues found out that almost half of the near earth objects (neo's) contain water mineral.

Some had calculated that roughly 15% of the near earth asteroids were "hydrated minerals." All I would need to do is cook them at very-hot oven temperatures and they give off steam, water steam. It would be like overcooking cookies in a hottest kitchen oven, to fry off the water. No electricity needed here.

Small detail that most of the rocks like that I knew about were as hard as a sidewalk. "Kinda hard to use, in space", I thought.

Nature then tempted me a little. The King of Near Earth Asteroids, Dr. John Lewis, told me that a good fraction of the neo's contain a higher percentage of platinum and gold than the best platinum ore on earth.

! Hey ! A Clear Profit !

It did not turn out that way at all.

Meanwhile, as each year passed, more and more objects in the space near earth turned up with water in some form. Another colleague, Dr. Gene Shoemaker, told me over a

really good hamburger at a rocket science meeting in San Juan Capistrano that only some neo's are hard rock meteorites, like those that make it to the Earth's surface and get into museums.

His neo's the neo's I cared about, typically would never make it to the ground. Most of those would be are relatively soft.

There were thousands of them swarming in the space truly near Earth itself. According to Gene, all it would take to fry off the water would be "heat, in a kitchen oven."

Gene didn't exactly emphasize that the "oven" would be nearly red hot and probably start the kitchen on fire. But, that did not matter because a nuclear reactor the size of a large garbage can could easily deliver that kind of heat.

Gene really surprised me. Gene knew. But almost no one else, other than my colleagues, knew about them, the hydrated clay neo's.

To me it meant water-bearing objects might be everywhere in the space relatively near Earth.

Just what I needed?

Other colleagues had decades earlier found almost invisible, ever-present comets in the space between here and Jupiter. Those almost invisible comets are apparently made of hydrocarbons, strangely similar to very dirty coal, or oil shale. Curiously, they appear to be about 1/3 water ice, 1/3 hydrocarbons, 1/3 silicates, a percent amines.

All I would need to do to get the water out would be to heat them, to heat their ice. A nuclear reactor the size of a garbage can could do that.

And they were dark, darker than chimney soot in a fire place, *almost invisible*. Scary!

The sky was full of them. We would almost never see them until a piece of their black scab skin would break off. Then, the water would evaporate and dust and fog would spew out, and they would light up in the sky. It almost never happens, so we could not realize that the night sky would be scary full of comet tails if they all lit up at once.

?? Oil Shale ?? Did I miss something?

The oil shale part was puzzling. I would almost joke when I said: "*The closest thing on earth could be cat feces in a dry ice cooler. Not dog, cat, because it's black.*"

These were mysterious stories. How would you get something like dusty dirty coal or oil shale in space?

What kind of dinosaur could live in space? Aliens?

All I wanted from space was water in space, not hydrocarbons or oil shale. I ignored the oil shale.

To my dismay, everyone else ignored the nearly unlimited "oil shale" as well. Nobody cared about oil in space. I wanted them to care about something, so I could get the money to inhabit the solar system.

It was a sad time again.

One more time, to the rescue, Mother Nature came through with a breakthrough.

Another space agency of the United States, the "Star Wars" guys at the Department of Defense, sent the first probe to find hidden ice deep in the forever dark poles of the Moon. It was called "Clementine." The Star Wars team did it completely on their own, for less than \$99 Million. Dr. Stu Nozette and Colonel Dr. Pete Worden

