Chapter I

SUMMARY OF FINDINGS

The following are the major findings of the OTA assessment on advanced high-speed aircraft—both subsonic and supersonic types—in the context of major uncertainties over world energy supplies:

- **Barring some** major disruption in the growth of the world **economy and assuming reasonable success in coping with increasingly costly energy, the total market for air travel and commercial aircraft should continue to expand in the future.** Growth in passenger-miles and airline route miles over the next **30** years will be closely tied to the price and availability of fuel. Accordingly, the demand for advanced long-range aircraft could vary from 2,200 to 3,300 units. This would represent sales by manufacturers on the order of $150 billion in 1979 dollars. (See table 1.)

Table 1.—World Requirements-New Aircraft

	1980 thru 2010	Potential sales 1979 dollars
Short and medium range (up to 2,700 nautical miles)	6,500-8,500[a]	$235 billion
Long range (over 2,700 nautical miles) .	2,200-3,300[a]	$150 billion

[a]Estimates exclude U S S R and the People's Republic of China.

SOURCE Off Ice of Technology Assessment

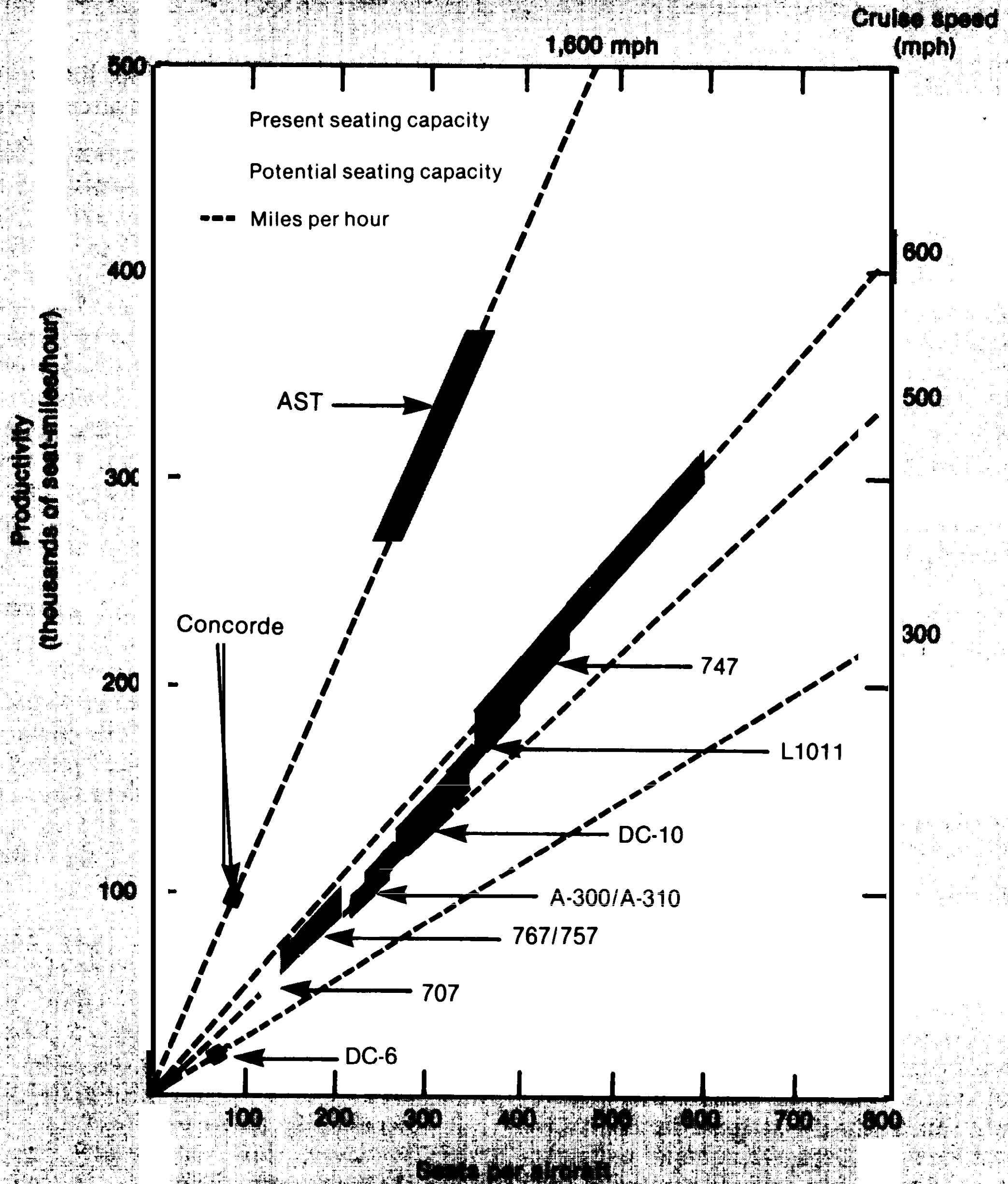
- **While supersonic aircraft might satisfy a portion of this long-range market, it is expected that the market will be dominated by subsonic aircraft—at least in this century.** Substantial improvements in technology for subsonic aircraft may provide the incentive for new designs. To offset rising fuel costs, manufacturers already are developing subsonic aircraft with more energy-efficient engines, such as the Boeing 767 and 757. This trend probably will continue and will most likely be fed by more technical advances in aerodynamic efficiency, lighter materials, and still more efficient engines. These could help lower operating costs, energy usage, and aircraft emissions.

