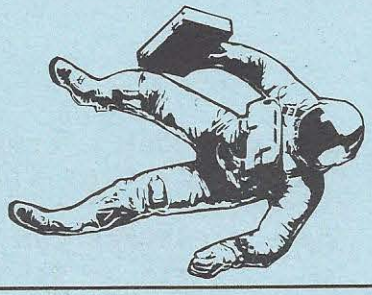
THE FOUNDATION
COMMERCIAL SPACE REPORT



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September

Dear Subscriber:

This month's Report is intended to bring our subscribers up to date on recent activities by Foundation and Foundation personnel. One major item is a new profit-making organization developed by former Foundation staff and others. At present the company, known as the A.P.T. (Advanced Propulsion Technologies) division of G.C.H. Inc., is working on the realization of private space launch systems. The fruit of considerable research done by Foundation over the past years, the new company is following two major lines of development: detonation wave propulsion and the "Big Dumb Booster". Foundation is continuing to support these ventures with long-term research.

Liquid Detonation Wave

Detonation wave propulsion is a method for utilizing more efficiently the energy available in chemical rocket propellants. Normally, a liquid rocket propellant is burned in a combustion chamber. The expanding gases then transfer kinetic energy into a nozzle, creating forward motion. (A large amount of heat is transferred as well). As the operating pressure of the engine is increased, the efficiency also increases. This is because the ratio of the engine nozzle diameter to the diameter of the throat (the "expansion ratio") can be made higher since a smaller throat can pass the same mass of gases at higher pressures. As the chamber pressure increases, however, the engine strength must be increased to prevent the chamber from bursting. Also, with an increase in pressure the efficiency of heat transfer to the walls becomes higher. This makes the engine harder to keep cool.

With detonation wave, the chemical reaction takes place as a rapid explosion or detonation, rather than by burning, a slower process. Transfer of kinetic energy is accomplished by the shock wave rather than by the heated gases. This shock is very rapid, transferring a large amount of energy in a very short time. This produces an increased efficiency in two ways:

First, the explosion transfers much more of the energy of the chemical reaction to the engine than a slower burn does.

Second, and more important, the detonation creates a very high chamber pressure for a short time. These pressures can range in the millions of pounds per square inch. Because the explosion is so quick, the engine chamber does not have time to react mechanically to the pressure before it drops back to zero. So, a much thinner engine wall can withstand it (A steady pressure of this magnitude would burst any engine instantly).

This produces a tremendously high expansion ratio, hence a very high efficiency over that short detonation time. The short period of the detonation also means that the extremely high rate of heat transfer at these pressures can also be handled.

Work is presently being done on several experimental detonation wave engines. It is hoped that the increased efficiency of this concept will make single stage to orbit even easier than before, and improve the performance of other designs.

Solid Detonation Wave

Research has shown that solid propellants also work well in a detonation mode. Development work is also taking place on small solid fuel rockets. These rockets are composed of stacks of thin discs of solid explosive. Discs of a shock moderator are placed between each explosive disc. The resulting cylinder is placed behind a payload. The solid fuel detonation wave rocket is fired by detonating the bottom disc, then each successive disc in rapid sequence. The resulting shocks create a more efficient rocket system than a normal solid fuel burn. Some uses include artillery, sounding rockets and other small rocket applications.

"Big Dumb Booster"

A major line of development is the "Big Dumb Booster". A modular rocket concept which has been covered in this newsletter before (April 1979), it has long been a prime goal for eager space developers. A.P.T. is presently developing a booster system of this type under the program name "Percheron" after a breed of powerful work horses.
The present booster is being configured to perform two jobs.
First, it will be used with a conventional rocket engine to perform a number of profitable missions to low earth orbit and geosynchronous orbit.
Second, it will be used as a testbed for early operations of the detonation wave engine, with the goal of creating a launch system of truly spectacular performance.

The design for the conventional engine system will use a module weighing approximately 200,000 lbs. fully fueled. The propellants will be liquid propane and liquid oxygen. The engine thrust will be 250,000 lbs. A single module will be ten feet in diameter and approximately 65 feet long. Combinations of three to seven modules staged in various patterns are expected to put up to 20,000 lbs. into low earth orbit, or 5,000 lbs. into geosynchronous.
Construction of test articles is expected to be under way before the end of 1980.

