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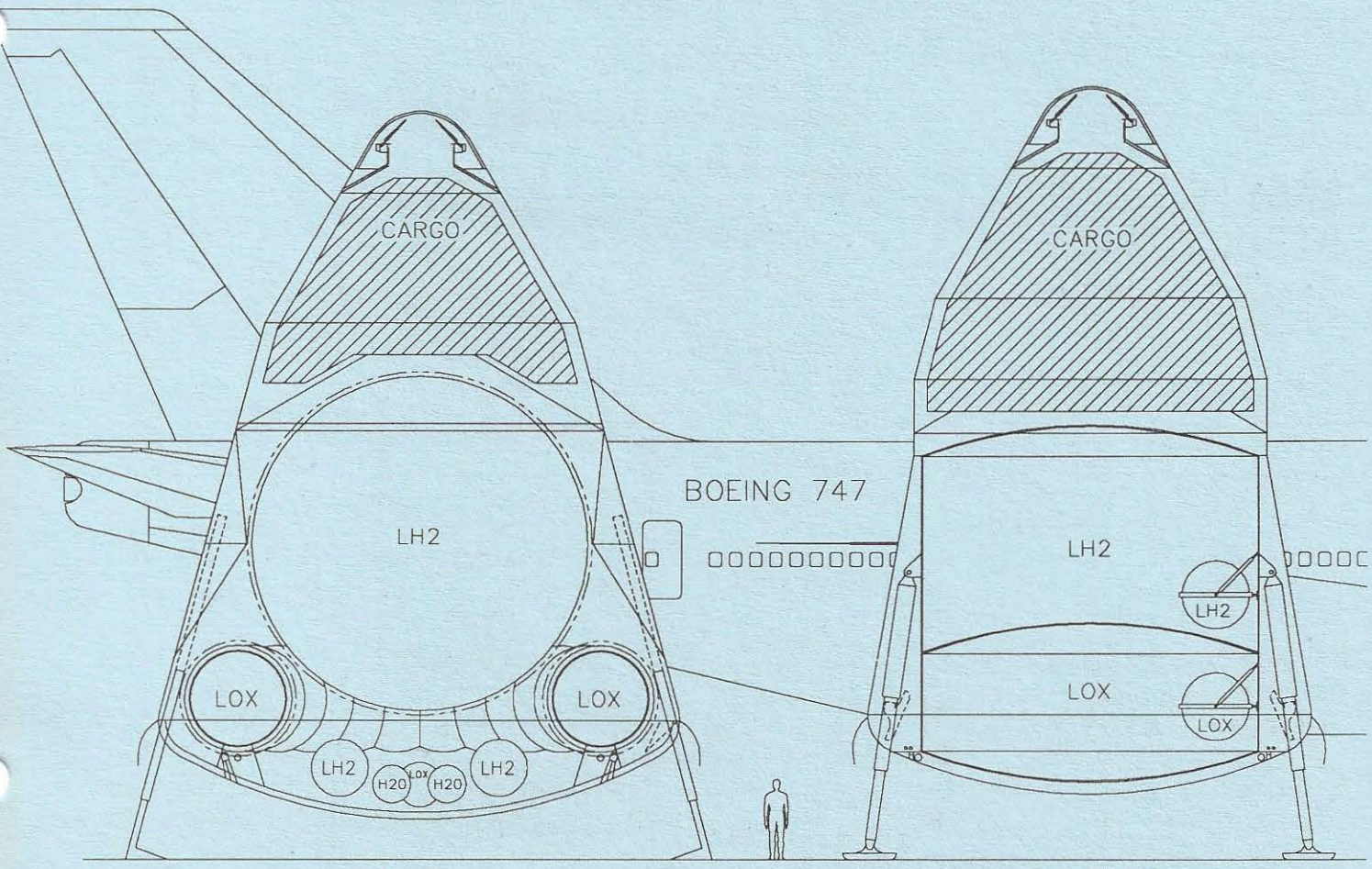
Phoenix Update

The Pacific American Phoenix reusable launch vehicle design has undergone some changes in recent months, including a major change in the basic propellant tank configuration and a minor change in the aerodynamic profile. The illustration below compares the current Phoenix with the previous design. Some of the changes were warranted by the ongoing Phoenix design work being done at Pacific American. Other changes, such as the aerodynamic shape, were a result of work done at Lockheed by a team managed by rocket engineer Max Hunter (more on this later).

