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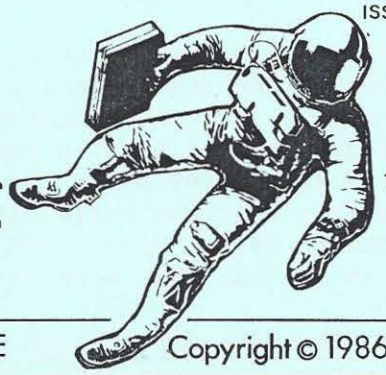

A MONTHLY NEWSLETTER ON FREE ENTERPRISE IN SPACE

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The U.S. National Aerospace Plane
or
"Is This Ship Necessary?"

The U.S. Government has begun developing in earnest what many consider to be the long-awaited successor to the Space Shuttle. This vehicle, a streamlined, needle-nosed, winged aircraft, would take off and land from runways like an ordinary airplane. Then, climbing high above the earth, the vehicle would accelerate itself through the atmosphere using advanced airbreathing engines. Top speed: over 17,000 miles per hour--25 times the speed of sound (Mach 25). At these velocities, it could easily fly into space and enter low earth orbit. During the flight, rocket engines would be used only for the final burst of speed to enter orbit and for orbital maneuvering.

This astounding concept has been referred to by a number of names: the Trans-Atmospheric Vehicle (TAV), Shuttle II, or the "Orient Express." The most accurate name, and the one which I will use from here on, is "aerospace plane." In its new status as a major government project, it is normally referred to as the "National Aerospace Plane," or NASP.

The NASP is currently a joint project of NASA and the Department of Defense (DOD), which have issued the first contracts to industry to begin development (I will discuss this in more detail later in this article). Both agencies are selling the concept as hard as they can to the public and the Congress, with enthusiastic support from the Administration and many space advocacy organizations.

The sales pitch is following the lines I predicted over a year ago in the March, 1985 C.S.R., when I saw "Shuttle II" coming over the horizon. Supporters of the NASP promise prices of less than $200 per pound to orbit and routine, airline-type operations. In addition, mention is made of passenger flights across the globe (hence the term, "Orient Express"). Exotic models and artist's conceptions abound.

However, discerning audiences are beginning to notice that the concept is a little vague, to say the least. No two of these beautiful models and paintings seem to depict the same vehicle. Technical details such as structure, propulsion, payloads, etc. are thoroughly surrounded by a thick fog of generalities (some details are classified). Financial and operational factors are glossed over.

In this article, I will attempt to bring some of the NASP project into focus.

First, a few technical details:

One major problem that must be solved before the NASP can be built involves the airframe. The NASP, which uses airbreathing engines, accelerates to near-orbital speeds while still in the atmosphere. (A rocket, on the other hand, flies out of the atmosphere as rapidly as possible and does most of its acceleration in space.)

This creates atmospheric heating problems for the NASP far more severe than those faced even by the Space Shuttle. (The Shuttle gets very hot, but for a relatively short time. It's on the ground long before the heat can penetrate its insulation. An analogy might be passing your hand quickly through a candle flame as opposed to holding it in boiling water for five minutes). The NASP will have to be constructed of materials that can resist high temperatures for extended lengths of time, with intermittent peaks up to 5000 degrees F. Researchers have some ideas that show promise in the lab, but work on this problem has barely begun.

The other major problem presented by the NASP is its method of propulsion. Like a rocket, it burns fuel with an oxidizer for thrust. However, whereas a rocket carries its own oxidizer along in tanks, the NASP uses the oxygen in the atmosphere to burn its fuel. In this, it is like any airplane with ordinary turbojet engines. Unfortunately, at the high velocities required to enter orbit, a turbojet engine cannot do the job.

A quick look at the problem(*): a turbojet has a compressor to compress entering air before fuel is injected and burned. As the turbojet's velocity increases, air "ramming" into the inlet and compressor and slowing down to subsonic velocities heats up until it exceeds the operating temperature of the engine. This "ram air heating" limits the upper velocity of a turbojet to about Mach 3.5.

A ramjet is basically a hollow tube. It has no turbines or other large moving parts and can operate at higher speeds than a turbojet. Unfortunately, unlike turbojets, ramjets do not work at all at low speeds, and require another method of propulsion to get them up to operating velocities (existing ramjet-powered missiles use solid rocket motors to get them up to speed). At about Mach 6, ram air heating overtakes this type of engine too, overheating even a ramjets simple interior. Here we move out of the realm of existing engines and into the realm of the NASP.