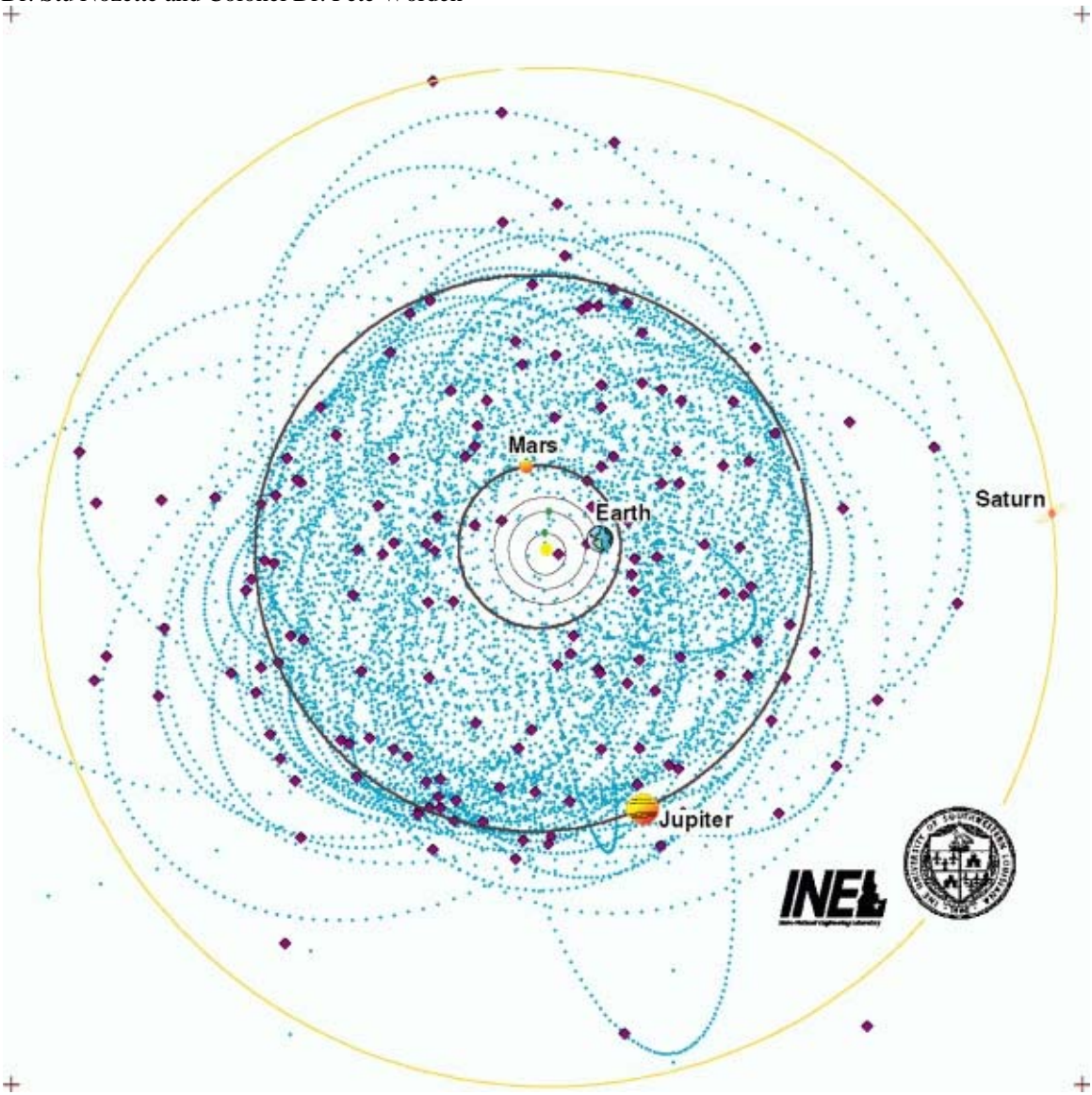
There had always been other "space agencies" of the United State, *other than NASA*.

Moon ice. Just what I needed.

NASA got jealous and finally paid Dr. Alan Binder send the Lunar Prospector probe. It found the same thing: apparently water ice. NASA said it was water ice.

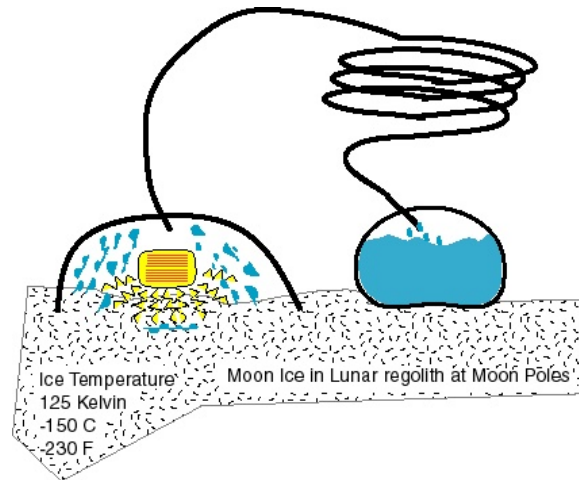
However, a professor and his colleague at Stanford said it was more like "Portland cement", hydrated alkaline oxides. To me, that was way better than water ice. It meant the water would not evaporate so easy, and that there ought to be huge amounts of it somewhere on the moon. Nobody knows.

We have to go there on a prospecting mission. No jumping somersaults. Just real work. Probably not NASA.