The use of new materials which have recently become widely available has resulted in significant design weight reductions. These materials include the new aluminum-lithium alloys which are lighter than standard aluminum alloys. Aluminum-lithium has moved out of the experimental phase and is being tested in many aerospace structures. Continuing advances in composites are also a key factor. These weight reductions give the Phoenix design greater margins, and may even result in an actual increase in Phoenix payloads.



PHOENIX (CURRENT VERSION)

PHOENIX (PREVIOUS VERSION)

The most apparent design change is in the Phoenix Mainstage, which has been altered into a "floating propellant tank" configuration with separate liquid hydrogen and liquid oxygen tanks. Earlier Phoenix designs used a cylindrical tank with a common bulkhead and shallow end domes. This earlier tank doubled as the thrust structure--the current design incorporates a separate thrust structure which is integral with the hull. The primary reason for the change was that the cylindrical tank with its integrally-milled ribs became too expensive when manufactured from aluminum-lithium. The new tanks are spherical, or composed of spherical elements, and thin-walled. This makes them lighter and less expensive.

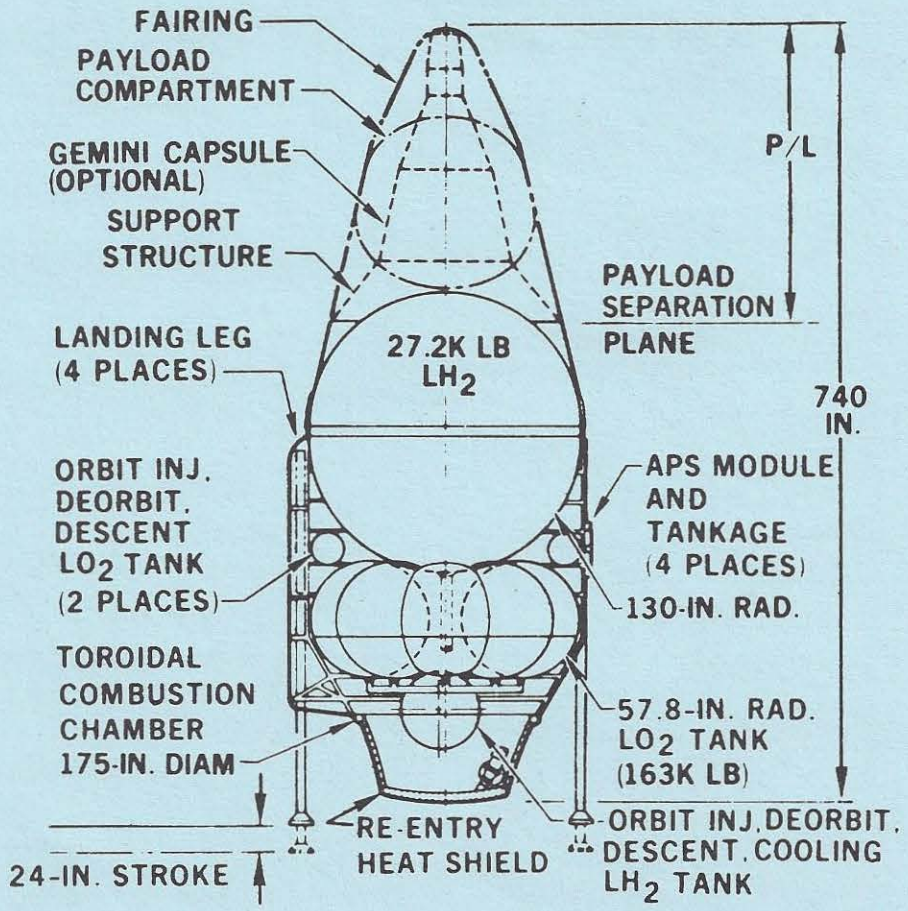
Readers familiar with the history of Vertical-Take-Off-and-Landing Single-Stage-To-Orbit (VTOL/SSTO) vehicles will note that the Phoenix tank configuration is now quite similar to the tank configurations of some of the vehicles proposed by Philip Bono in the 1960s and early 1970s. In particular compare the Phoenix tank configuration with that Bono's Saturn Application Single Stage To Orbit (SASSTO) vehicle shown in the illustration below. The SASSTO is described in the book *Frontiers of Space* by Philip Bono and Ken Gatland (Blandford Press, London), along with other Bono VTOL/SSTO designs such as Hyperion, Pegasus, Rombus and Ithacus. I don't know if the book is still in print, but it can be found in many libraries. I recommend this book to anyone interested in Bono's work, which was a major influence on the early design of the Phoenix and related vehicles.

