THE FOUNDATION
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Several readers have recently written asking that for a few issues we concentrate on the new directions in technology that are available for commercial exploitation in the next several years. Being a technologist myself, I am perfectly happy to accomodate such a request. To this end, the next three months of the Commercial Space Report will be devoted to the matter of new technology opportunities in space for private enterprise, what Foundation, Inc. is doing about them and what I myself am doing. This issue will discuss some recent activities by rocket entrepeneur Captain Bob Truax, work done at the NASA Woods Hole Workshop conducted last year and some new thoughts from the Global Technology Conference of the American Institute for Astronautics and Aeronautics conducted this May in Baltimore. Next month we will discuss the application of robotics and self-replicating machines to extraterrestrial resource exploitation. A conference on this subject is currently in progress with a month long workshop supported by NASA at Santa Clara College in California. And in the September issue we will finally let everyone know what the Foundation and myself are up to.

Project Private Enterprise, Inc.

Captain Robert Truax began his career in rockets in the late 1930's. He is a pioneer in rocket, missile and space fields with research and development expertise dating from that time. He spent nearly 30 years with the government and 9 years in executive positions in private industry. He conceived, organized and directed the U.S. Naval Rocket Project at Annapolis prior to enduring World War II, served as first head of the Intermediate Range Ballistic Missile Program in 1955 and headed the military space program of the Advanced Research Projects Agency of the Department of Defense in 1958. His resume goes on for three more pages of single spaced type. I already knew most of these things when we journeyed to Fremont airport on the east side of the San Francisco Bay on June 24th, 1980 to watch Bob Truax fire all four engines of his X-3 rocket vehicle for television and press. To me, all of the inventions and honors and awards that Bob Truax has received do not seem as real as his little 24 inch diameter, 25 foot rocket spouting flames for 60 seconds in front of a garbage dump. It must have seemed that way to the press as well. Although they had treated him and his idea of flying a human being to greater than 50 miles altitude to qualify for astronaut wings as a stunt or joke, their attitude changed suddenly on that day. With extensive local press coverage and some national news media exposure, Truax is well on his way to convincing many of the skeptics. His Project Private Enterprise, Inc. has

raised $1 million dollars from a group of Chicago businessmen and space enthusiasts.

According to an article in the L.A. Times, Truax's project is designed to achieve three goals. The first one is to demonstrate to the White House and the Congress that there is deep and widespread public support for an expanded Space Program. The second is to goad the aerospace industry into taking a more active and entrepeneurial role in space exploration and exploitation. And the third is to show that simple and straightforward technology can be successfully applied to the difficult problems of space flight. Truax's backers may have other ideas, however. In conversations with reporters, Jim Oelerich, an industrial real estate broker from Chicago (who organized the syndicate of 38 investors which has put up the $1 million dollars for Project Private Enterprise) talked about learning first how to walk before one runs. If the walking he was referring to was the X-3 rocket and the launching of a human being to altitudes in excess of 50 miles, the running seems aimed at the development of earth orbital commercial space transportation systems. It is clear that the backers of Project Private Enterprise are looking to the future not merely the present. We can only wish them well.

For the present, however, Truax plans to fly his vehicle in an unmanned suborbital flight sometime within one year. Immediately after a successful flight a human astronaut would be launched, probably in the fall of 1981.

New NASA Directions

Believe it or not, NASA is looking to the future. In June of 1979, the agency assembled a group of thirty consultants at Woods Hole to explore "New Directions for NASA". The New Concepts Symposium consisted mostly of academic scientists, though several aerospace industry representatives attended. Though much of what was discussed at the sessions is old hat to space industry enthusiasts, several new concepts did emerge which bear mention. Naturally, NASA disclaims any intent to suggest that any of these programs are suitable for promotion by the agency.

Eight groups were convened to discuss individual topics: Astrophysics, Climate, Communications/Navigation, Energy, Large Structures, Planetary Exploration, Propulsion and Transportation, and Telefactors.

Astrophysics. This group suggested development of a very long baseline interferometer which could measure the curvature of the universe as well as the distance to quasars more than a billion light-years away. A smaller interferometer might be used to detect earth-sized planets orbiting stars up to 32 light-years distant. This latter machine would be only 10 meters on a side. Following location of such a planet, it would be possible to investigate it more closely with a 100 meter diameter optical telescope which would be two orders of magnitude better in resolution than the Space Telescope now under development.

