THE COMMERCIAL SPACE REPORT™

PUBLISHED MONTHLY

Dear Subscriber: September, 1982

<u>Space Services Ready To Launch "Conestoga I"</u> Space Services is preparing to conduct a suborbital test launch of the firm's solid rocket booster no earlier than Sept. 8 (see July, 1982 <u>Report</u>). The vehicle, the "Conestoga I", will travel on a ten-and-one-half minute flight over the Gulf of Mexico, on an azimuth of 137°. Planned maximum altitude is 167 nautical miles, with the vehicle traveling 279 nautical miles downrange before plunging into international waters in the Gulf. There are no plans to recover any part of the launch vehicle.

Just before apogee in the trajectory, the 1,097 lb. dummy payload will separate, and "spin up", simulating the type of maneuver that would be required to place a satellite into orbit. The payload will then follow the booster into the sea.

The mission objectives are to:

- Demonstrate SSI's ability to organize, fund, and develop privately owned launch systems.
- Create a cooperative interface between the private sector and relevant Federal agencies.
- Acquire operational experience for SSI's management and industrial teams.

The primary engineering goals involve testing the guidance systems and the upper stage/payload systems.

To propel the upper stage into space, Conestoga I will utilize an off-the-shelf M56A1 solid rocket motor, hitherto used as the second stage for the Minuteman missile, and as the workhorse for the Aries sounding rocket program.

One such motor was purchased and delivered to the Matagorda Island launch site from the White Sands Missile Range. The cost for this was approximately $365,000. A backup motor is available at White Sands if it should become necessary.

Initially, it was reported that the M56A1 motor, in a commercial form, was to be used as an upper stage in the future orbital system planned by SSI. However, the M56A1 is no longer in production, and the tooling to build it has been dismantled. The motor being used for Conestoga I is, therefore, a surplus item only, and could not be used in a production vehicle without the huge expense of re-tooling to manufacture it. This indicates that the use of such a motor as an upper stage in the orbital configuration is not feasible, and sources at Space Services confirm this, stating that the final design for an orbital system has not been firmly fixed.

The other boosters being considered by SSI, such as the Algol motor, are in production at this time and do not present the same kind of problems.

If the attempt is on schedule, an analysis of the flight of Conestoga I will appear in the next issue of the <u>Report</u>.

Salyut Update. Salyut 6, along with Cosmos 1,267 (a suspected anti-satellite test system) was commanded to a destructive re-entry over the Pacific Ocean July 29.

On August 19, a Soyuz flight was launched to a rendezvous with the new Soviet space station, Salyut 7. The three cosmonauts on board the Soyuz joined two cosmonauts already on Salyut. One of the new crew members is Svetlana Savitskaya, who has now become the second woman in space. (The first was cosmonaut Valentina Tereshkova, who flew in space in June of 1963.)

Astronaut Sally Ride is scheduled to be the first American woman in space with her launch aboard Shuttle mission 7 in April, 1983.

* * *

Low Cost Liquids Not Yet Out of the Picture. Space Services Inc. originally planned to utilize liquid-fueled launch vehicles for a private space launch system. To that end, SSI contracted with G.C.H., Inc. to design and build a prototype test unit of a low-cost, pressure-fed, modular rocket system. The final system design (detailed in the July, 1981 Report) was intended to place payloads in the 2000-3000 lb. range into low earth orbit.

At the time of this effort, I was Project Engineer for G.C.H., and responsible for most of the structural and systems design for both the test vehicle and the engine test stand. I also coined the name for this workhorse of space: Percheron.

Since then, G.C.H., Inc. has ceased to be active in launch system development, Space Services has moved into solid fuel systems, and I am now an independent contractor and part-time publisher. Nevertheless, I am still convinced that a launch system can be developed using liquid fuels that would be cheaper, more efficient, and easier to manufacture than any solid fuel or existing liquid fuel system, and capable of handling larger payloads than either the original Percheron or the proposed SSI orbital vehicle. This was the philosophy which led, in the past, to the various "Big Dumb Booster" concepts (Report, April 1979; October 1981).

To show the feasibility of such an idea, I have, over the past months, developed a launch vehicle concept which combines the large payload capability of a Big Dumb Booster with the pressure-fed simplicity of the Percheron vehicle.

I call this system "Percheron II", and following are some excerpts from a short monograph I have written describing the system:

* * *

Percheron II. The "Percheron 2" is a conceptual design for a modular, heavy-lift, pressure-fed launch vehicle intended to meet the following general design goals: marketable payload capacities into a variety of orbits, low cost, ease of manufacture, and simplicity of design.