Rocket Engineer Promoting VTOL/SSTO To Department of Defense and NASA

Some time ago rocket engineer Maxwell Hunter, while working with Gary C. Hudson on the Phoenix at Pacific American, suggested promoting a man-rated VTOL/SSTO to the U.S. government for development. Pacific American did not oppose this idea, but was reluctant to involve the government in the company's Phoenix program, intending that the vehicle be developed by the private sector. Under the circumstances, both Hunter and PacAm agreed that it would be better to present a "generic" VTOL/SSTO concept to the government rather than a specific design from a particular company, such as the Phoenix. Such a generic approach would keep the Phoenix out of government hands. It would also broaden the appeal of the concept to a wider variety of potential Washington supporters, since it would not have the appearance of a particular private company fishing for contracts.

SASSTO STRUCTURAL CONFIGURATION

LIFTOFF THRUST = 270K LB
LIFTOFF GROSS WT = 216K LB
TOTAL HDW WT = 14.7K LB
$\lambda' = 0.910$
G.F. = $\frac{216}{8.1}$
P/L FRACT = 3.75%
GROSS P/L = 8,100 LB
(USEFUL P/L = 6,200 LB)



Hunter put together a small engineering team at Lockheed, where he worked at the time (Hunter is currently retired), and they began an analysis of a generic VTOL/SSTO design which was called the "X-Rocket." When the team was through, the vehicle that emerged was different from the Phoenix, but still similar in many ways. Some design features were improvements on the Phoenix, and have since been readily adopted by Pacific American (the altered, more conical shape of the current Phoenix is the most obvious of these changes). The X-Rocket possessed all the advantages of the Phoenix: reusability, low development costs, low operational costs, and off-the-shelf technological solutions. Estimated cost of the development program: well under $1 billion. Estimated development time from program start to first orbital flight: about four years.

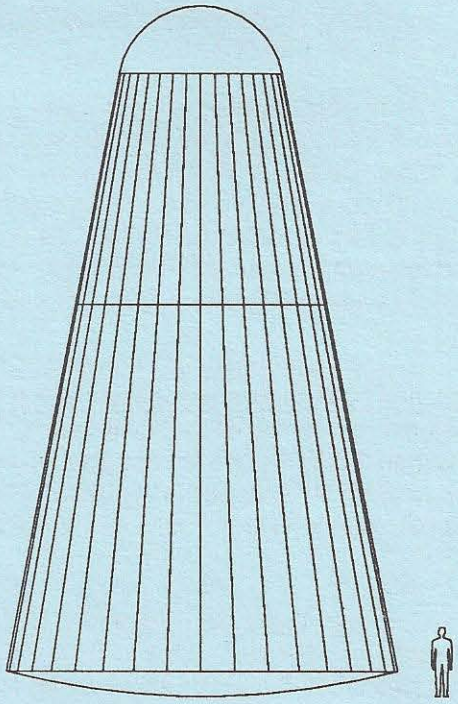
Lockheed displayed no interest in following up the completed study, and when Hunter retired, he took the concept out on his own. Hunter renamed the X-Rocket the "SSX" (SpaceShip Experimental), and went to Washington and elsewhere with it. His message: that a low-cost reusable launch vehicle is not only possible but practical, is familiar to readers of this newsletter. But to many people unfamiliar with the concept, it must have seemed like a breath of fresh air.