Teleoperator Systems: Update

Last month's Report covered new concepts in remote observation and manipulation. G.C.H. is funding a certain amount of work in these areas as well. Aside from earth and space applications discussed in the Report, further development is being done on a possible market dubbed "Teletourism".

The basic concept involves high-resolution cameras that transmit a picture to a helmet which reproduces the scene for the helmet's wearer.

The key to the operation is, again, the servo system that causes the camera to turn as the helmet wearer's head turns, allowing him to look around and generating the illusion that he is really at the location of the camera ("telepresence"). In a tourism market, the system would allow people to feel that they are actually at remote and/or dangerous locales while only cameras are being transported and risked. In addition to the reduced danger at hostile locations, there are other market advantages. Camera units are far lighter to transport than the tourists themselves, reducing expense. Logistics of food, lodging and other tourist problems are eliminated.

Teletourism is a market which can be developed more easily than other teleoperator systems since the observation-only concept does not require the remote manipulators needed for most scientific and industrial applications of teleoperators.

Initial applications would be earth locales. Later systems would transport cameras to space and planetary locations for the illusion of space travel for the tourist at far less expense and with far less risk.

One problem that develops involves the bandwidth required to send a high-resolution video signal from a large number of cameras to the helmets of a large number of users (economics of tourism require large numbers at a given location). Each camera is looking wherever the tourist's head is pointed, so each will broadcast a different picture. This requires laser-type wavelengths to transmit so many pictures at once. Another problem, one that affects even single-user systems, involves the time lag between the camera and the user, unnoticable on earth but obvious for space applications. The helmet signal to turn the camera and the resulting picture change would be so delayed that disorientation would result on the part of the user.

One solution being explored by G.C.H. is to use a wide-angle "fisheye" type optical system to transmit a single signal from a single camera of the entire view at once. Computer systems near the user would then transmit a portion or "window" of this hemispherical panorama to those users whose heads happened to be pointed in the direction of that specific "window". Although a picture from the moon or Mars would still be delayed, this would not be apparent to the user since the link which moves his point of view is only between him and a computer rather than between him and a distant camera. This concept, although it does not alleviate the time-delay problem for remote manipulators, cures it for all applications involving observation only, where viewing a scene several seconds to several hours old is not critical, i.e. Teletourism.

This approach also reduces the bandwidth problem since only a single signal is used. This permits an almost unlimited number of users to view a given "scene" while using only a single optical pickup and transmitter, a much less complex proposition than a large number of motorized narrow-angle cameras. The advantages of this latter feature for earth-based tourism are impressive, even though the time lag of the signal is not a problem for "local" transmissions. In an advanced system of high resolution and low cost, Teletourism could be an acceptable substitute for many tourists to actually being there, although unlike space locales, the earth locales can be accessed without special equipment. Some advantages for earth use:

Since only a single optical unit is required, the cost per user drops dramatically, far below that for multi-camera systems. This would reduce costs for the user to the point where even relatively close, non-hostile

locales would appeal to the budget-conscious tourist.
Also, the environmental advantage to replacing a horde of eager sightseers with a single small omni-directional optical pickup is obvious, particularly in small, secluded, or environmentally delicate locales.
Permanent emplacements of an optical pickup at sites of interest would be even lower in cost than mobile units, yet provide hours of entertainment for users looking at the scene. An emplacement on a coral reef, for example. Sound could be included, along with other features to enhance the illusion.
At this time, patent documents have been filed pertaining to this "single camera-multiple user" approach, and research progresses.
Teletourism appears to be a large potential market, even discounting the number of non-tourism applications using the same basic observation-only concept.

OTRAG: Update

OTRAG is apparently still active. According to the Space Information Center in Belgium, the company has reportedly secured a new launch site, again in a developing country. Our own sources suspect that this country may be Brazil. Among the reasons for this, the primary one is Brazil's relative immunity to the kind of outside pressure that made OTRAG's first venture so difficult.

At present, released plans include a pair of suborbital flights of singe stage modules before the end of 1980. In 1981, a series of two-stage suborbital flights with science payloads is planned. By the end of 1982, OTRAG hopes to launch a small orbiting satellite. One wishes them luck, and a measure of political stability.

Until next month.

Sincerely,

Gary C. Hudson

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