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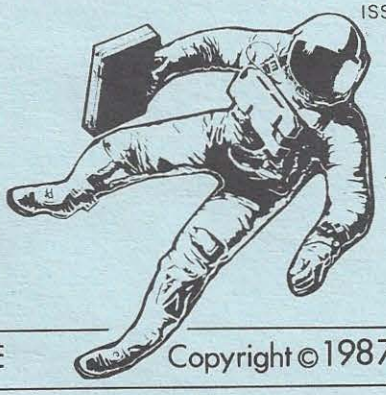


A MONTHLY NEWSLETTER ON FREE ENTERPRISE IN SPACE

Volume 11, No. 8 August, 1987

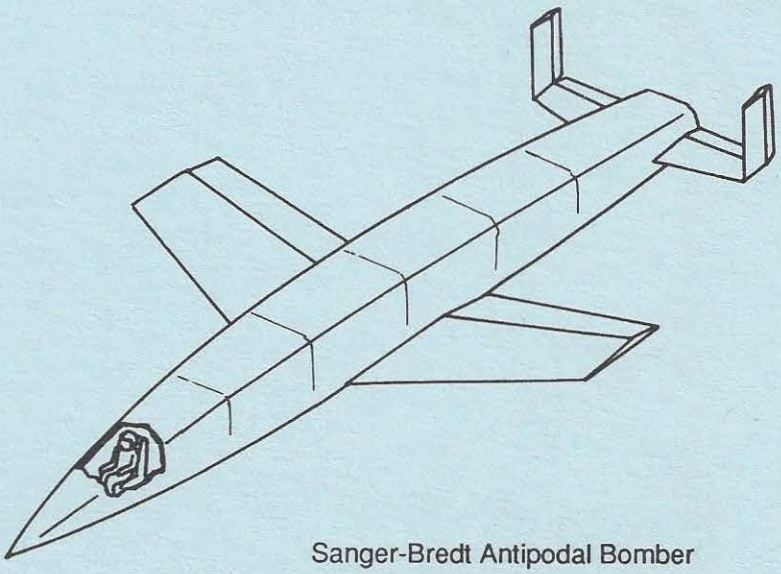
The Spaceplanes of Europe
(Part Two)

Sänger: An Old Idea For The Twenty-First Century

At the age of 24, Eugen Sänger envisioned a manned, winged aircraft capable of reaching space. The spaceplane, which he called "Silverbird," would be powered by advanced liquid-fueled rocket engines.

The place was Austria. The year, 1929. From then until Sänger's death in 1964, his Silverbird spaceplane would come tantalizingly close to reality several times. Tantalizingly--and sometimes frighteningly.

In the late 1930s, Hitler's Third Reich saw a promising weapon in Sänger's vision, and invited him to Germany to work with the Luftwaffe. Sänger, along with mathematician Dr. Irene Bredt (later to become Sänger's wife) continued the development of his ideas and, at the beginning of the Second World War, laid his proposal before the Luftwaffe High Command for a winged, military rocket plane: the Sänger-Bredt Antipodal bomber (below). The rocket engines that would power it were not capable of propelling the 100-metric-ton (220,460 lb.) vehicle to the Mach 25 velocity required to attain orbit. Sänger's solution: accelerate the bomber to Mach 1.5 on a two-mile rocket sled and, after the plane was released, use on-board rocket engines to continue accelerating to Mach 10. At this speed, the spaceplane would climb to an altitude of 174 miles. As it descended, the bomber would dive into the upper layers of the Earth's atmosphere and literally "skip" back into space. During the "skip," the bomber's metal hull would be able to radiate into space the frictional heat generated during the brief dive into the atmosphere. Repeating this roller-coaster maneuver several times, the vehicle could reach the other side of the world, drop its bomb, and still retain enough velocity to eventually glide back to its launch point.



Sanger-Bredt Antipodal Bomber

Germany dubbed this vehicle the "Amerika Bomber"--among its intended targets: New York City. Under the command of the Luftwaffe, the bomber project proceeded to the point of actual engine testing. Unfortunately for

Sänger (but perhaps fortunately for the United States), Germany opted for the quicker solutions offered by Wernher Von Braun and the rival rocket project headed by the German Army at Peenemunde. The Amerika Bomber was never built.