To alleviate the problem of ram air heating, an engine must be built which does not slow the air down to subsonic speeds as it enters the engine. Such an engine is called a Supersonic Combustion Ramjet, or "scramjet." Its design involves some exceedingly complex aerodynamic tinkering. To oversimplify, if the air entering the engine is slowed too much, ram air heating will melt it down. If the air is not slowed enough, combustion cannot take place as the engine literally blows itself out like a candle (the only fuel that can burn fast enough to be used in an engine like this is hydrogen). To remedy this, the inlets of most scramjet designs contain edges and surfaces that can be adjusted by computers at different speeds to tailor the supersonic flow through the engine. The body of the aircraft can also figure in this flow adjustment. The one thing that most current designs for the NASP have in common is that the engines are slung under the aft section of the vehicle so that the entire nose can help shape the flow of the air into the engines. Like a ramjet a scramjet will not work at low speeds. Sets of auxiliary engines of other types, or exotic hybridizations have been suggested to solve this problem.

No scramjet has ever been flown operationally on an aircraft. Research has been done in wind tunnels, but current wind tunnels cannot exceed about Mach 8. Considerable amounts of work can be done by modeling simulated airflows on high-speed supercomputers, such as the Cray systems located at NASA-Ames, but it has become obvious to proponents of the NASP that the only way to develop the engine properly would be to attach it to a flying prototype.

(*) For a more comprehensive look at aerospace plane technology, particularly engines, I recommend an article in the January, 1986 issue of Discover magazine titled "The New Orient Express." Another good article is contained in the May, 1986 issue of Popular Science. Both articles include pictures of a number of different concepts for aerospace planes.

So, in order to develop the National Aerospace Plane, NASA and the Department of Defense plan the construction of a small test vehicle, the X-30A, which will actually enter the strange flight regimes of the NASP. Originally begun under the code name of "Copper Canyon," this project became the X-31, then, for obscure reasons, the X-30A. The X-30A would be the latest in a long and honorable line of X-aircraft which includes, among others, the X-15 and Chuck Yeager's X-1. As currently envisioned, although no real details are available, the X-30A would carry two men and possibly a payload of about a ton.

NASA and the Defense Advanced Research Projects Agency (DARPA) awarded contracts to seven large aerospace companies to pursue the construction of the X-30A. Contracts for airframe design, with potential values up to $32 million, went to all five companies that submitted proposals: Boeing, General Dynamics, Lockheed, McDonnell Douglas and North American Rockwell. These companies will compete, and one of them will eventually become the contractor for the X-30A airframe. Contracts for propulsion work, each valued at $175 million, went to General Electric and United Technologies' Pratt & Whitney.

By the end of 1989, a total of about $600 million will have been spent. At this point, NASA and DARPA will make the decision as to whether or not to build the X-30A.

Go ahead, go back and read that again. After over a half billion dollars is spent, the U.S. Government will decide on whether or not to build the experimental prototype that would be the precursor to the final NASP.

The actual cost of building and testing the X-30A is expected to float somewhere around the $3 billion mark. God knows what the eventual budget for the NASP itself will be--even its backers don't seem to know. Tens of billions at the least.

I know you've gazed at the pictures in magazines and newspapers. I know you've heard the sales pitch from enthusiasts, including the President, and I hate to throw cold water on all the fun and excitement, but the conclusion is beginning to look inescapable: the National Aerospace Plane is taking us on the same old ride we took with the Shuttle. The government trough is being filled to the brim and the same old piggies (look at the contractors listed above) are lining up again to root and snort in the goodies wrung out of the taxpayer.

I will repeat this until I don't have to anymore: government space programs waste stupendous quantities of wealth, human effort and human dreams. They return little except monumental technological grandstand plays that, although impressive, actually accomplish almost nothing to advance us permanently into the universe.

If what you have read in past issues of this newsletter aren't enough to convince you of the methods of nationalized space exploration, check out the article in the April 23 edition of the New York Times. The headline: "NASA Wasted Billions, Federal Audits Disclose." The article is filled with multiple abuses of the taxpayers' money, ranging from incompetence to outright fraud. The Times is not my favorite source for information, but if even half of the things they dug up are true, it's far too much. (A sequel in the April 24th edition of the Times discusses NASA and safety issues, but that's another story.) Don't say that this time it will be different, and that we need the National Aerospace Plane. It won't, and we don't.