In December of 1988, Max Hunter and Gary Hudson presented the SSX to the Citizens' Advisory Council on National Space Policy, which lent it enthusiastic support. Among the council members were General Daniel O. Graham and Brig. Gen. Robert C. Richardson, founders of High Frontier, an organization advocating large scale development of space for civilian and military use. High Frontier is one of the most prominent supporters of the U.S. Strategic Defense Initiative (SDI). SDI's feasibility would be greatly enhanced by low-cost, readily available space transportation, and Gens. Graham and Richardson saw the potential of the SSX in this context. High Frontier also became an SSX supporter.

Early this year, Hunter, the Citizens' Council, and High Frontier presented the SSX to the National Space Council (NSC), and its chairman, Vice President Dan Quayle. The National Space Council is a newly-formed interagency group intended to coordinate and direct U.S. space policy, which is currently in disarray. When the NSC is fully active, the members of the NSC will include the Vice President, the Secretaries of State, Defense, Commerce and Transportation, the administrator of NASA, the Director of the Office of Management and Budget, the Director of Central Intelligence, the Assistant to the President for National Security Affairs, and the Chief of Staff to the President. Other officials would participate in council meetings as appropriate. Mark Albrecht, chief legislative assistant to Sen. Pete Wilson (R-Calif.), was recently appointed as NSC director.

Other organizations were also briefed on SSX. The most recent such briefing was on April 12, when High Frontier invited a number of legislators and industry leaders to a meeting in Washinton on SSX.

When Max Hunter first started selling the SSX in Washington, it seemed to me to have little hope of success. Although the low-cost launch system did receive some support from various space interest groups, I anticipated a brick wall when the idea hit the legislature. There is normally little incentive in the U.S. Congress to develop low-cost approaches to anything. The object of the game is to enrich the voters of your district with "infusions of essential Federal funds" (which can be roughly translated as "pork"). Legislators who consistently fail to accomplish this get voted out--evolution in action. In the aerospace business, this means that a congressman will tend to support expensive programs employing thousands of voters (the U.S. Space Shuttle, the U.S. Space Station, the B-1 and B-2 bombers, etc.) over inexpensive programs that would employ a tiny fraction of that number (SSX). It is no coincidence that major aerospace projects like the Shuttle are spread among hundreds of large and small contractors evenly distributed across the U.S. (in fact, it is difficult to find any industrial congressional district that does not have at least one company building some obscure Shuttle part).



X–ROCKET

But things in Washington may be changing. The NASA Space Shuttle and the National Aerospace Plane (NASP), considered the cornerstones of present and future manned space transportation, are both in trouble.

The Space Shuttle, despite the cheerful "We're Back In Space" optimism since it started flying again, is still an accident waiting to happen. NASA itself now admits that statistically, the risk of a catastrophic Shuttle failure currently stands at 1 in 78. Other sources place it as low as 1 in 25, or even worse.

If another orbiter is lost, the Shuttle program would be seriously endangered. If we make the optimistic assumption that the cause of the accident will be quickly identified and repaired, allowing flights to continue with only a minor delay (as opposed to the two-year hiatus last time), the Shuttle fleet would still be reduced to three orbiters again, or even two if the new Shuttle orbiter currently under construction is not yet operational (the as-yet-unnamed orbiter is scheduled to make its first flight in early 1992). The Shuttle would be unable to carry out many of its currently-planned missions, and lose what remains of its credibility as a reliable means of space transportation. Payloads would be transferred to unmanned launch systems.

NASA would be stuck with a diminished fleet and would be unable to remedy the situation. There is not much chance that the agency would be able to build yet another $2 billion replacement for a lost orbiter. NASA barely got the funding to build the *Challenger* replacement, even with considerable public support, and in this time of budget worries, there is currently little enthusiasm in Congress for dumping more billions into the Shuttle program. So, over the following years the Shuttle fleet would continue to be reduced one by one as inevitably, more Shuttle orbiters are lost. Finally, the program would die. No doubt space enthusiasts are counting on the government or the private sector to come through with a replacement for the Shuttle by the time this happens. If we are fortunate, this will be the case. If not, then the U.S. manned space program will be finished.