- **The most compelling argument for an advanced supersonic transport (AST) is improved aircraft productivity—seat-miles generated by an aircraft per unit of time.** Since the advent of jets, major productivity improvements have resulted almost entirely from increases in size. (See figure 1.) But the potential for further productivity gains through scaling up aircraft size is not as impressive as in the past. Thus, while aircraft may be further stretched, the market for larger subsonic jets will be constrained by the number of airline routes with sufficiently high passenger densities to warrant placing them into service.

  Increased speed offers another avenue for major productivity improvement. An aircraft able to fly at better than 1,600 mph (Mach 2 +) can transport twice as many passengers a day on long-distance flights (more than 2,700 nautical miles) as a subsonic aircraft of equivalent size. This higher speed provides a significant timesaving for the passenger on these long-distance journeys.

- The drawback in the past from pursuing speed-derived productivity has been cost. The productivity could have been achieved, but at too high a proportionate increase in total operating costs (TOC). In other words, **higher productivity does not necessarily mean profitability.** Over time, however, this cost penalty has been decreasing—the difference in the potential cost of supersonic aircraft compared to subsonic aircraft has been shrinking. While rising energy costs could slow the trend, it is reasonable to expect that through technological improvements this convergence will continue. To **the extent that it does, the economic penalty of supersonic cruising aircraft will become less. (See figure 2.)**