I've listened to the proponents of the NASP expound on all the arguments in its favor:

"You've said the Shuttle needs to be replaced, and that a manned, low-cost system is necessary for the full exploitation of space." Correct on both accounts,

but the full scale NASP, if built, won't come into use until after the turn of the century. If the Shuttle system is not supplanted before then, we are going to be so far behind in the race to exploit space that it may not even be worth running anymore.

Low cost? I'll believe $200 per pound real costs out of a state-built launch vehicle when I see it. The Shuttle was going to be $150 per pound into orbit too. Instead, its over $1,000 per pound. To add insult to injury, not only is this price subsidized, but the subsidy does not even include the development costs, which the taxpayer has been given the honor of eating. If precedent counts for anything, we are in for a rude surprise. No, there are other ways to replace the Shuttle besides the NASP, which I will get to in a moment.

"The NASP will see extensive use as a surface-to-surface civilian transport--the 'Orient Express.'" Pull the other one. We're talking about a system that is certain to run hundreds of millions, if not billions, of dollars per vehicle, and uses exotic technologies which the government perceives as having a heavy military use. Maybe to the airlines, money is no object. Maybe the DOD won't object to widespread commercial use of the world's most advanced airbreathing engines. And maybe Pan Am will park its NASPs in the hangar next to their Pan Am SR-71 Blackbird aircraft, which I hear are very attractive to hurried business executives due to their Mach 3+ velocity.

The truth is that the NASP is primarily a military project, and will come with a military price tag and a military classification. As it stands now, the funding split between the DOD and NASA looks to be about 80/20 (which is interesting since the DOD bent over backwards to avoid paying for the Shuttle's original development and is currently refusing to cough up anything for a new Shuttle orbiter if one is ever approved). Sources say that pushing the vehicle as a wonderful civilian airliner is considered by some in the military as the only way to win over Congress. A hypersonic (that is, about Mach 6) "Orient Express" airliner may be built one day, but the NASP is not it, and everyone involved in the project knows it.

The proponents then look me in the eye and play their trump card: "Okay, we accept that the major user will be the Pentagon, which say it will use the NASP as part of the Strategic Defense Initiative. However, according to you, defense is a legitimate use for government funds, and the SDI is an essential defense development. Doesn't this justify building the system?" The proponents lean back, a satisfied smile on their faces (later they will probably ask me not to tell anyone they said anything of the sort).

Yes, Strategic Defense is essential, and an excellent reason for developing low cost space transportation. However, just because something is a legitimate use of government funds does not justify waste of those funds. The Defense Department throws enough money down the drain as it is, and I submit that the NASP is just another example of this.

Although the DOD may mention the NASP in the same breath as SDI, on closer examination this connection doesn't hold much water. Current concepts for SDI require heavy-lift capability to hoist large elements of a defensive system into orbit. Although no payload has been defined for the operational NASP, it will probably not be more than about 20,000 lbs. The only way to apply the NASP to SDI, other than in minor servicing missions, is to use a Strategic Defense System which could be constructed using small payloads assembled in orbit. If such a system is workable, and if it is adopted, the NASP might find a role in SDI transport.

The other major military role seen for the NASP is as a reconnaissance vehicle. This requires the flexibility of a small vehicle with a large crossrange, and needs no large payload. The problem with this is that it seems to me that a production

version of the X-30A could accomplish this mission just as well, and that the NASP would not be needed.

Still, even if there was something that the NASP could accomplish, does that mean we need to build one? Are there alternatives that can do the job?

The answer is yes. We can use one of the manned launch systems currently proposed by private industry.

Pacific American Launch Systems Inc.'s "Phoenix" is a wingless, vertical take-off-and-landing vehicle capable of carrying about 20,000 lbs. into low earth orbit (C.S.R., Oct. 1984; Sept. 1985). It is propelled by hydrogen-oxygen rocket engines. Its structure is ordinary aluminum, cooled during launch and reentry by simply percolating water out through holes in its skin (such a solution is impossible for the NASP--the long heating period would require far too much water.)