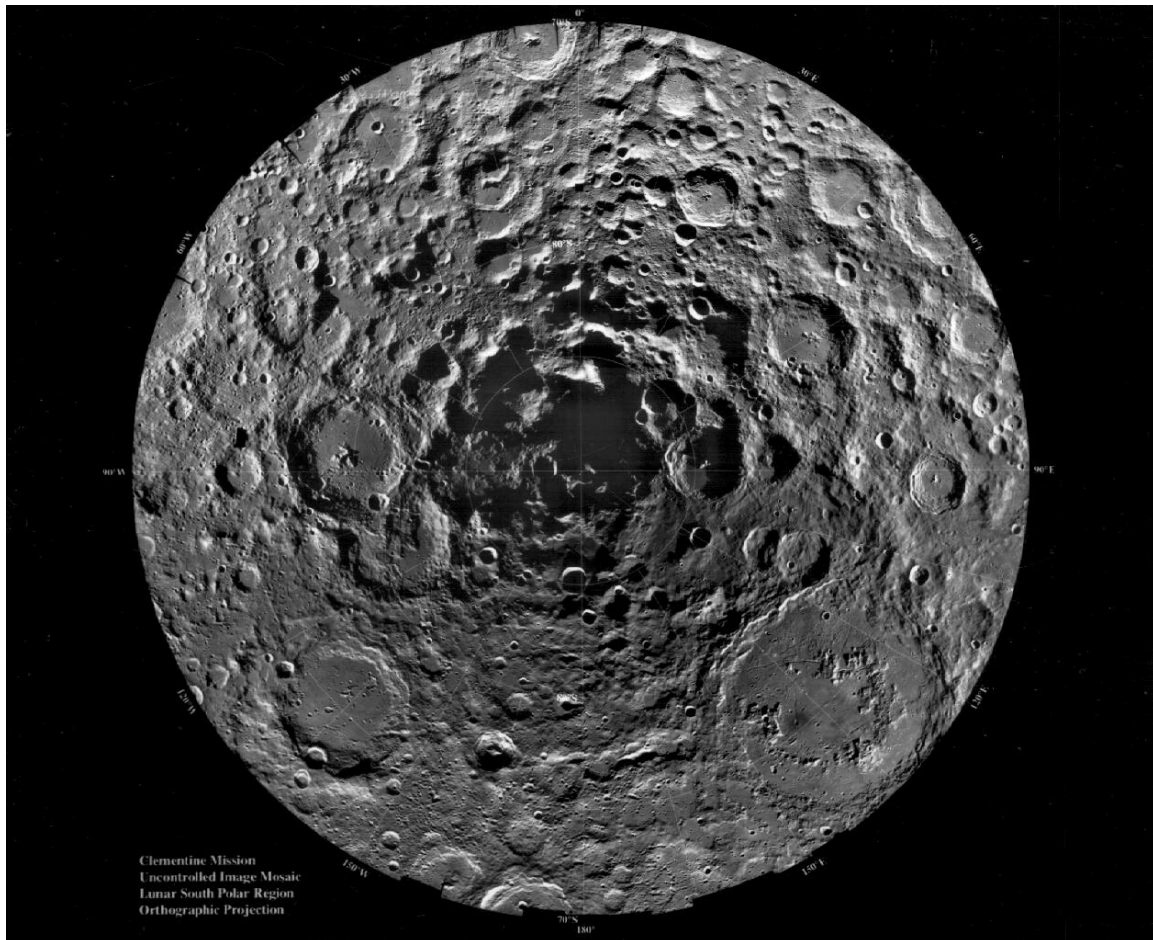


My colleagues also found another swarm of almost invisible, dark, black comets mostly between Mars and Jupiter.

The comets are the dark diamonds in the figure. Their orbits are the dotted lines. In Cosmic time, this picture changes like a swarm of bees. I took a snapshot, and it's like it was the day we taped the Discovery Channel show, 6 Oct 1996.

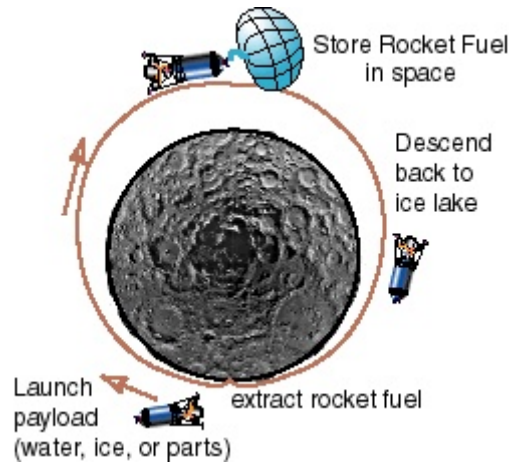


Heating moon ice yields water steam. Does moon ice exist? Does moon water exist? Is the water just a water mineral, loosely chemically bound to moon dirt?