After the war, Sänger gladly abandoned his bomber concepts to continue design work on civilian versions of his spaceplane. Work went on sporadically during the following years. Finally, in the early 1960s, his dream of a spaceplane once again seemed near to reality. Europe was interested in developing a new version of his spaceplane--the Raumtransporter (space transporter) called, appropriately, "Sänger I." The Sänger I was a research project of Junkers/Messerschmitt-Bölkow-Blohm (MBB). Sänger acted as the project's advisor.

The Sänger I design was a two-stage vehicle comprised of a winged orbiter mounted on the back of a reusable winged booster. Like the original antipodal bomber, the Sänger booster and orbiter would have been launched together horizontally, again assisted by a rail-mounted rocket sled (see box below for more on sled-launched spaceplanes). Both booster and orbiter were powered by liquid-fueled rockets. The Sänger I would have delivered about 2.75 metric tons (6060 lbs.) into low earth orbit, and had a gross take-off weight (booster and orbiter together) of about 187,000 kg. (412,260 lbs.).

Sadly, Sänger died in 1964, and the project was again shelved. For twenty years, Sänger's manned spacecraft ideas remained obscure while the world's attention followed the Americans and the Russians into orbit and onto the Moon.

Then, in 1985, West Germany and MBB's Space Division resurrected the idea of a reusable, low-cost launch system, and are now proposing that the European Space Agency (ESA) develop a new and updated spaceplane concept as Europe's launch system for the 21st century. In so doing, the advocates of this new vehicle have shown that they have not forgotten their roots.

The name of the new launch system: the Sänger II. The Sänger II is similar in concept to the Sänger I, a two-stage vehicle with the first stage being a large, winged booster, but there are important differences which will become apparent as the new vehicle is described.

The Sänger II booster/orbiter assembly is twice as large as the Sänger I, with a length of 92 meters (302 ft.), a wingspan of about 50 meters (164 ft.) and a gross take-off weight of up to 386,000 kg. (850,980 lbs.) This is roughly comparable to the dimensions and weight of a fully-loaded Boeing 747.

The payload of the Sänger II is also larger than that of its predecessor. The Sänger II is designed to carry two different upper stages: either a winged, manned orbiter called HORUS (Hypersonic Orbital Research and Utilization System), or an unmanned, wingless rocket called CARGUS (derived from "cargo"). HORUS' payload into low earth orbit would be 4 metric tons

