NASA and Military Press for a Spaceplane

The aerospace plane, a possible alternative to the shuttle, is to be designed with military goals in mind more than commercial travel

JUDGING by the ink spilled over it, the aerospace plane has arrived. But what is it? Is it the shuttle's next of kin, a self-propelled vehicle to carry freight into orbit, or is it to be—as news stories report—an incredibly fast passenger plane, able to whisk executives from Los Angeles to Tokyo in 2 hours? The enthusiasts say it will be both; the cautious ones say, a research plane; and the realists say, a military project.

The idea is to combine new, light airframe materials with advanced "scramjet" engines and construct a plane that can do fantastic things: take off from ordinary airports, fly at a speed of more than Mach 5 (five times the speed of sound), send payloads into orbit, and pick up passengers at breakfast time on the U.S. East Coast and unload them on the other side of the Pacific Ocean before lunch.

Just about everyone who considers the idea likes it. But as of now, there is no clear technological path to the goal, and there is sharp disagreement on whether it makes sense to reach for the hypersonic passenger plane described in the news stories before building an advanced supersonic plane (faster than the Concorde, but far slower than this dream plane). Furthermore, some industry leaders see the aerospace plane strictly as a military vehicle. In this view, it is a mistake to pin commercial hopes on it.

As a military craft, the hypersonic plane's main selling point is its hoped-for ability to reduce the cost of sending payloads into orbit. A tenfold reduction below present costs is deemed the minimum necessary to bring the Strategic Defense Initiative (SDI) within credible budget limits.

The chief enthusiast for the aerospace plane is George Keyworth, II, ex–science adviser to the President. He took the lead last July before the House science and technology subcommittee on transportation, aviation, and materials, where he made a plea for funding. His testimony followed a decision in late spring to appeal for public support, known in the bureaucracy as Phase I. The big push required the cooperation of the Defense Advanced Research Projects Agency (DARPA), which supports classifed work in hypersonics, and the National Aeronautics and Space Administration (NASA), which runs a smaller program of civil research.

The Pentagon estimates that DARPA, the Air Force, and the Navy each have been spending less than $50 million a year in this area. NASA has been spending around $15 million. If approved, the push to test components would cost an additional $500 to $600 million through 1988, the end of Phase II. If successful, this will lead to Phase III, construction and testing of a research plane, costing perhaps another $2 to $3 billion through 1993–1995. Eighty percent of this will be financed by defense agencies and 20 percent by NASA, reflecting the military's keen interest in it.

> ***"This technology is here. It is not waiting to be developed. It is simply waiting to be used."***

"We must all be very cautious not to overdefine exactly what these opportunities are here," said Keyworth at the hearings in July, fairly gushing about the prospects for a spaceplane. "I hear reference made to a transatmospheric vehicle, Mach 3, Mach 5, Mach x. That is not the point. The point is that travel from here to the Pacific Basin can be made routine and simple," he said, stressing the business imperative. He added that he was sure the plane would also reduce the cost of carrying cargo to space by a factor of 5, if not 100.

The best news, Keyworth said, is that the United States need not wait until 1997. "This technology is here. It is not waiting to be developed. It is simply waiting to be used and put together and assembled in an innovative fashion. . . . " Most important, Keyworth claimed, "We have simply skipped over what would be, if you wish, the commercially feasible supersonic transport," and made "a true double jump in technology" to the faster aerospace plane. He went so far as to say that ticket prices on the new plane could be competitive with ticket prices today.

Keyworth intended, as he said, "to pump energy into this objective," and he did. He pumped again during a Capitol Hill breakfast meeting on 20 November for members of the aviation forum, an informal group of members of Congress and staff. The deputy director of DARPA, James Tegnelia, and an associate director of NASA, Raymond Colladay, also spoke, and like Keyworth, they advertised the idea as a commercial technology.

Exactly what has happened recently to make the aerospace plane credible as a passenger vehicle? Tegnelia declined to discuss the issue, but Lana Couch, NASA's manager of the aerospace plane program, cited the main innovations in an interview, skirting classified data. (Asked to explain why DARPA decided to declassify some of its work and advertise it this year, she said the answer was "classified.")

