SST: Commercial Race or Technology Experiment?

Late this summer the Senate will decide whether the United States will continue what may be the most controversial nonmilitary venture in high technology ever undertaken—the supersonic transport (SST) project. In past years this project, which began under President Kennedy and now has the support of President Nixon, faced no major opposition, although it has been regularly denounced as a costly subsidy to private industry and a potential nuisance to those who might be exposed to the SST's sonic boom.

This year, however, given rising inflation, another tight wartime budget, and mounting concern about the environment, opposition to the project has been growing. For many, the SST has become a symbol of misplaced priorities and of a tendency to design environmental standards to fit machines, rather than vice versa. In May the project survived a challenge in the House by only 14 votes and an even closer vote seems in prospect in the Senate.

"Technological Renunciation"

The Senate vote, on money for the SST, will probably be decisive, for the SST project is now in a "metal-cutting" stage that cannot be stretched out except at exorbitant costs. During a symposium last fall on environmental questions, Murray Gell-Mann, Nobel laureate in physics, observed that in the past most things that were technologically possible to do were in fact done. Gell-Mann called for some landmark acts of "technological renunciation" for the sake of protecting the environment, and suggested that the SST might be a project best renounced.

Yet, for national leaders, the question of whether to build or not to build the SST is not that simple a matter. Neither the arguments made for this project nor those against it are easily dismissed—nor is it even clear that all of the most pertinent policy questions have been identified.

In the Senate struggle, both sides to this dispute will be potently represented. Leading the fight for the SST will be Henry M. Jackson and Warren G. Magnuson, popular and influential senators from the state of Washington, home of the Boeing Company, which is assembling the SST. Both of these senators are powerful committee chairmen and senior members of the Senate "club."

But on the other side will be an equally, if not more, potent senator, Edmund S. Muskie of Maine, frontrunner for the Democratic presidential nomination in 1972. Muskie will lend muscle to the efforts of William Proxmire of Wisconsin, a Senate maverick (and frequent loser) who always has led the opposition to the SST, such as it has been. A possible straw in the wind is the fact that the anti-SST cause recently gained a prominent Republican convert, Senator Charles H. Percy of Illinois, a former supporter of the SST who has publicly announced that he is switching sides.

Lobbying for the SST by Department of Transportation officials and by friends and representatives of the aerospace industry may be intense, but the opposition will be working the Senate corridors too. A Coalition Against the SST was formed last spring by more than a dozen groups such as the Sierra Club, the National Wildlife Federation, and the Citizens League Against the Sonic Boom, together with two labor unions and a conservative taxpayers' group. These and other foes of the SST are building their case partly on the statements of a number of Nixon Administration officials and advisers who have expressed strong doubts about this aircraft.

The Senate is being urged to kill the SST project on the grounds that the aircraft will be uneconomic; that it is taking money that could be better spent on such things as urban mass transit and pollution control; and that it gives rise not only to the problem of the sonic boom, but also of teeth-rattling airport noise and possibly even of changes in the upper atmosphere which could bring catastrophe on earth.

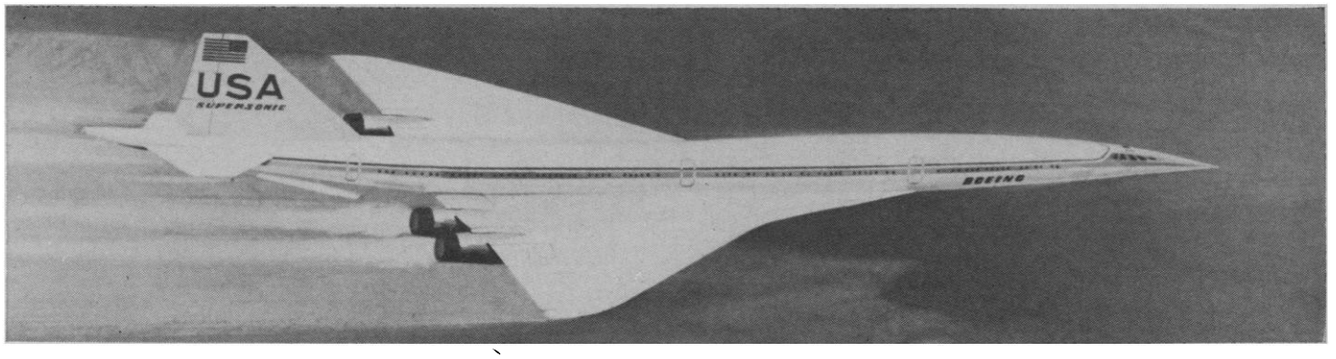
On the other hand, leaders of the SST project argue that such environmental questions either can be dismissed as the conjectures of alarmists or dealt with through further engineering research and the prohibition of potentially annoying boom-producing flight except when the SST is over water or polar regions. They contend, further, that the SST represents an inevitable technological advance that will revolutionize systems of global transport; and, finally, that the United States cannot allow its aerospace industry, which last year produced $3.15 billion in exports and contributed importantly to the favorable U.S. balance of trade, to fall behind foreign competitors.