The minimum design payload goals are:

Low Earth Orbit:	35,000 lbs.
Geostationary Transfer Orbit:	10,000 lbs.
Geostationary Insertion:	2,000 lbs.

Percheron 2 is a modular system. This means that a launch vehicle assembly is made up of a collection of individual rockets, or modules, mounted in parallel. A standard configuration consists of seven of these modules, mounted with six modules equally arranged about a single center module (see FIGURE 1, page 4).

Standard staging procedure for a seven-module cluster is:

- Stage 1: Four outboard modules burn and drop off.
- Stage 2: Remaining two outboard modules burn and drop off.
- Stage 3: Center module burns and injects payload into orbit.

This staging procedure eliminates any requirement for propellant cross-feed during flight, since stages are burned sequentially.

Preliminary calculations indicate that maximum effectiveness can be obtained by utilizing a dense, lower-energy fuel in the first stage modules, and a lighter, higher-energy fuel in the modules of the upper stages. The first stage fuel combination is Liquid Oxygen and a hydrocarbon fuel. The fuel would be either RP 1 or Subcooled Propane. (Use of propane would improve performance and simplify some systems such as tank pressurization.) The upper stages are fueled by a LOX/Liquid Hydrogen propellant mix.

The basic structure of each module consists of a standardized cylindrical propellant tank with hemispherical ends and a single engine mounted aft on a simple thrust structure.

Propellant Tanks. The propellant tank assembly is pressure stabilized, meaning that the major structural strength of the tank is supplied by its internal pressure, similar to the fuel tank of the Atlas rocket. The tank is a simple, thin-walled, monocoque structure; cylindrical, with hemispherical ends. A common bulkhead inside the tank separates the fuel and oxidizers. The tank is 108 inches in diameter and approximately 77 feet long. The tanks are made from Inconel 718, operates at a working pressure of 380 psi., and weigh about 9000 lbs.

Engine. The engine design is similar to existing pressure-fed designs proposed by TRW Inc., with a pintle-type injector and film-dump or ablative cooling. Steering is accomplished by thrust vectoring, preferably by some means of moving the aft portion of the nozzle rather than gimballing the entire engine.

Each stage utilizes engines specifically sized for optimum thrust and expansion ratios. This results in three slightly different sizes of engine for a standard system, with thrust ranging from 148,000 to 474,000 lbs.

The engine material consists of a combination of metals and composites, depending on heating conditions and weight requirements. Design chamber pressure is 250 psi.

Fluid Systems. The propellant feed and vent systems can be the most complex portion of a launch vehicle. Several methods can be used to reduce complexity and costs. A major one is using explosive valves and quick disconnects where possible, rather than solenoid or gas-operated valves.

Propellant tank pressurization is accomplished by using heat exchangers in the engine assembly to heat propellant to a vapor which pressurizes the tank containing that propellant. This method works well with cryogens like LOX, Liquid Hydrogen, or subcooled propane. A LOX/RP1 propellant combination would require an additional fluid such as helium or nitrogen to pressurize the RP1 tanks. This is another factor in favor of using propane as a first stage fuel.

Avionics. Avionics comprise a very large portion of the cost of the vehicle. To reduce costs, and duplication of systems, a single avionics package is mounted on the final stage. This controls all stages until they are jettisoned.

Individual systems for each stage are kept to a minimum, although independent units may be required for some command-destruct or recovery functions.

<u>System</u> <u>Performance</u> Performance of the Percheron 2 launch system is measured by a payload accelerated to a certain delta-V. Results of preliminary calculations seem to indicate that the present design exceeds all targeted payload/delta-V goals. However, these results are as yet only estimates, and it is best to regard them as a design safety margin rather than an indicator of actual performance beyond the initial goals. This margin may be reduced considerably if, as seems likely, there are unforeseen design conditions resulting in lower engine performance or an increase in module inert weights.

What these results do indicate is the overall feasibility of the Percheron 2 concept, showing that a simple pressure-stabilized, pressure-fed,non-recoverable, mass-producable launch system can be an effective method of competing with existing systems.

* * *

Photocopies of the original paper (30 pages including figures and appendices) are available for $5.00 each. Send orders directly to the <u>Report</u>.