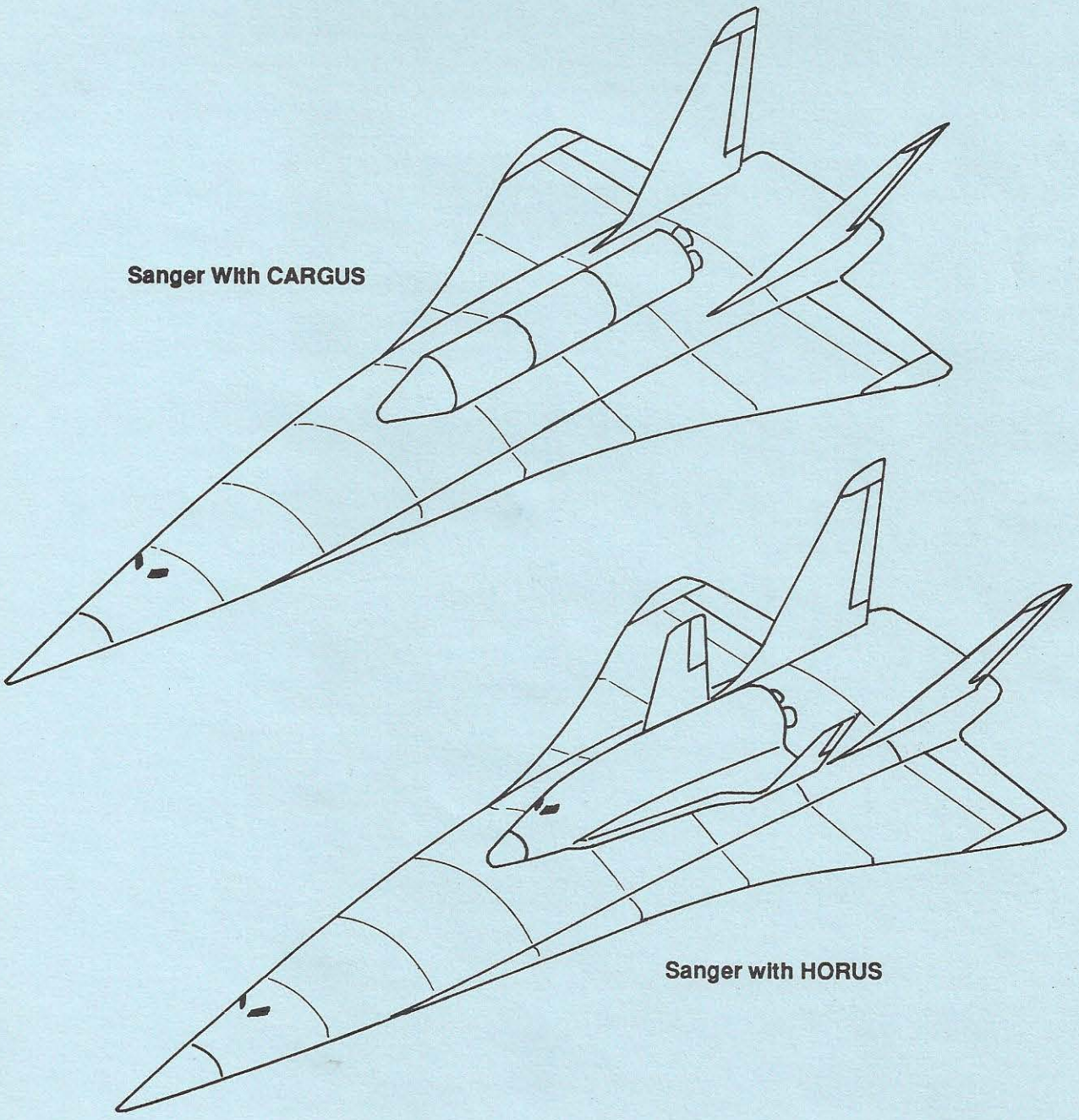
Rocket Sleds for Spaceplanes

Some spaceplane concepts designed for horizontal takeoff use some form of sled or "trolley" to support the vehicle during its takeoff run. Once the spaceplane attains flight speed, it is released--the sled remains on the ground. The main advantage to this arrangement is that the spaceplane, loaded with tons of fuel, need not carry into orbit the heavy landing gear that would be required to support that weight during the take-off roll. Later, the returning vehicle, largely empty [except perhaps for a payload in the cargo bay], can utilize a much lighter set of landing gear for its horizontal landing. Some designs, such as the Antipodal Bomber and the Sanger I, use a rocket-powered sled to act as a sort of "first stage" to bring the vehicle to take-off speed. Others, like the British HOTOL, use a simple unpowered trolley which relies on the spaceplane to supply all the take-off thrust.

(8,800 lbs.) in addition to a crew of two. The CARGUS upper stage would have a payload of 10 to 15 metric tons (22,000 - 33,000 lbs.) The two versions are shown in the illustration below.

Both upper stages would be propelled by liquid oxygen/liquid hydrogen rocket engines. The engines would be an advanced design, with a chamber pressure as high as 3,500 psi (the liquid-fueled main engines of the U.S. Space Shuttle operate with a chamber pressure of about 3,000 psi).

The winged booster of the Sänger II would use six airbreathing engines for propulsion instead of rockets (the intakes for these engines are out of sight underneath the vehicles in the illustration). These turbo-ramjet engines would burn liquid hydrogen as their fuel, and propel the booster to a speed of Mach 7 and an altitude of 35 km (21.7 miles), where the booster would release its upper stage to continue into orbit.



Sanger With CARGUS

Sanger with HORUS

The use of airbreathing engines in the booster stage has both advantages and disadvantages compared with rockets. The major advantage is enhanced operational flexibility. The Sänger II could take off from standard airport runways (2,500 meters [8,200 ft.] or more) without the need for a special trolley or rocket sled, and cruise for long distances through the atmosphere before launching its upper stage into space. This would allow the Sänger to depart from European airports at high latitudes yet still launch payloads into orbit from the equator or any other latitude appropriate for a particular orbital plane.

Another advantage: It did not escape the notice of the Sänger II designers that the airbreathing booster could be transformed into a commercial hypersonic transport by simply adding a passenger cabin. Such a transport could carry up to 250 passengers with cargo at speeds of up to Mach 5 for distances of up to 15,000 km (9,320 miles). This would give the builders of the Sänger II two transportation systems for the price of one development program.