The French-British Concorde and the Soviet TU-144 are SST's capable of neither the high passenger-carrying capacity nor quite the speed expected of the U.S. plane. But prototypes of both these foreign aircraft already are flying. If the commercial version of the Concorde appears on the market in 1973, as scheduled, it will have a 5-year lead on the American SST. The Soviets also will enjoy a similar lead if they make a serious bid to market their plane outside the bloc countries, which they might succeed in doing if they offer overflight rights as part of their sales pitch.

New Emphasis on Tests

Proponents of the SST argue, moreover, that over the past 2 years the project has been changed to provide assurance that, if the aircraft is produced commercially, it will be economical and compatible with the intercontinental airports and traffic control systems developed for big subsonic jets. Development of the SST prototypes has been "decoupled," they say, from production of commercial models. According to previous plans, production work was to start even before the first flight tests of the prototype. Now, plans call for the testing of two prototype aircraft for 100 hours before it is decided whether commercial production is in order. The prototype tests would be expected to indicate design changes to make the production model a better aircraft—in fact, more extensive testing prior to the production decision probably would be carried out if there were not such haste to enter the market against the Concorde.

Here, a blow has been struck for common sense, although the decoupling provides a convenient explanation for the fact that the prototype will not meet some of the key performance requirements of a commercial aircraft. William M. Magruder, director of SST development for the Department of Transportation, observes that, "Originally, the prototypes were just earlier replicas of a preset production aircarft. Now, the prototypes have their own specific per-



formance requirements, consistent with production objectives broad enough to permit the airlines and the manufacturers to design and build the right aircraft."

The SST issue has developed in such a manner that Congress is offered no easy way to hedge its bet. Congress can kill the project, at such risks as that may entail and at the loss of a substantial past investment in the SST. Or it can put large additional sums on the U.S. entry in a competition that involves a technological leap of a magnitude usually associated with military projects and runaway costs. And this is a competition already fostering economic pressures for a relaxation of airport noise standards. Some fear that ultimately there will be demands to allow boom-producing flights over desert and wilderness regions, if not over heavily populated areas.

The first goal of the SST project is for the Boeing Company and General Electric, the prime contractors, to have the two prototypes ready by 1973. Nearly $1 billion has been appropriated for the SST project since the early 1960's, and Congress is asked to appropriate another $290 million this year. The total cost of the project through the preprototype and prototype phases is now officially placed at $1.6 billion, up $76 million from last year's estimate. For the prototype project, the government is to contribute about $1 billion; the contractors are putting up over $300 million; and the 26 U.S. and foreign airlines that have taken options to buy 122 SST's have contributed $59 million.

If all goes well, production of the commercial model of the SST would begin in 1974, with the first deliveries in 1978. This plane must be good enough to outsell the Concorde and the TU-144, even as a latecomer. It would seat up to 298 passengers, compared to 128 or fewer for its competitors, and it would fly at Mach 2.7 (about 1800 miles per hour), as compared to top speeds of Mach 2.05 for the Concorde and Mach 2.35 for the TU-144. It would sell for not less than $51 million in 1980 dollars (inflation projected); this is more than twice the price the Concorde is expected to sell for in 1973 and better than twice the current price of the Boeing 747, the subsonic jumbo jet that can carry up to 490 passengers.

The Financing Problem

According to Department of Transportation market analyses, which are in dispute, no fewer than 500 American SST's will be sold. The royalty arrangements would permit the government to recover its investment from the sale of the first 300 planes and to receive an additional $1.1 billion from the sale of the remaining 200. But many believe that the government is caught in an all-night poker game with losing cards. Although the government is supposed to be able to leave the game after the project's prototype phase, it may be staying around for a few more hands if the $3 to $3.5 billion needed to start production of the commercial aircraft cannot be obtained through private financing.