A reduced Shuttle fleet would also endanger the NASA Space Station program. The planned launch schedule for the Space Station will strain or exceed the resources of even a four-orbiter fleet, and it would be almost impossible with fewer. And, as a manned system, the Space Station does not have the option of switching to expendable boosters, unless a new program is build manned space capsules again.

And if NASA sacrifices the Space Station and is somehow permitted to transfer those funds to an ailing Shuttle program, then the Shuttle loses its current justification for existence. NASA has been pushing the Shuttle primarily as a tool for the Space Station since the Shuttle proved too expensive and unreliable for other missions that could be more effectively carried out by unmanned, expendable launch vehicles.

NASA must successfully complete both programs, or lose both. This is why the hair of NASA personnel turns gray and falls out.

The National Aerospace Plane, although considered by many space enthusiasts to be the successor to the Space Shuttle, is not in good shape either. As this is being written, the NASP project is in danger of being severely cut back. Costs are spiraling out of control. But then the research program for the NASP, a manned, winged, single-stage-to-orbit vehicle, was not--advertisements to the contrary--really intended to accomplish low-cost, routine space transportation. Rather, the program is a vast research effort which is investigating the exotic technologies required to make the NASP work. This effort, of course, involves hundreds of aerospace firms across the U.S. (refer to earlier definition of "pork," above).

The Department of Defense (DOD), currently funding 80% of the NASP work, is undergoing severe budget cuts, and NASP looks like a likely victim. If DOD drops out, whole ball of wax would be tossed to NASA which is doing the remainder of the NASP work. But NASA--as mentioned earlier--is pumping from an even drier money hole than the DOD, and is committed to doing all it can to keep the Shuttle propped up and the Space Station alive. The NASP's only chance is the army of lobbyists from the aerospace industries which is even now descending on Capitol Hill, the White House and the Pentagon to save their pet project (for more on NASP, see the April 1986 *C.S.R.*)

Under these circumstances, the SSX may appear considerably more interesting to pro-space interests in Washington. However, if the U.S. government does decide that SSX is the way to go, it may not turn out to be as beneficial to the future of U.S. manned space travel as it might initially appear.

If the basic SSX concept is accepted in Washington, almost certainly the design will be reviewed and reworked by NASA, the DOD, and the large aerospace contractors who will doubtless be given the job of making the SSX a reality (Hunter and his colleagues will be politely set aside). These organizations will return their estimates of costs and lead times for SSX development, and I will be astonished if Hunter's $1 billion, four year program has not been converted to a $10 billion program that will be completed by the aerospace establishment's favorite time--"around the turn of the century."

If the government proceeds with an inflated SSX program, the chances of a real low-cost, rapid program being accomplished by the private sector decreases markedly. Despite its past performance with projects like the Shuttle, the government's credibility in the field of space transportation is still unaccountably high, and investors and customers will likely sit on their hands waiting for the official NASA/DOD launch system--let's call it the "United States SpaceShip Experimental" (USSSX)--to appear over the horizon rather than invest in a "risky" private venture. Those who aren't sitting on their hands won't believe that the development of SSX can be accomplished as cheaply and as quickly as Hunter says, because by then the government will have made it official that the project must cost ten times as much and take three times as long, and they should know, right? Of course, years from now, when only four USSSXs roll off the line, at a cost of about $4 billion each--and then don't work--it will be far too late to say "I told you so."

If you don't think this is how launch vehicle investors and customers think, then you should have been with Gary Hudson and me in the early '70s, trying to sell the Phoenix to people enamored with the Miraculous Shuttle that would solve all our space transportation problems. The Space Shuttle! $50 a pound, and two flights a week! See? it says so right there on the label. By the time the truth about the Shuttle was known, Pacific American had already switched to low-cost expendables as its main development program. It was that or quit the business.

I wish Max Hunter success in his efforts to sell SSX as a government program, but my opinion, however cynical, is that success may be no less painful than failure.