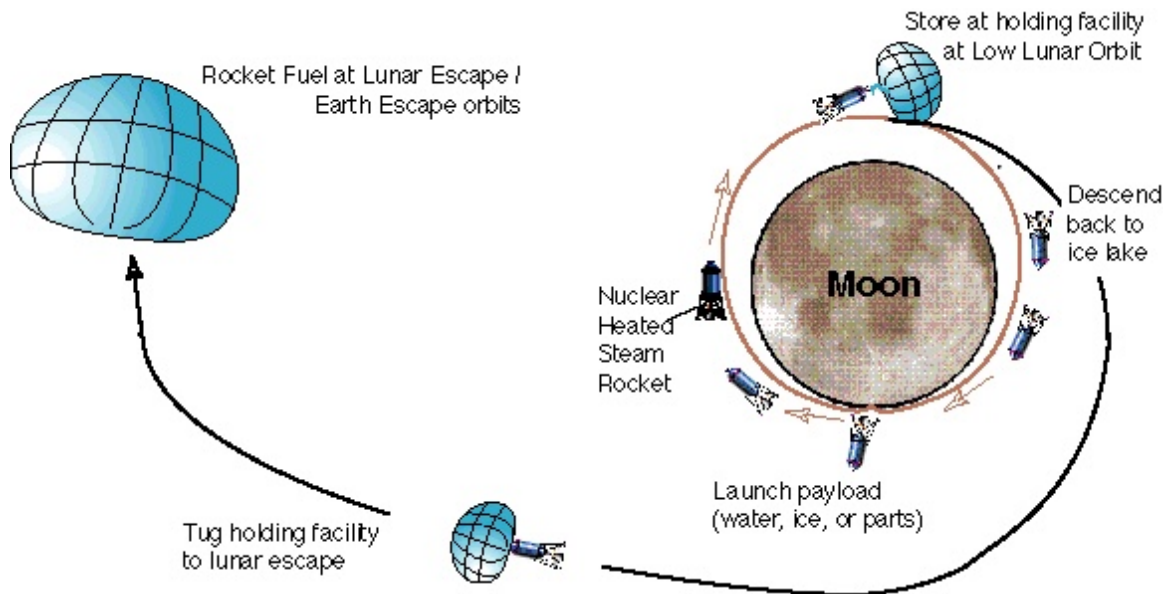


Earth's moon, viewed from its bottom, its forever-dark south pole, taken by the US Defense Department (DOD) Clementine mission, for \$99 M. Measurements suggested water ice inside the bottoms of the extremely cold, forever-dark craters at the top and bottom of our moon. More recent observations could not find as much water as they first

suspected. It might just be hydrogen-bearing mineral, like Portland cement.



I showed how to use steam rockets to transport the moon's water into space. To me, water was "rocket fuel."



If the moon really would have enough water, we could provide rocket propellant (fuel) stations in space.

"This means we could Inhabit the Solar System." I thought.

Part 09: Daydreams, Not Visions

Some people hated my scheme. One astronomer named Professor Anita Cochran complained insultingly that we would rip off the precious formations of ice just to go joy-riding in space. Another, Dr. Ben Clarke, told me I would rip up and destroy the fossil layers of time with my open pit space miner behemoth.

When they told me that, I stopped in my shoes. I agreed with them. I would be like the bad guys who rip off stalactites and stalagmites from caves. I would destroy the tree rings of time, the layers of whatever on the moon that would tell it's history, or on a comet.

I did not know what to do.

I stuck with it anyway.

The story developed a new twist. We could also use a steam rocket to push "killer asteroids" or "killer comets" away from colliding with Earth.

If we could do that, maybe someone would want to inhabit the solar system.

I showed my colleagues that if we were already inhabiting solar system, we would be able to land on comets and asteroids that had plenty of water. We would break off a "small piece" of such a comet or asteroid and gently shove it into an orbit that would collide with that dangerous something killer that was destined to crash with earth. When the small piece would crash into the killer, it would move a bit, and the killer bad things in space would no longer collide into earth.

We would save the world. We would be heroes. We would have moved celestial objects to do so.

All we would need is a comet or asteroid with a convenient orbit.

Mother Nature was so nice to us, again, one more time. She provided a neospace full of such convenient objects with convenient orbits.

Nature was nice twice, because the "small piece" would only need to be as big across as a football field. The water needed to shove it would be about the same size. The nuclear reactors to do this work and the steam rockets to propel the "small piece" would only be as heavy as a Space Shuttle.

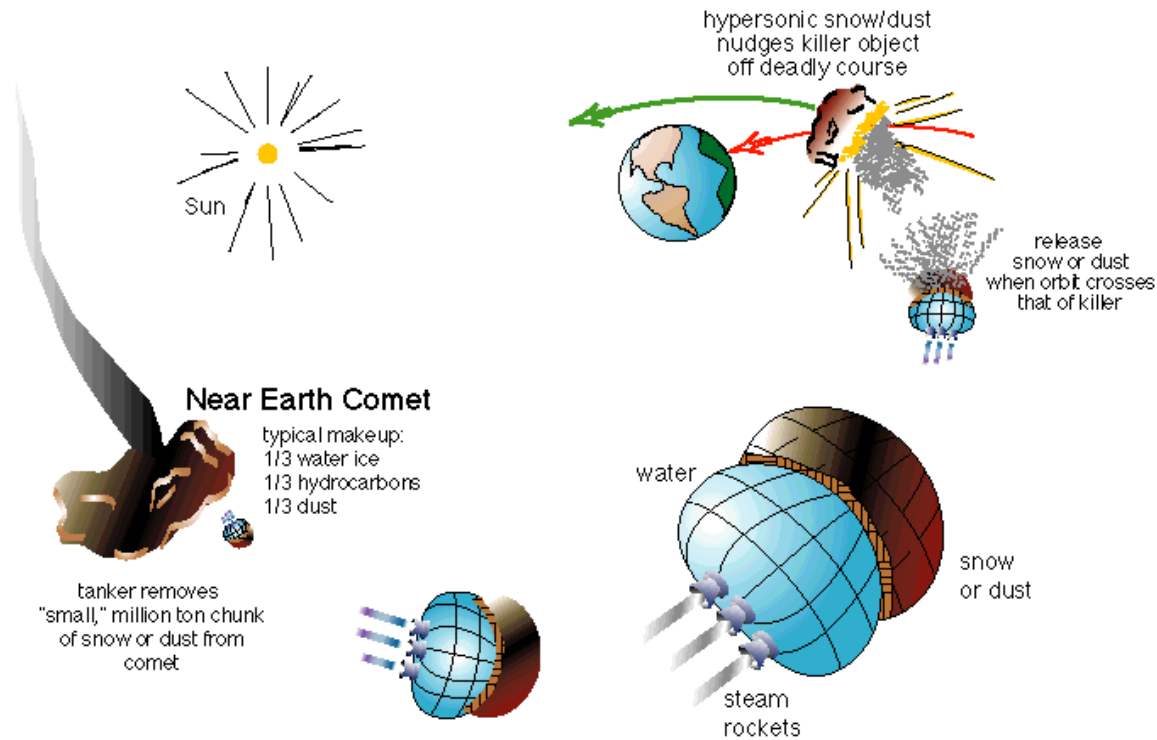
This was intriguing because my NASA and DOE and DOD competition were seriously talking about using a huge, absolutely huge, 1000 Megaton atomic bomb to try and do the same thing.