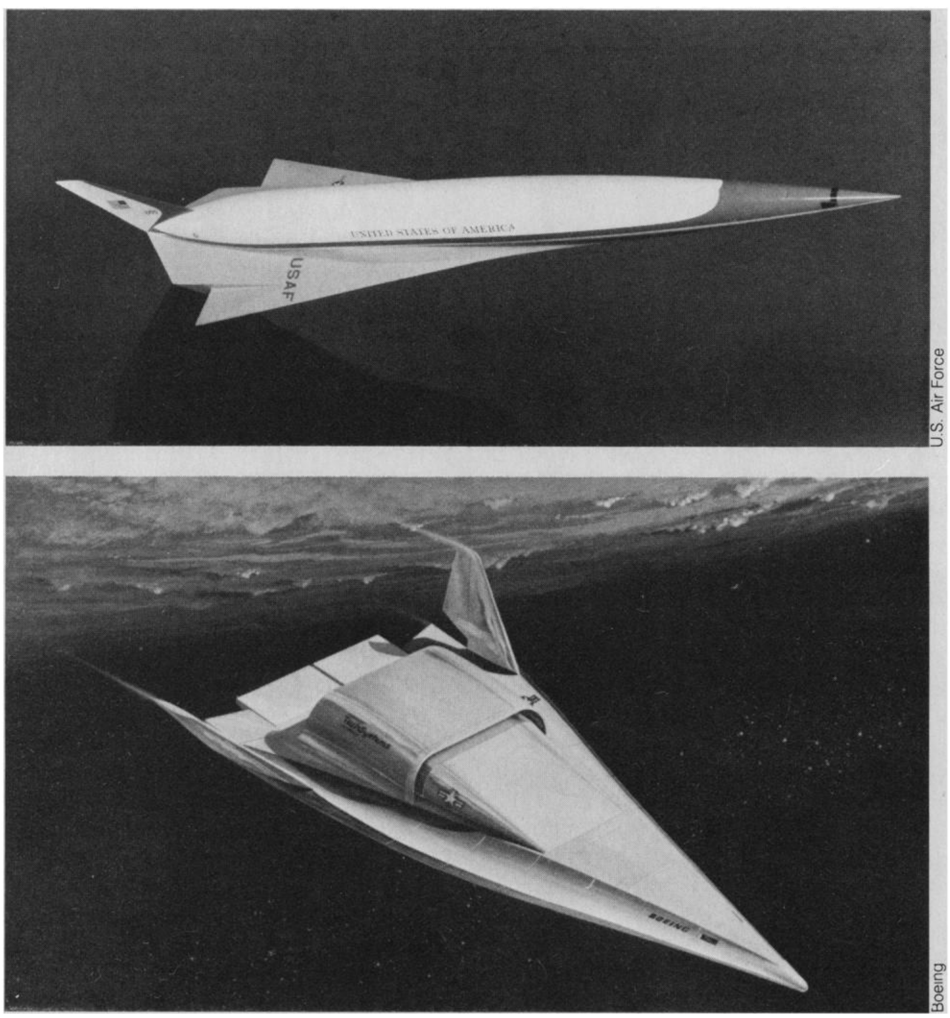
Three critical technologies have come together, Couch said. These are advances in air-breathing propulsion (the scramjet engine), the creation of very light heat-resistant materials for use in the airframe and engine, and a dramatic improvement in computer power that makes it possible to integrate components in the design stage. More than any aircraft before, this one will require that the engines, the fuel, the tanks, and frame operate interactively. For example, liquefied hydrogen will be used not only as a fuel but as a coolant to be pumped through the hot edges of the frame. The airframe itself serves as part of the engine. The entire underside of the plane will be shaped as an air intake funnel. In this way, design changes in any single part involve changes in all the others, leading to a mind-boggling complexity that can only be handled by supercomputers.

Technical reviewers have singled out the propulsion system as the key factor that will make or break the plane. Couch says there is reason for optimism because in the last 3 years NASA has tested scramjets (supersonic combustion ramjets) at its Langley research lab up to a speed of Mach 7. Airliners are powered by turbine engines, which compress air for high-pressure combustion. A ramjet has no turbine but relies on the speed of the engine moving through the surrounding atmosphere to create the necessary compression and heating. A scramjet does the same thing but faster. As Couch says, a scramjet "swallows the shock," meaning that air and fuel pass through the engine at supersonic speed and the shock wave moves from before the combustion area to somewhere aft of it.