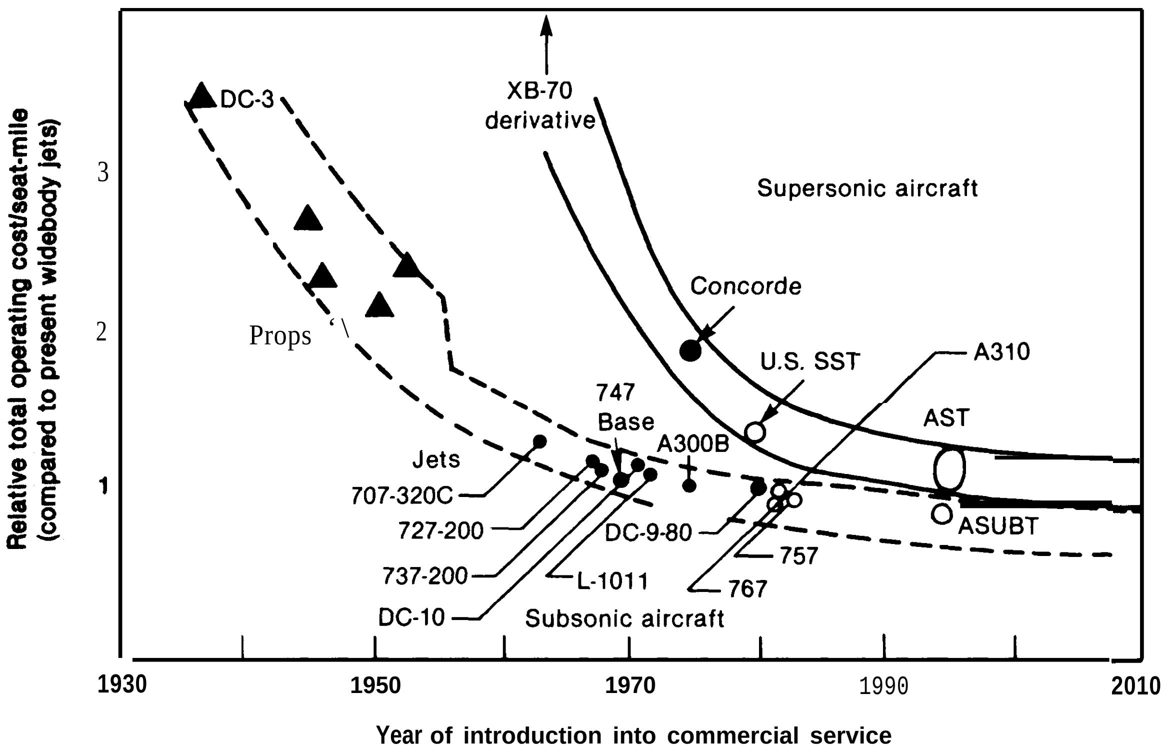
Figure 1.—Aircraft Productivity



$$\text{Cost per seat-mile} = \frac{\text{Total cost}}{\text{productivity}}$$

SOURCE: Office of Technology Assessment, based on industry data.

Figure 2.—Relative Total Costs of Supersonic and Subsonic Aircraft



SOURCE: Office of Technology Assessment based on industry data.

- **Assuming that an economically viable and environmentally acceptable AST could be developed in the 1990-2010 period, its greater productivity could command sales of about 400 aircraft worth about $50 billion in 1979 dollars.** This would represent approximately one-third of the total sales anticipated for the long-range market through 2010. AST sales would mean fewer sales of subsonic aircraft. It is estimated that 400 ASTs could replace approximately 800 subsonic aircraft.

- **While the market outlook for an AST appears to be inviting, the actual development, production, and operation of such an aircraft are clouded by major uncertainties.** Two principal uncertainties are fuel price and availability and the technical feasibility and cost of satisfying increased community sensitivity to noise around airports.

—**Fuel price and availability:** There are great unknowns as to the future price and availability of fuel. However, given that an AST would have fuel consumption rates at least 1.5 to 2 times greater per seat-mile than equivalently sized subsonic transports, it would be more sensitive to fuel price increases than a subsonic aircraft. Therefore, future fuel price increases could have a larger impact on the total operating cost of an AST than on a subsonic transport and could be a significant factor in determining its future viability.

Further, fuel for transport aircraft must be available on a worldwide basis. Examination of alternative fuels such as synthetics or liquid hydrogen or methane should be continued.

—**Noise:** One of the greatest obstacles appears to be the ability of an AST to cope with diminishing public tolerance toward noise, especially in the vicinity of airports. Public attitudes are likely to bring about more stringent noise standards in the future, affecting both supersonic and subsonic aircraft as well as airport operations. While present supersonic work by the National Aeronautics and Space Administration (NASA) indicates the possibility of meeting the Federal Aviation Administration (FAA) (FAR part 36, stage 2) noise regulations, more research and technology development, at further expense, would be needed to meet more stringent regulations. Until the uncertainty over changes in the regulations is resolved and the uncertainty about supersonic aircraft noise is reduced, aircraft manufacturers may be reluctant to commit themselves to a new supersonic aircraft program. The investment would be too large to risk failure of not meeting a more stringent noise standard.

- **The Supersonic Cruise Research (SCR) program conducted by NASA since the American supersonic transport (SST)* was canceled by Congress in 1971 has identified and made advances in several technology areas—aerodynamics, structures, propulsion, and noise reduction on takeoff and landing.** Significant improvements may be achieved with further work, but even if these technology advances are validated there can be no guarantee that the aerospace industry would act on them. The cost of applying this technology to the design and development of a suitable aircraft could run to $2 billion in 1979 dollars. Tooling up and starting production could require at least an additional $5 billion to $7 billion–sums believed to be far beyond the resources of any one company. **The financial risk could be reduced by the formation of a domestic consortium of two or more aerospace companies, or perhaps by an international consortium that would include foreign manufacturers. Formation of a corporation similar to that of COMSAT is another alternative which may be applicable for undertaking such a program. ***