The trade journal *Aviation Week* has said that government participation in the financing is likely to be necessary. And even Under Secretary of Transportation James M. Beggs, who professes greater optimism, does not rule out that possibility. In sum, if the government is to have a chance to recover its investment in the prototype, it may have to put up still more money—at a risk that a number of economists, including Hendrick Houthakker, a member of the President's Council of Economic Advisers, consider very high indeed.

The beginnings of the SST project go back to late 1959 when an SST study group was formed within the Federal Aviation Agency (FAA). According to retired Air Force General Elwood R. Quesada, who was administrator of the FAA at the time, the concept then prevailing was that the government might modestly assist development of a commercial SST which would draw on the new technology growing out of the proposed B-70 supersonic bomber project. But the B-70 project was given up as a bad idea in 1962, although two experimental aircraft eventually were built.

Nevertheless, to Quesada's surprise and displeasure, the SST project soon became a major government program in its own right. "It was never anticipated that the federal government would be the major sponsor of a supersonic transport," Quesada last year told a Presidential review panel on the SST. "I gag at the government's, by its own positive action, replacing economic demand," he added.

Quesada's statement has been cited jubilantly by opponents of the SST, although it would seem to lead one to look to the arms race to stimulate major advances in civilian technology. He was saying, in effect, that it is acceptable for such technology to benefit indirectly from military R & D, but that it is not acceptable for industry to receive a direct subsidy for development of a commercial project such as an airliner, even when the technology involved entails high risks, huge costs, and long-deferred financial return.

The aviation industry in Europe also had become interested in supersonic technology early on, and, by 1962, discussions between the British and French governments looking to a joint project were well along. In late 1962, the two governments, seeking to do jointly what neither country could afford to do alone, agreed to build the Concorde, with the French to construct the airframe, the British to build the engines, and both countries to assemble prototypes and production aircraft.

This French-British commitment was

a sharp competitive spur to Washington and contributed to the U.S. decision in 1963 to build the SST. In June of that year, President Kennedy called for a joint government-industry effort to develop an SST prototype superior to any being built abroad. Built with a more heat-resistant airframe of titanium, the American SST would fly 400 miles per hour faster than the aluminum-built Concorde. A huge plane nearly 300 feet long, the U.S. aircraft also would be much larger than its rival. Yet, however ambitious, the SST project was not supposed to be open-ended. "In no event will the government investment be permitted to exceed $750 million," President Kennedy said.

The SST was to be flying by 1970, but the design competition from which Boeing and General Electric emerged the winners was not completed until late 1966. Further delay occurred when, in 1968, the engineers at Boeing and the FAA reluctantly concluded that an SST built to the variable swept-wing design that had been adopted would be too heavy to carry a profitable load of passengers. A fixed-wing design was then prepared and submitted in January 1969 to the incoming Nixon Administration.

Turbulent Environmentalists

Meanwhile, another problem had arisen for the SST when some turbulent environmentalists turned up in the flight envelope. The sonic boom, which resembles a clap of thunder, is as inescapable a product of physical laws as the wake of a boat. This was recognized from the start by the SST project leaders, and a prohibition against supersonic flight over land was considered likely. These leaders also recognized that such a restriction would reduce the SST's usefulness, and they clearly were apprehensive lest restrictions render the plane noncompetitive with subsonic jets. The ambiguity of their position encouraged people such as William A. Shurcliff, who will never love the boom, to keep the SST under a steady barrage of flak.

Early in 1967 Shurcliff, a 61-year-old senior research associate at the Cambridge Electron Accelerator and a self-styled "pamphleteer" of great energy, organized the Citizens League Against the Sonic Boom, for which Shurcliff now claims 4200 members. Through newspaper advertisements, a voluminous correspondence, personal lobbying, and authorship of a *SST and Sonic Boom Handbook* (150,000 copies in print), Shurcliff is one of several anti-SST militants who have forced leaders of the SST project to stay busy reassuring people that no boom from an SST will ever startle them.