Climate. Most of the attention of this group was directed towards earth once they had determined that a early proposal to modify the Martian

atmosphere to support human life was not feasible. (However, it should be noted that the amount of chemical catalyst found necessary to do this in a short time was about 20,000 tons. This was deemed too large, but space exploitation enthusiasts know better.) The group revived the SOLARES/SOLETTA concept and suggested placing 100,000 square kilometers of reflector surface in geosynchronous orbit to warm patches of ocean in an attempt to steer weather patterns over the U.S. The effect of this pulsing of the atmosphere would lead to a better understanding of the earth's weather machine.

Communications/Navigation. The familiar concept of hand-held personal communicators was again suggested by this group. High capacity "trunking" satellites in non-geosynchronous orbits were also proposed as one method of dealing with increasing spectrum and orbit crowding in the 24-hour orbit. Additionally, the group suggested that future missions to the planets might carry their own navigational beacons and satellite which could make exploratory (and one might hope, commercial) operations at distant locations independent of earth-based navigational tracking.

Energy. A new type of microwave solar power satellite was studied by the Energy task force. The system consists of a 70 km long waveguide for the microwaves plus a flared 6 km diameter "horn" which would broadcast the microwaves to the ground rectenna. Strung along the side of the waveguide are two dozen solar panels each 2 km wide by 0.5 km high. The microwave klystrons are mounted on the panels and feed the central waveguide directly. This concept is self-stabilizing and should weigh and cost as much as 40% less than the reference NASA/DoE SPS. Another technique to reduce the weight of a SPS was to use solar cells specifically tuned for various portions of the sun's spectral output and then direct only that portion of the light from a solar reflector to them. This would increase the effective energy conversion efficiency of an SPS from the present 15% to as much as 60%, yielding a four-fold decrease in size and thus a decrease in mass on orbit. The group also suggested "importing" energy to earth orbit in the form of raw materials from extraterrestrial sources. While it was not proposed, importing of finished goods, especially metal products, would greatly increase the importance of the concept. The same holds true of importing either the raw material or finished products to the surface of earth.

Large Structures. The large structures group had no really novel suggestions, but repeated a very important point: large structure should be designed to be modular to facilitate development, deployment and maintainance. While they did not mention it, the necessity for modularity in large structure design can be traced to important business needs as well. Smaller funding levels are needed when the new hardware development can be introduced gradually rather than all at once. It is also important to be able to realize some return on investment from a partially completed system in space prior ro full scale deployment.

Planetary Exploration. The most significant output of this group is contained in a statement by John Naugle, former NASA official in charge of planetary programs: "(the) group thought the goals of NASA should progress from exploration, through a comprehensive understanding of the solar system, to an assessment and ultimate use of its resources. The establishment of such long term goals would have to involve a community

larger than NASA and the scientists and engineers now involved in planetary exploration."

Propulsion and Transportation. While laser launching from the ground was again proposed, the most interesting idea was to use tethers from orbiting platforms for snaring payloads launched by suborbital shuttles. The tethered payload would then be accelerated to orbit slowly by means of electrical propulsion engines on board the orbital platform. A similar device might also be used for transport to geosynchronous orbit. Solar sails of the ultra thin film type were also proposed for planetary exploration and resource exploitation.

Telefactors. Even if transport costs were very low or free, the expense of labor and machine time to manufacture very large space structure might make some space enterprises uneconomic. The Telefactors group proposed the development of self-replicating machines which would produce both copies of themselves as well as some specific end product (say solar cells). (This idea was originally invented by Ted Taylor and is called the "Santa Claus machine".) Even though it would be a great effort to design and build such systems, their exponetially increasing output means the cost would be well worth their development. As an example: if we wanted a million tons of output from 1000 tons of machine (to start with), a linear system would take (according to NASA estimates) a few thousand years to produce it, where an exponential system would take about ten years. Next month's newsletter will discuss this topic.

SSTO's and STARSHIPS

In closing, I must mention two items from the Global Technology Conference of the AIAA which I attended in early May in Baltimore. First, the matter of propane. A NASA researcher from the Lewis Research Center in Cleveland presented data on the performance of liquid oxygen and propane in a high pressure rocket engine. The engine performance at high chamber pressure and high expansion ratios (the ratio between the area of the rocket throat and nozzle exit) can approach the low end performance of lox and hydrogen. Yet because of the much higher density of the lox/propane, it is easier to carry it all on a single stage to orbit vehicle. In a nutshell: we can build SSTO's using cheap fuels and small vehicles. And we can do it now. More on this in a future newsletter.

Finally, Dr. Robert Forward gave a paper in which he proposed using a combination of very light weight solar sails and high power lasers (20,000 GW's!) to send starship probes to stars as far away as 40 light years. To accomplish this trick requires a Fresnel lens 1000 km in diameter which masses about 200,000 tons. The combination of laser and lens would seem to have some commercial applications in this solar system as well.

Until next month,

Sincerely,

Gary C. Hudson