Making this engine work is a tall order, but the hardest part is, literally, getting it off the ground. The scramjet only begins to work at speeds above Mach 4, twice as fast as the Concorde travels. NASA and DARPA have begun a competition among engine designers to test a variety of ways of getting the plane up to scramjet speed. At the moment, it looks as though the design will incorporate two, maybe three, different types of engines and possibly a rocket system as well. In addition, small maneuvering rockets would be needed for space travel. One possibility would be to use an air turboramjet (a 20-year-old design that combines a turbine with a ramjet) to move the plane from takeoff to a speed of Mach 4, after which the scramjet would kick in. But none of these engines has been flight-tested. Making them work in harmony will be a challenge.

As NASA sees it, the purpose of the new program will be to test these ideas and put together a research airplane using data from the engine tests. It is, as Couch says, a plan to acquire a "broad technology base." Among the questions that need to be answered are:

- Will the oxygen at high altitudes be dense enough to support combustion in a scramjet?
- Will rockets be needed to reach orbital speeds?
- Are the heat-resistant materials now available sufficient for sustained use in a scramjet combustion chamber?
- Can the new airframe materials withstand the very prolonged high temperatures that this kind of plane would encounter? (The shuttle endures high heat, but not for long periods.)
- What kind of environmental problems will the aerospace plane create, in particular, at takeoff?



The aerospace plane has as many different designs as designers. A sleek Air Force concept (top) contrasts with a blunter version by Boeing (bottom).

Because so much needs to be investigated, Couch stresses the research nature of the project. It is premature to state what the final product will be, she says. The DARPA-NASA research may produce several craft. The time to ask about a working airplane, Couch says, will be 1995, after the technology has been explored. Commercial uses cannot be expected before 2000 or 2010.

Meanwhile, one industry leader—John Steiner—says the talk of a hypersonic passenger plane may be misleading. Steiner worked for the Boeing company for 42 years, the last 22 as a vice president. He retired in 1983 and served as chairman of the White House Aeronautical Policy Review Committee, a group assembled by Keyworth. Boeing, which was commissioned, then decomissioned, as builder of the U.S. supersonic transport, knows to take government predictions with a grain of salt.

"This whole idea of a hypersonic airplane is good from a military standpoint," Steiner says, "but it is being way overplayed as an 'Orient Express.'" The latter name was coined by congressional advocates of the hypersonic passenger plane. For some time, DARPA has been thinking about building a spaceplane that would carry small payloads to orbit more cheaply than the shuttle. This craft would be more versatile and better protected than the shuttle, which Steiner calls "hopelessly vulnerable" from a military standpoint. These goals reflect genuine military needs arising from the Strategic Defense Initiative, but, in Steiner's view, they are not relevant to commercial transport. A second line of research is needed to produce a new commercial plane, he thinks.

Steiner says "I get mad" when people discard the close-by technology of a supersonic plane in favor of the dream of hypersonic transport. He believes there is a fast-growing and stable demand for rapid travel to the Pacific Rim, and he thinks airlines would be willing to pay for a new supersonic plane. But the government's promotion of a hypersonic transport, is "baloney." It is economically unsound, according to Steiner, because it would require every user to invest in a totally new cryogenic fuel supply system (hydrogen or methane), at a time when many airlines are short of cash. Furthermore, the noisy engines will probably be unusable at commercial airports.

One of the "disappointments of my life" Steiner adds, is that people have misused a booklet published in April by the White

House group he chaired on aerospace goals. He thinks officials have "jumped on" goal number three, the idea of building a hypersonic plane, as a way to get money in the budget for a military project. But in doing so, they have cast aside goal number two, the plea for research on a commercial supersonic plane.

After sitting through one recent briefing, Steiner went over to a military official and chided him for opening his presentation with a drawing of a hypersonic plane with passengers at the windows sitting on a runway at Dulles Airport. Steiner called it a shoddy sales technique. The response, Steiner says, was something to the effect that, "This is the way you've got to talk in front of Congress."

One watchdog of space programs, John Pike of the Federation of American Scientists, thinks the aerospace plane is a hot item strictly because it fits in with plans for the Strategic Defense Initiative. "The SDI people have been quite frank about the need to reduce the cost of launch by an order of magnitude," he says.