But, if the American SST was having its problems, so was the Concorde. The original estimate that the Concorde could be developed for less than $500 million had been wildly inaccurate. (The latest estimate is $1.8 billion.) In a 1968 speech before an engineering society in New York, Sir George Edwards, chairman of the British Aircraft Corporation, suggested that the United States and Europe set up a joint program to manufacture the Concorde and later the American SST. "The free world needs to examine the virtues of doing collaborative activities before it sets itself automatically on a collision course with competitive projects and the enormous attendant costs," Sir George said.

To this suggestion Sir George got what he later described as a "polite response." Many government and industry officials involved in the SST project felt that in a joint U.S.-European program the exchange of technology would be one-sided. As one official now puts it, "The United States has invested billions in high-temperature materials and technology. If we share our technology with other nations, which all have lower labor costs than ours, we'll have no way to compete." However, Dana Orwick, head of the Office of International Cooperation in the Department of Transportation (DOT), thinks it regrettable that the possibility of a joint project was not vigorously pursued when the Concorde and SST projects were getting under way. "The industrial nations should be able to agree on joint approaches and avoid wasteful competition," Orwick told *Science*.

The many unknowns involved in building, marketing, and living with the SST were pointed up during the Nixon Administration's extensive review of the project last year. Project evaluations were obtained from five sources: the major domestic airlines; a technical review group of government aeronautical experts; a panel of three aeronautical specialists from M.I.T., Caltech, and the Rand Corporation; a high-level interagency ad hoc review committee; and a panel headed by Richard L. Garwin, a physicist and member of the President's Science Advisory Committee.

The reports of all these evaluators except the ad hoc review committee and the Garwin panel favored construction of the prototype aircraft. For some, the overriding consideration was their belief that the SST, despite major problems and uncertainties facing it, represents the next step in the evolution of air transport. This was the point of view expressed by Arthur E. Raymond of the Rand Corporation:

> The eventual size and character of the market for this airplane is [uncertain]. Its operations will be heavily constrained because of sonic boom and because of sideline noise in the airport areas. It is not likely to be able to compete effectively with the subsonic jets in the low-cost, high-mass-travel market. Nor will it be a contender over long routes beyond its maximum [4000-mile] range. Medium- to short-range operation is, of course, also out, particularly over land. It is primarily a premium-fare prestige airplane for long overwater routes, within its range limitations. One is tempted to conclude that the game is not worth the candle and say, as some have, that this project should be abandoned. But this is undoubtedly too narrow a view. . . . Both the market and the capabilities of this airplane will certainly grow with time.

A Shrinking Globe

This view, that the age of supersonic travel is coming and will make distant countries such as Japan, Australia, and Argentina as close to the United States in a time sense as Europe is today, was expressed by President Nixon last September when he announced that the SST project would proceed. Even the initial production aircraft, though incapable of nonstop trans-Pacific flights, would be capable of serving Pacific routes, making stops at places such as Hawaii to refuel. Nixon also stressed the importance of U.S. aviation staying ahead of its competition.

The President clearly was not persuaded by the decidedly unfavorable reports on the SST tendered by the Garwin panel and the ad hoc review committee. Under Secretary James M. Beggs, chairman of the ad hoc group, sought to brighten up the pessimistic tenor of the group's findings in his summary of the views submitted by working panels that had considered the SST's implications for the environment and such things as the balance of payments and "technological fallout." But the chairmen of these panels reacted sharply. For instance, Houthakker, of the Council of Economic Advisers, wrote Beggs that the summary "distorts the implications and tenor of the report." Lee DuBridge, the President's Science Adviser, also rejected the sum-

mary and observed that the "serious environmental and nuisance problems" of the SST should be avoided and that "a device which has neither commercial attractiveness nor public acceptance" should not be subsidized.

Similar views were expressed by Russell E. Train, who at the time was Under Secretary of Interior. This past May, appearing before Senator William Proxmire's Subcommittee on Economy in Government as chairman of the President's new Council on Environmental Quality, Train said that the two SST prototypes would not in themselves cause environmental problems. And he noted that already the FAA had proposed a ban on all supersonic flight producing a boom detectable at ground level within the United States. He acknowledged that sonic booms might bother people at sea and disturb wildlife, such as birds nesting on isolated islands.

A question which Train said was "highly speculative" but worthy of careful attention is whether the water vapor put into the stratosphere by the SST would bring on possibly disastrous environmental changes. One conceivable effect would be to increase the earth's cloud cover and cause climatic change. Another would be to reduce the ozone in the stratosphere enough to impair the earth's shielding from destructive ultraviolet radiation.