The estimated development cost for the Phoenix is about $200 million. Payload cost per pound into LEO is estimated at $100 or less.

Third Millennium Inc.'s "Space Van" is a small, winged orbiter launched from the back of a larger booster (C.S.R., June 1985). Its payload into LEO is a little over 6,000 lbs. The Space Van orbiter is powered by modified RL-10 hydrogen-oxygen rocket engines. The booster is powered by standard turbojets and rockets.

Estimated development cost for the Space Van is about $750 million. Payload cost per pound into LEO is estimated to be as low as $160.

Both systems would be privately financed. Both rely heavily on existing technologies, with strict limits on the amount of new technology that would have to be developed. Both could be put into production for about a third of the estimated cost of the X-30A test vehicle alone.

The question that must be asked is: what can the National Aerospace Plane deliver to the American military and civilian space effort that a Phoenix or a Space Van cannot?

Take-off and landing at airports? The Phoenix could land at any airport that provided a heat-resistant surface about fifty feet across. Since it lands vertically, it could also land at a lot of places besides airports. A simple ablative flame-deflecting assembly would allow the Phoenix to take off from airports (and other unprepared sites) as well. Space Van could land anywhere there is a long runway. Its current design uses a booster which requires a special launch site, but an earlier concept, equally valid, used a modified 747 airplane as a booster, which could of course use any standard jet airport.

Low cost? Look again at the launch prices. Advertised cost per pound into orbit is comparable for all three. However, the development costs, as pointed out above, are so much higher for the NASP project that even the X-vehicle alone dwarfs the private endeavors. How may Phoenix or Space Van vehicles do you think you could build and operate for the tens of billions the NASP project will cost?

In fact, there are a number of things that Phoenix and Space Van can do that the NASP cannot. Both vehicles are designed to be refueled for missions to geosynchronous orbits. The NASP could not do this unless it was equipped with rockets and refueling capability. The Phoenix can operate unmanned. As far as is known, this in not true for the NASP. The vertical landing capability of the Phoenix has already been mentioned. Because of this, the Phoenix, with orbital refueling, could even land on the Moon. The NASP, with wings and airbreathing engines, would find this somewhat difficult.

So, why build the NASP? Let me tell you what attributes really set the National Aerospace Plane apart from the private alternatives and make it attractive as a major government project:

First, the NASP, in all its current incarnations, is a long, elegant, streamlined, beautiful vehicle. It would look great in photographs sitting on wet runways, its image reflected in the water. Pilots, particularly military pilots, dream of such aircraft. They want to strap themselves into this rakish bird of prey and dash in and out of the upper atmosphere, hand on the stick, G-forces pulling at their bodies, imaginary white scarf flying in the wind, and oozing the Right Stuff from every pore. The Phoenix and Space Van, designed primarily as workhorse spacecraft, are not particularly rakish. The Space Van looks a little wierd. The Phoenix looks downright dumpy. They fly dully back and forth to orbit, transporting delicate passengers and cargo with as little fuss as possible. Not nearly as exciting--except perhaps to payload customers.

If you think this is trivial, if you don't think appearance and image makes a difference in selling a concept to the Air Force, I suggest you examine the workings of how our Defense Department chooses its weapons. The Paris Air Show can be educational. I also suggest you check the backgrcund of the people in the Air Force who call the shots. Many worked up through the ranks as pilots, and no few of them still wear those invisible white scarfs.

However, it is a second attribute of the NASP that is really the main incentive for its construction. The NASP project promises to deliver billions of dollars in contracts to hungry aerospace industries and research facilities who have more than enough places to spend it. The Phoenix and the Space Van, although they could be sold to the government (just another customer), do not rely on taxpayers for development money and are forced to be frugal. What contracts may be issued to the aerospace industry from these companies would seem poor fare indeed compared to what the industry is used to.

If you think these two attributes are worth the tens of billions they will cost, if you think they will promote the movement of humanity into space, then you're entitled to your opinion. You know mine.

* * *

Note on the National Space Commission Report

As yet, the final report of the President's National Commission on Space is not available, and Commission representatives assure me that the documents on which articles in Aviation Week and other publications were based were not final drafts and were not accurate. The article on this subject which I mentioned last month will therefore have to wait until I can get the Real Thing from the Commission.

Until next time, Tom Brosz

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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