Imagine launching an atomic bomb off Cape Kennedy so big that if it accidentally blew up, it would blow up the entire East Coast of the USA. Who would let you drive down their road to deliver that thing?

It did not matter. This twist was only interesting, not profitable. Nobody I could find with money thought this would be a reason to go to space.

It was all Daydreams.

Deflect Celestial Objects by Leveraging NEO Resources



Part 10: Vision, but No Clear Profit

There is no money in pushing killer asteroids in space, because there aren't any killers. We haven't found one yet that will kill the whole world. Anything less dangerous than that is not worth the effort. Pushing asteroids gets to be extremely expensive, compared to all the money in the

world (about \$ 50 Trillion).

Mother Nature was kind yet again. She did not bring money. She did not force us to spend \$50 Trillion. She brought a Vision.

To make a spaceship big enough to haul 1000 people at a time would only take a hundred thousand tons, plus or

minus. A hundred thousand tons of water. A hundred thousand tons of space ship.

Nature was kind because one could get that 100,000 tons from a single chunk of the right kind of neo. The chunk would be no bigger across than a football field.

Shoemaker and Fay and all sorts of other near earth asteroid astronomers reminded me that a single, 3 km sized near earth asteroid of the hydrated clay type would be 10 football fields across, and that would be 1000 chunks of the size I wanted. Just one such neo would be worth a thousand, huge payload trips.

Our team had calculated we could push a *million* ton payload in space using steam rockets. And there was water everywhere in neospace to do it. Our team included Tom Larson, Bruce Schnitzler, John Rice, Bill Richins, Marland Stanley, John Martinell, Lawrence Redd, Michael Jacox, Tom Hill, sometimes Dave Buden, and a several others.

It looked good on paper, except for one, tiny, little detail. **There was *no clear profit*.**

"The Conquest Of Space is going nowhere until there is a clear profit," said the mathematician working for another space agency of the United States

Government. He helped point space telescopes *towards earth* instead of away from it. I never forgot when Don Summers pointy finger poked me in the chest.

Nature only gave us a start. The rest is hard and very expensive.

The steam rocket and the water objects in neospace did not solve all our problems. I didn't win everything. I only won the first race.

Enemies everywhere were against me.

It would still be about 1000 times less expensive to do anything on Earth than the same thing in space.

No Clear Profit. Damn.

Steam rockets only work when going to the Moon, some of the near earth asteroids and comets, to Mars, Jupiter, and the big planets. But not anywhere else. Nature gave us huge amounts of water from the Jupiter family comets and near Earth asteroids, and ice moons. But to go everywhere else would take too much water.

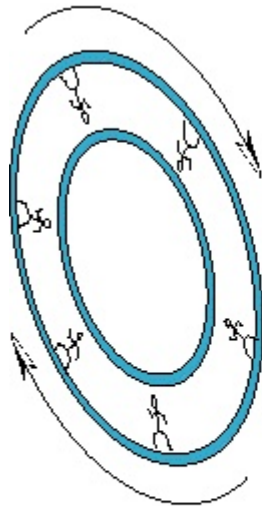
The rest of the job would be too hard.

Life is rough. Then you die. But I did not give up.