After completion of a new SDI architecture study in the fall, according to Pike, it became clear that the system would demand on the order of not 100 large space platforms but 1000 small ones. In addition, the new design called for periodic maintenance trips to space. This architecture would be impossible to support with the present shuttle. Of the hypersonic plane, Pike says:"It makes a lot of sense for SDI, but I can't imagine why anybody else would look at it."

Because of the military's interest in a new space vehicle, research on the hypersonic plane will surely go forward. But the debate about its commercial future may be made academic by money problems. The Gramm-Rudman-Hollings resolution, which aims to end the federal deficit in 5 years, will take a heavy toll on ambitious technological start-up programs in 1986, and the aerospace plane could be one of the victims. It may be possible to continue the kind of conceptual and engine research NASA and DARPA have proposed for the next few years by trimming other programs. But at the moment, it is hard to imagine where the program will go beyond that. ■

ELIOT MARSHALL

A Risk Reduction Center Gains U.S. Support

A series of shrewd maneuvers by two congressmen led to an agreement at the summit to start bilateral talks on risk reduction centers

FOUR years ago, in a brief letter to an official of the Strategic Air Command (SAC), Senator Sam Nunn (D–GA) posed the following question: What would happen if a single nuclear weapon were to explode on U.S. or Soviet soil at the height of an international crisis? After a detailed study, SAC concluded that the origin of the blast might be unclear and that the superpowers could respond in such a manner that global nuclear conflict became inevitable.

This alarming conclusion attracted little public attention at the time, but it made a deep impression on Nunn and several of his colleagues. With the assistance of arms control specialists in the academic community, they set in motion a chain of events that culminated in the only substantive arms control progress by President Reagan and Mikhail Gorbachev at the November summit. Specifically, the two leaders agreed to discuss the establishment of "centers" that could be used to reduce the risk of accidental nuclear war stemming from scenarios such as that involving a single nuclear detonation.

The agreement was apparently hard-won on both sides. In the United States, it was resisted for a long time by elements of the diplomatic and military bureaucracies that presently concern themselves with crises, partly out of concern that their own roles could potentially be diminished and partly out of genuine skepticism that such an idea could be made to work. In the Soviet Union, according to U.S. officials, it was resisted primarily out of concern that progress in such a peripheral area would detract from the central topic of strategic arms reductions.

The process by which Nunn and his colleagues overcame this resistance and placed their pet idea on the agenda for discussions between the world's two most powerful leaders is virtually a model of successful political action in Washington. Having established a nucleus of support in the Congress, they reached out to a community of well-regarded independent experts, skillfully exerted pressure on the executive branch, and ultimately served as go-betweens in the delicate negotiations leading up to the summit itself.

The notion of a risk reduction "center," at which various experts can jawbone about minor scrapes and help avert a nuclear cataclysm, is at least 25 years old. Henry Kissinger, while still a professor at Harvard University urged in 1960 that ranking officials jointly staff centers in Moscow and Washington, that could dispatch special surveillance teams for on-site dispute resolution. But the concept largely lay dormant until 1981, when Nunn, a widely respected member of the Senate Armed Services Committee, asked General Richard Ellis, who was then the SAC commander, to perform the study.

As Nunn explained at a hearing before the Senate Foreign Relations Committee last year, "the study that was done by the Strategic Air Command . . . started with a classified analysis of how many nations and which nations could conceivably have nuclear weapons by the year 1991. When you look at that list in a classified way, it is overwhelming in terms of the message that it delivers." The study persuaded Nunn that the most likely cause of a general nuclear war might be the fear and uncertainty that would follow the detonation of a nuclear bomb by terrorists, rather than a straightforward first strike, he told *Science*.

Nunn discussed the study with Senators Henry Jackson (D–WA) and John Warner (R–VA) and together they seized on the notion of a multinational crisis control center as the best means of averting such a conflict. Warner, a former Secretary of the Navy, was the chief U.S. negotiator of a 1972 U.S.–Soviet agreement aimed at preventing accidents and confrontations at sea. He says that he likes the idea because it has a parallel goal. Nunn, Warner, and Jackson proposed a successful amendment to the 1982 defense bill requiring the Reagan Administration to conduct a formal study of the concept, along with several additional "risk reduction" ideas, such as modernizing the U.S.–Soviet Hotline for crisis communication and reducing the vulnerability of