The major disadvantage of an airbreathing booster, of course, is the complexity and high development cost of a hypersonic jet propulsion system compared to a rocket engine of similar capability. The Sänger II's designers have managed to avoid the worst of this by limiting the operational velocity of the booster to Mach 6, allowing the use of ramjet technology for its engines. The turbo-ramjets proposed for the Sänger II would still be difficult and expensive to develop, but such engines are relatively simple compared to the scramjets and other exotic airbreathing engines which would be required for flight through the atmosphere at velocities of Mach 8 and higher.

The price of an orbital Sänger launch is estimated to be less than $2,000/kg ($900/lb.), including amortization of development costs, which are expected to be between $8 - 10 billion (launch cost estimates are based on a vehicle design lifetime of 100 flights).

The Sänger II's backers hope that the program will receive the support of the ESA to fund further studies through 1989 (the Sänger II studies are currently being funded by the West German government to the tune of about $1 million). If all goes well, the first operational Sänger flights could begin by the turn of the century.

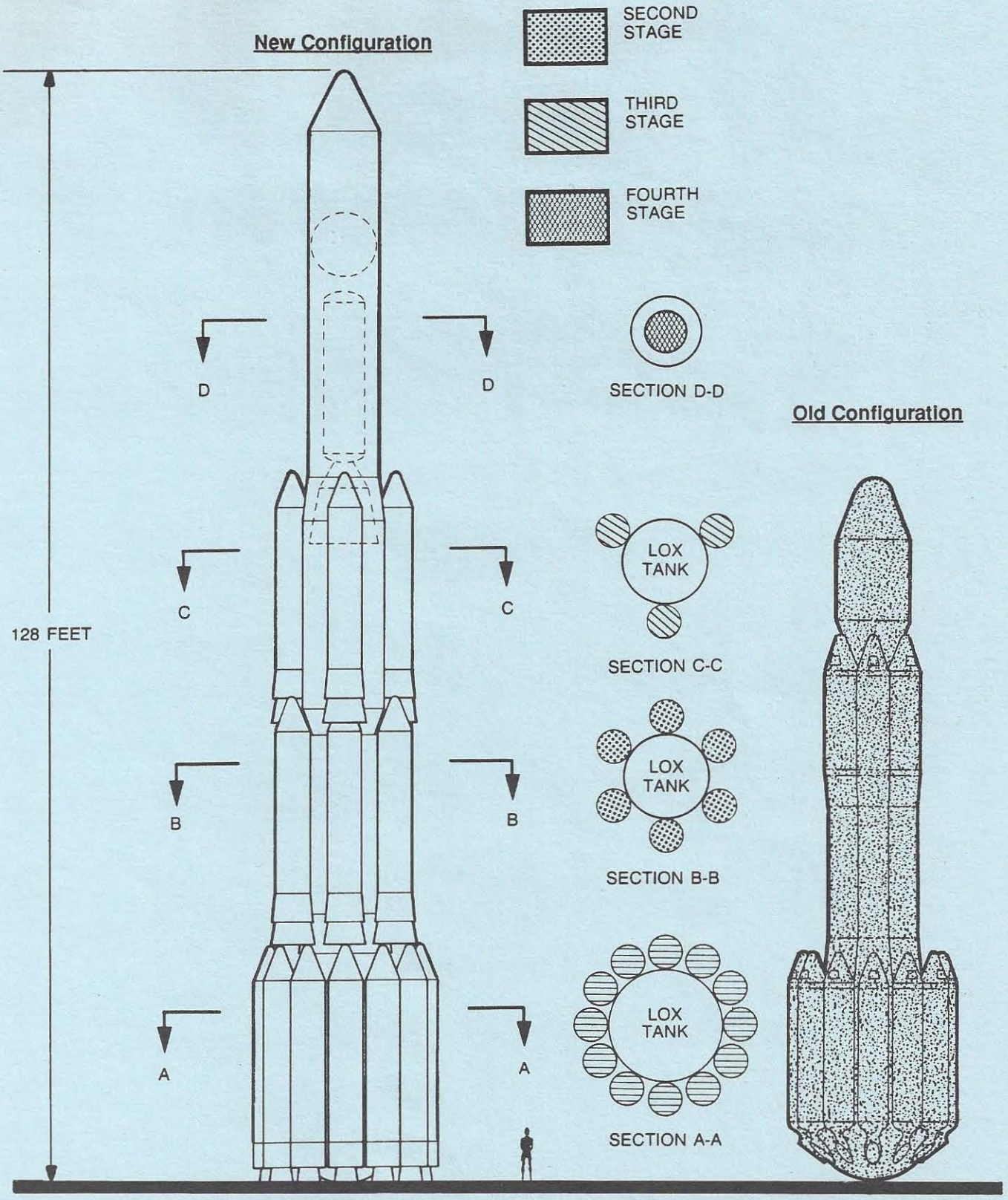
The West German government is in a somewhat delicate position with respect to the European Space Agency. As a member of the ESA, Germany participates in the agency's programs, and contributes funding for them. Currently, the Hermes spaceplane, developed in France, is one of these programs (see last month's issue). Now, the Hermes concept is a direct competitor to the Sänger II concept, despite soothing noises to the contrary (made by hopeful ESA members and European industries who wouldn't mind seeing all the proposals receive some funding).