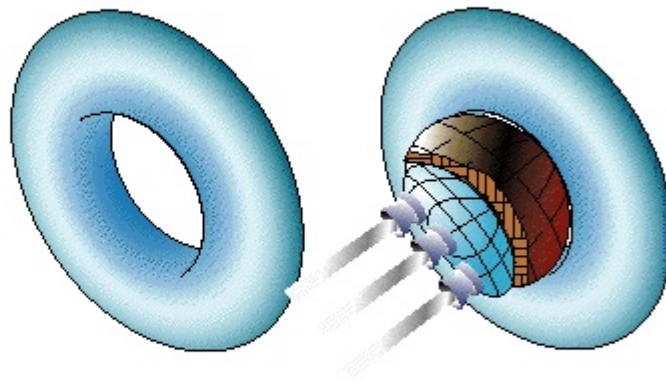
Part 11: The Iceship Spaceship

Nature was good to us one more time. We found out how to use water ice to make a spaceship, a big spaceship, an ice spaceship. It was a bit of fun in the midst of angst.

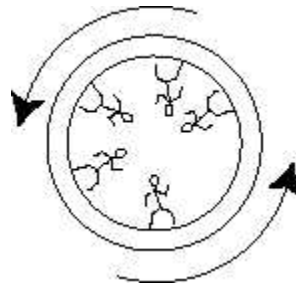
"Ice Tire" Torus Space Ship



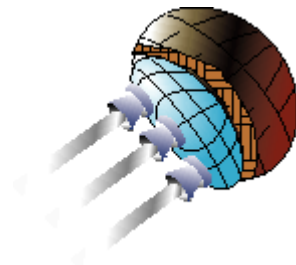
slowly spins
to give "gravity"



ice2_VG.ai
zuppero ineel 980422p1027

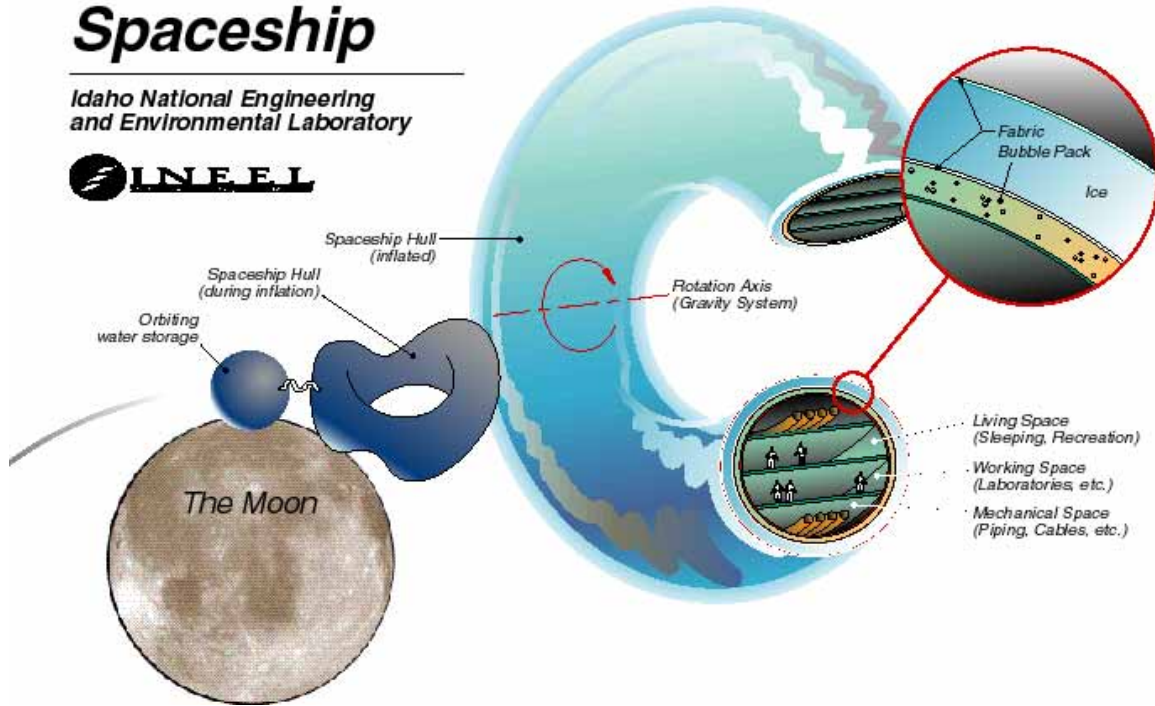


If ice was not good, we would make the ship out of fried clay, melted clay, lava, stone, bricks, and that would work.



Ice Structure Spaceship

Idaho National Engineering
and Environmental Laboratory



Just making a big ice cube into a space ship would not be so amazing. The amazing part was that the ice was strong enough to let me spin a "small" ship without tearing it apart.

When I put the people on the inside, I could turn their gravity on by spinning it. We must have gravity because we are humanoids.

Our bones can lose calcium when we don't have gravity for a long time. Our immune system seems to work poorly in zero gravity. Cartilage does not grow correctly in zero gravity. The ice ship would keep us from being space sick.

This time NASA listened. They liked the Ice ship.

Part 12: Ice Moons, Surprise

The most exhilarating, exasperating and last discovery was finding out how to use the water and steam rockets and ice ships to travel on, and off, *and between* the ice moons of Jupiter.