Train indicated that the SST's clearest environmental threat is that its powerful engines may produce a frightful din for people at or close to airports. According to him, the "airport noise" made by the SST early during take off would be three to four times louder than that allowed for subsonic jets, although the "community noise" made by the SST during its steep ascent and later during landings should be tolerable. Train assured Proxmire, however, that the administration will not permit the environment in and around airports to be degraded by increased noise. But the noise standards set by the FAA must, as a matter of law, be "economically reasonable, technologically practicable, and appropriate for the particular type of aircraft" to which they apply. This means, beyond doubt, that the airport noise standards which the agency will soon propose for supersonic aircraft will be more permissive than those that apply to subsonic jets. If they should not be more lenient, the Concorde and the American SST would be denied use of U.S. airports.

The National Environmental Policy Act (NEPA) of 1969 under which Train's council was established calls for agencies to report on the potential environmental impact of their actions. Department of Transportation officials have briefed the council on the SST, but the extensive report contemplated under NEPA is not expected to be ready for several months. A suit brought by a leader of Friends of the Earth and a Sierra Club official demands that such a report be filed immediately, before more money for the SST can be appropriated. And a petition filed by the Environmental Defense Fund calls for an immediate start on rule-making proceedings for the setting of noise and other environmental standards for the SST.

Ironically, the senator chiefly responsible for the passage of NEPA was Henry Jackson, who is both a leader of conservation causes in Congress and one of the SST's leading advocates.

Research Expanded

Although no one can now clearly foresee the environmental effects of the SST, the federal research effort on aircraft noise suppression, upper atmosphere phenomena, and other topics related to the SST is being expanded. In fact, early this week William M. Magruder, director of SST development, announced to a National Press Club audience that up to $27.6 million will be spent on such research over the next 4 years. Magruder said that two independent advisory councils, one on atmospheric problems, the other on noise suppression, are being set up to help guide the research effort.

The Concorde will be undergoing trial flights at its top design speed off the British coast later this summer. Unless the Concorde's sonic boom leads to mass protests or the plane's performance falls far below expectations, proponents of the SST will point again to what they regard as alarming evidence that the United States may lose its leadership in aviation. So it has gone from the start. Instead of an international program to build an experimental supersonic aircraft which might, or might not, be more of a blessing than a nuisance, there has been a race to capture whatever market exists for commercial SST's. As Congress considers once again whether to vote more money for the SST, it should raise the long neglected question of how to convert the commercial race into a technological experiment.

—LUTHER J. CARTER

NEWS IN BRIEF

● **NATIONAL GROWTH POLICY**: American policy-makers must enlarge the criteria by which technological projects have been judged to include, for example, the environmental effects of technological change, according to a Presidential panel. The National Goals Research Staff, directed by the President's Special Consultant, Leonard Garment, has produced a report entitled *Toward Balanced Growth: Quantity with Quality*. The report examines the areas of population growth, environment, education, consumerism, technology assessment, basic natural science, economic choices, and balanced growth; it comes to few conclusions as to what ought to be done in these areas. Instead, the report outlines options open to policy-makers and discusses the advantages and disadvantages of various actions. The report generally emphasizes the need for long-range planning and for anticipating events rather than reacting to crises. Copies of the report may be obtained for $1.50 from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

● **MERCURY POLLUTION**: Secretary of the Interior Walter J. Hickel has telegraphed governors of 17 states warning that the federal government will bring suits against industries polluting waterways with mercury unless local action is taken swiftly. Vermont and Alabama, two of the states affected, have halted commercial fishing. Meanwhile, commercial fishermen have filed at least three lawsuits against plants for allegedly damaging the livelihood of fishermen, and the United Auto Workers is considering filing suit on the ground that halting fishing deprives union members of recreation.

● **NSF AUTHORIZATION BILL**: Congress has sent to President Nixon a $537.7 million authorization bill for the present fiscal year for the National Science Foundation (NSF). The bill, which sets a maximum on the amount which may be appropriated for NSF, exceeds the President's budget request by $26.7 million. The largest addition by Congress was $20 million for academic science projects transferred to NSF from mission agencies. The appropriations bill for NSF is currently in a House-Senate conference.