So West Germany is divided on the route to follow to space. Many voices in the German government are joining the aforementioned peacemakers who feel that both Hermes and Sänger should be funded. Others wouldn't mind seeing the Sänger II replace the Hermes as an ESA program. Still others would just as soon not spend German funds on either program (the British HOTOL spaceplane concept gets wrapped up in all this as well, but that's another story for a later issue).

One interesting solution that has been proposed that would create a German private space organization to undertake space projects separately from the ESA. The role this agency would play in relation to the German government is not clear (in Europe, the separation between government and "private" industry is often fuzzy at best). It is also not clear that such an agency would support the Sänger project. Still, it may be that if the ESA decides not to support the Sänger spaceplane, that Germany will decide to go it alone.

NEXT MONTH: HOTOL

American Rocket Company ILV Configurations



American Rocket Company Revises Launch Vehicle Design

Lower-than-expected results from static engine tests have forced the American Rocket Company (AMROC) to increase the size of its Industrial Launch Vehicle (ILV) design. The new ILV configuration will have the same payload as the older version: about 3,100 lbs. into a 250-nautical-mile circular polar orbit.

The new design is over twice the weight of the old one, with a gross lift-off weight (GLOW) of 617,294 lbs, and stands 128 ft. tall. The older ILV design had a GLOW of 271,169 lbs., and stood only 82 ft. tall (*C.S.R.*, Sept. 1986, pp. 2-4). The illustration on page 5 shows the configuration of the new ILV, which, like the old version, is comprised of a series of clustered hybrid rocket motors stacked around central liquid oxygen tanks (an outline of the old ILV is shown for comparison).

The original design assumed a mass fraction (ratio of usable propellant mass to initial mass) of 0.85, and an engine specific impulse (Isp) of 300 seconds. The new version reflects a more conservative mass fraction of 0.825, and a lower specific impulse of slightly less that 290 seconds.

AMROC claims that the enlarged ILV will not result in a corresponding increase of the price charged for an ILV launch, currently $8 million. AMROC's current plans call for a suborbital test flight of a single hybrid engine module in early 1988. The first orbital flight of an ILV could take place as early as 1989.

Articles of Interest In Other Publications

More historical information on Eugen Sänger and his ideas appears in the August/September issue of the Smithsonian's *Air & Space* magazine.

An illuminating article on the aerospace contractors vying for a piece of the U.S. Space Station appears in the August, 1987 issue of *High Technology* magazine. The current work on the Space Station has been divided into four main segments. The article, by Peter Gwynne, describes each of the four segments and the lead contractors and subcontractors competing for them. In addition, it is a good overall look at the Space Station program itself.

This article is a great help for those, like myself, who have had a great deal of difficulty trying to sort out the whole Space Station project (there has been a considerable amount of confusion surrounding the Space Station and its cost to the taxpayer, which is only now beginning to settle out, and I am currently collecting information on the subject for a future newsletter).

An excellent set of articles on the problems of, and possible solutions for, the U.S. space program appeared in the August 17 issue of *Newsweek*. The first article, by senior editor Larry Martz describes in detail the problems of NASA and the status of the space program. The second article, by contributing editor Gregg Easterbrook, discusses possible solutions to the space transportation problem--specifically the concept of the low-cost "Big Dumb Booster"--and tells us why NASA, the government, and the existing aerospace establishment ignored these solutions. This article is well worth a trip to the library, or ordering a back issue from the publisher ($3.00 from *Newsweek* Inc., 444 Madison Ave., New York, NY 10022).

Until next time,

Tom Brz

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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