Most of the dozens of moons of Jupiter are made of ice and rock. Almost all the dozens of moons of all the gas giant planets are made of ice and rock. Some, the big ones, would be like a giant Antarctica the size of the moon, except that they are totally without air and so cold that ice is as hard as a sidewalk.

Aside from that small detail, we could live there.

We could burrow deep into the ice moons and live like ice tunnel ants in our Ice-kimo space suits. We would be Ice-tro-nauts.

Small detail: ! Warning ! ! Warning Will Robinson ! Wrong species warning ! I was Lost In Space.

I ignored the warning.

The Ice Moon calculations sounded too good to be true. After I retired from the U.S. Department of Energy national laboratory that supported this rocket science work, I did the calculation one more time.

How well, or not, would a steam rocket work on the planet Mars, the planet Mercury, and the ice moons of Jupiter?

I did not expect things would change much just because I did them again 5 years later.

Disappointing, as expected, a steam rocket will just not

work very good at all trying to lift off Mars. NERVA might work, using liquid hydrogen, just like the rocket scientist said.

Disappointing but expected, a steam rocket would not get me to the planet Mercury, and would not be able to launch off Mercury.

! Pow ! The calculations in the Excel spreadsheet almost exploded.

Totally unexpected, the steam rocket would be powerful enough to launch off the largest moon of Jupiter, an ice moon where water was "unlimited." Whatever would work on our own moon would work on any moon of Jupiter, of Saturn, Uranus and Neptune.

Then I did the next logical calculation. What are the orbital mechanics to jump from one moon to the next?

! Wow! I could go from any Moon to any other moon of Jupiter with only days, certainly no more than weeks, of travel.

! Wow!

Then I did the next logical calculation: how well could I go from gas giant to gas giant, from Jupiter to Saturn?

! Wow Again !

I could go from Jupiter to Saturn, to Uranus, to Neptune, one at a time, in sequence, landing and launching from each of them.

With all that water for rocket propellant, I could "gas up" anywhere I landed.

A small little detail, however, the only drawback going from one gas giant to another would be the travel time. Could be years. Could be ten's of years. Oh well.

! Warning! Warning! Will Robinson ! Transit time could take decades!

At least the images were stunning.

I needed to do this part again, to be sure I did it right. I was overjoyed when I found that a steam rocket could land on and take off from every ice moon in the solar system, and then, fuel up and go to any other ice moon in the entire solar system.

The orbital mechanics worked out to send an ice ship *between* the gas giant planets themselves, *using steam rockets*. We could travel from Jupiter to Saturn, from

Saturn to Uranus, from Uranus to Neptune. We could travel between the gas giant planets.

When the NASA guys would look at my orbital mechanics, my orbit, they would shout Stop!

My beautiful orbital maneuver would first shoot me way out to past most of the moons of Jupiter. A nice, peaceful ride. Then I would swing by as close to Jupiter as I could get, and turn on my rocket.

! Stop ! they would yell.
! Stop ! Radiation ! the NASA guys would scream.

Those poor, wimpy NASA space ships had no radiation shields. We come from the Department of Energy, *nuclear energy*. We know. "Shield it or Die".

Jupiter is so radioactive that it would fry their computers and electronics on those wimpy NASA toys. Our space ship has 50,000 tons of shielding, which we use as a structure.

Radiation? No Problem.

Rocket fuel? No Problem.

I could take on as much water for the steam rocket as I wanted off the ice moons. The dozens of ice moons had become quite accessible.

I could not believe it when the orbital mechanics worked out. Surprised, I found I really could use steam as the propulsion.

Part 13: Too Late

My message was too late. The train left. The party was over and everybody went home. Nobody was left to care or argue about it.

I was still hyped up, like a drunk host wandering around the empty party room, rehashing all the conversation.

If I would do what nearly all the rocket scientists said, I would have at least a thousand times *smaller* total payloads. I would need to generate electricity and make liquid hydrogen and liquid oxygen rocket fuel. To do that, I would have to haul absolutely huge electric generators, electrolysis device, cryofuel refrigerators and liquefiers.

And because I was just using water, I did not have to do any of that.

Even though steam rockets really were primitive, horrible

rockets, terribly awful rockets, compared to the stunning nuclear rockets we tested 40 years ago, steam rockets could use the ice.

Nobody could compete with me because no one else could use the ice.

I had whole moons of ice. And neospace was full of water objects.

And, all the moons were small enough that a single engine steam rocket could land on and take off from any ice moon in the entire solar system.

I won.

It meant we could occupy. We could own. We could stop at and make permanent space stations on at least dozens of the water moons of the Solar System.

We could inhabit!

Clearly Stupid.

Unfortunately, there was still no clear profit. The trip times were still too long. It was still too expensive. We were still the wrong species. Nobody cared. Some rocket scientists still said it was wrong.

Nobody cared even though the payoff to just find nearby gas stations would have been really clear. Why did I not see this 10 years earlier? It might have changed everything.