Space Services Successfully Launches Sounding Rocket

On March 29, Space Services, Inc. (SSI) of Houston, Texas successfully launched its Starfire I suborbital sounding rocket from White Sands Missile Range in New Mexico. The two-stage rocket, derived from the Black Brant sounding rocket, carried a 600 lb. payload consisting of six scientific experiments assembled by the University of Alabama in Huntsville (UAH). The rocket reached an altitude of 187 miles, and achieved over 7 minutes of microgravity for the experiments. Upon reentry, the payload was recovered intact 50 miles downrange at White Sands. Whether the mission was completely successful will not be known until the experiments are analyzed. This launch was the first to have been granted an official license by the U.S. Department of Transportation's Office of Commercial Space.

The payload package was called Consort I, after the customer, the Consortium for Materials Development in Space (the NASA Center for the Commercial Development of Space which has been established at UAH). The six experiments were all related to materials processing.

Space Services is offering customers a wide variety of launch capabilities, all based on various configurations of existing or slightly modified solid rocket motors. Besides Starfire I, there are also the Starfire II and III configurations, which can provide up to 20 minutes of microgravity for payloads. SSI also offers orbital capability with its Conestoga series of launch vehicles: Conestoga II, III, and IV. Payloads to low earth orbit ranging from 300 to 4,000 lbs. can be accommodated. SSI says that orbital payloads can be launched within 14 months of contract start.

This is the second rocket launch for Space Services. On September 9, 1982, SSI launched the Conestoga I sounding rocket, the first privately-financed U.S. space launch vehicle, from Matagorda Island in Texas.

Panel Recommends Against Use of Industrial Space Facility

A panel from the National Academy of Sciences' National Research Council (NRC) has advised NASA against leasing a commercial free-flying space facility, claiming that other facilities, such as a long-duration version of the Space Shuttle orbiter, can fill the needs of microgravity users until the U.S. Space Station becomes available.

If acted on, the "Report of the Committee on the Commercially Developed Space Facility" (CDSF) will effectively kill the NASA CDSF initiative.

In the process, it may also kill Space Industries, Inc., the company whose Industrial Space Facility (ISF) was the only real candidate for the CDSF. As designed by Space Industries, the ISF is a commercial, free-flying, pressurized laboratory module which would supply power and other necessities for on-board experiments or processes. The ISF would be man-tended, which means that it would be occupied only temporarily when docked to a Space Shuttle at intervals for servicing. The ISF, although pressurized, would not contain any life-support equipment, relying on the Shuttle's life-support system while docked to the orbiter (for more on the ISF, see the January, 1988 *C.S.R.*)

NASA has been trying to kill the ISF dead since it was first proposed. Despite SII's valiant attempts to hobble the ISF concept to avoid competing with the Space Station (for example, the lack of an integral life support system), it was always painfully obvious that Space Industries' technology could duplicate almost all of the functions of the U.S. Space Station at a tiny fraction of the cost (for details, see "A Modest Proposal, Revisited," also in the January, 1988 *C.S.R.*). In an article in *Aviation Week & Space Technology* (April 17, 1988, pp. 20-21), Theresa M. Foley quotes unnamed industry and government officials who charge that the "committee based its conclusions in large part on NASA's statements" and "had adopted NASA's viewpoint and disregarded other information that presented the [ISF] in a more favorable light."

Conveniently overlooked in the NRC report is the obvious superiority of man-tended or unmanned free-flying facilities for microgravity research or manufacturing, when compared to continuously manned systems like the Shuttle or the Space Station. The constant vibrations and movements that are unavoidable in manned facilities are disastrous for many types of delicate microgravity processes.

Oddly, a 1988 NRC report from the council's Space Applications Board (titled "Industrial Applications of the Microgravity Environment") was favorable toward free-flying platforms like the ISF. The issue will be settled in May, when the Congress examines the leased facility issue in detail, along with NASA's response to the two reports.

Until next time,

Tom Brosz
April 25, 1989

The Commercial Space Report (C.S.R.) is published monthly, and endeavors to report and analyze developments in the field of private initiatives in space transportation and exploitation.

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