Until next time,

Tom Brosz

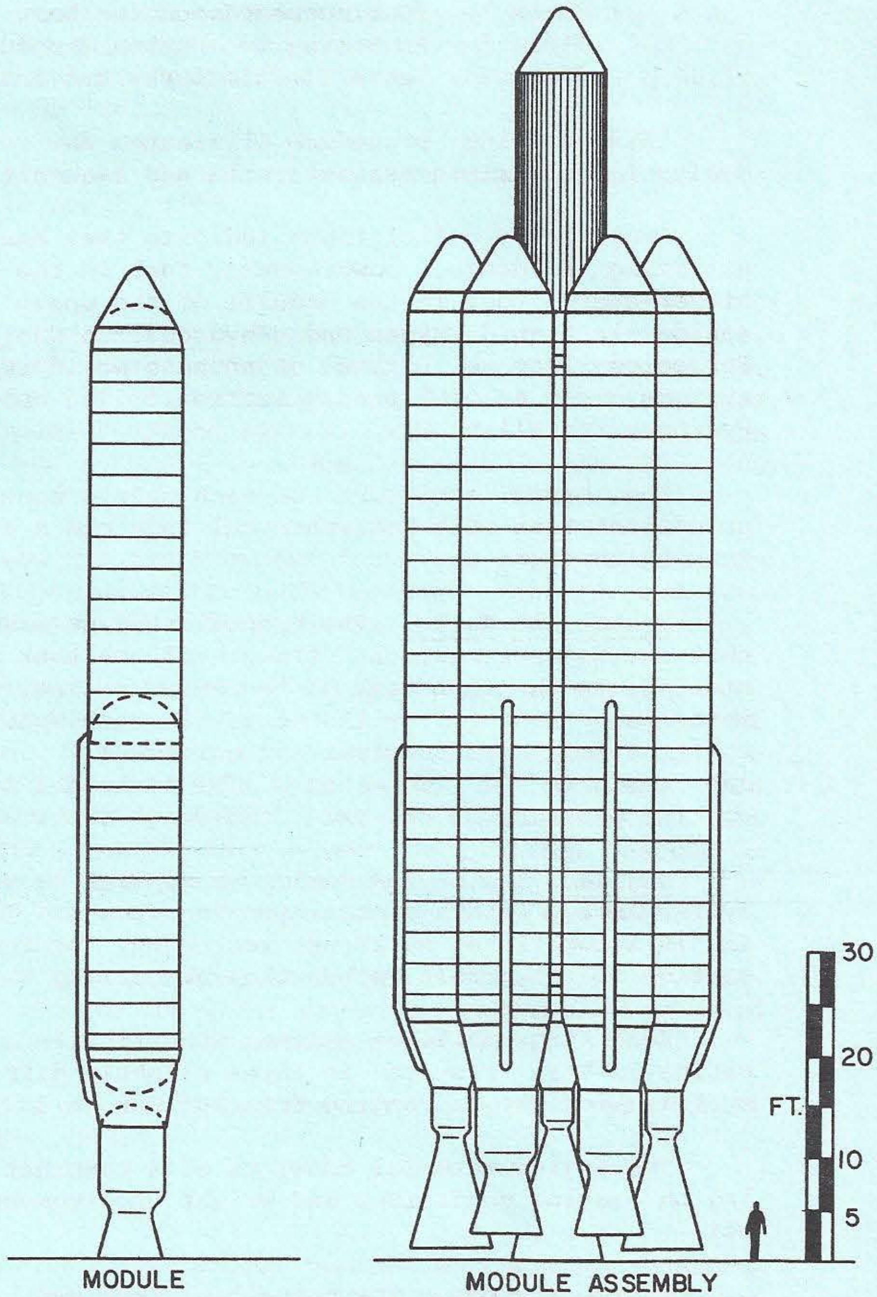

FIGURE I

THE COMMERCIAL SPACE REPORT™

The **Report** is published monthly, and has a subscription price of $12 per year. Back issues are available at $1.50 each from September, 1977. Xerographic copies may be substituted as stocks are depleted. Address all correspondence to: Commercial Space Report, P.O. Box 60547, Sunnyvale, CA 94088. Editor: Tom A. Brosz. Contributing Editor: Gary C. Hudson. The **Commercial Space Report** is a concentrated effort to report and analyze all areas of private and industrial initiatives in the development of space. Comments, ideas, or requests for information are welcomed, as are any items which may be of interest to our readers. No correspondence or information will be published unless permission is specifically granted. The opinions contained in the **Report** are those of the writer or writers, and do not necessarily reflect those of any organization or company.