I might have won if I had seen this when I was getting paid to do it. We could have started to hunt for gas stations. Prospecting with a Vision and purpose would be a clear "win."

I saw in a flash I had wasted my entire time at General Dynamics and at the Department of Energy in Idaho, thrown away the opportunity.

"I am a case of clear stupidity, and I can prove it", I thought, over and over, perseverating, frustrated.

I was an Aspie, and it showed.

I had focused so hard and so intensely that I failed to see the big picture and do the simple obvious things.

All because of my stupidity, I did not just do the simple, logical calculations. I could have shown how to use the known ice moons to travel the solar system. I could have done this before I had ever left my high-pay, secure day job as a space spy. Then, as soon as anyone would find any water objects any easier to get to, I could have used

them and it would have worked even better.

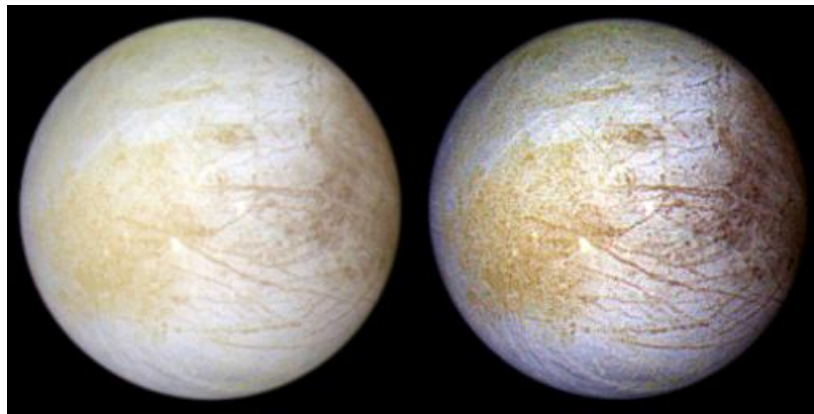
I could have seen that I would win because I provided the *least expensive* way to occupy and inhabit the Solar System.

Part 14: Other Worlds Near Enough

I could have won. Now, somebody else will get to tell the final story. Dejected, I got on the internet and collected the images of the ice moons we could inhabit.



Ganymede of Jupiter, ice moon



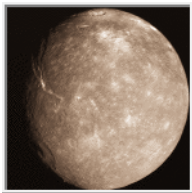
Europa of Jupiter, ice moon



Callisto of Jupiter



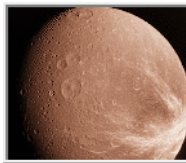
The Moons of Jupiter, Ice moons



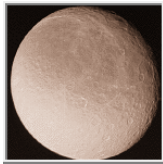
Titania of Saturn,



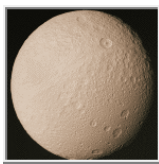
Miranda, Uranus



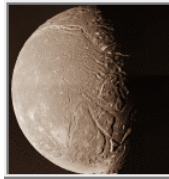
Dione



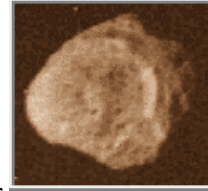
Rhea



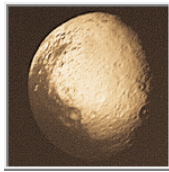
Tethys



Ariel Uranus,



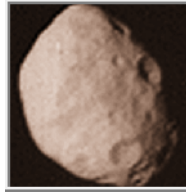
Hyperion Saturn,



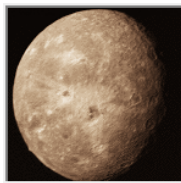
Iapetus Saturn, ,



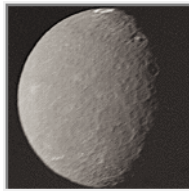
Enceladus Saturn,



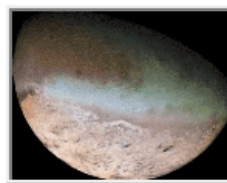
Janus Saturn,



Oberon Uranus,



Umbriel Uranus,



Triton, Neptune

Moons of Jupiter, Saturn, Uranus and Neptune we could inhabit.

Amazingly, Mother Nature gave us just barely what we would need to inhabit the entire space between Earth and Neptune. We could inhabit New worlds, worlds of ice in space, and own the space gas stations, for their *neofuel*.

We are still the wrong species. It is still far too expensive to do now. And, there is no interest in humans going to space. There is no way to pay for it.

There was no clear profit. There is still no clear profit.

The best I can do is send prospector space ships to find and stake a claim on the water objects in space. I would sprinkle them with the names of those who sent them, and plant legal claims to own them.

Too bad we are broke. Too bad, my generation is not the right species for space.

Oh Well. Our direct descendants, like the Cyborgs, the Digi-Sapiens, the computer-zoids, bionic androids, and others, they will get to inhabit the solar system.

I struggled to a hill top and saw.



We would Inhabit the Solar System

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