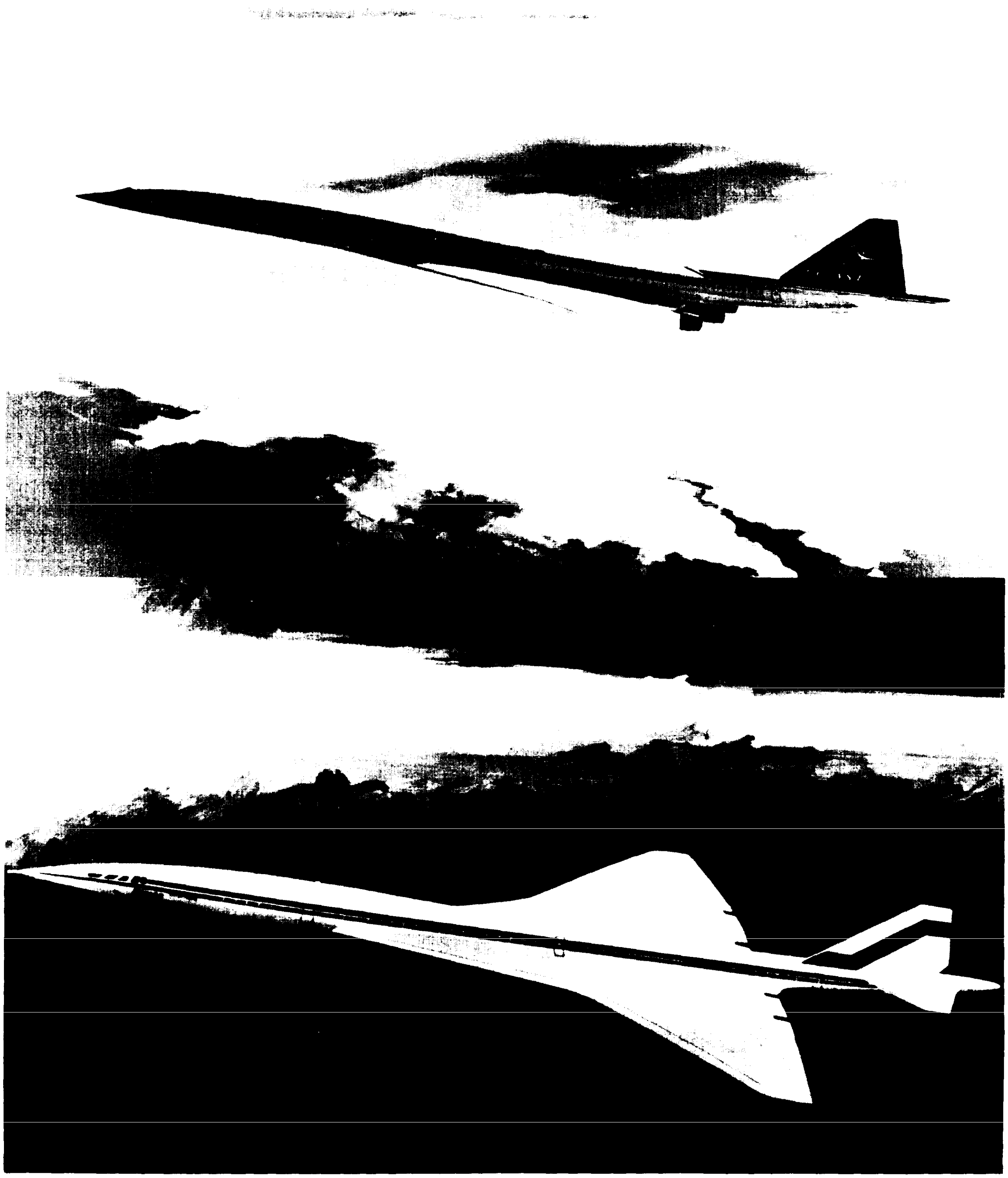
- Foreign manufacturers are moving ahead in the subsonic field. Their willingness to embark on an AST appears to be tempered by the same uncertainties as those facing the U.S. industry. However, the supersonic area does present them with another opening where they could alter the longstanding U.S. competitive advantage in the sale of long-range aircraft. **Thus, given the probability of an expanded market for air transportation in the future and the importance to our domestic economy and our international trade balance of sustaining U.S. leadership in commercial aviation, it appears that it would be in our national interest to keep our options open in the supersonic field.**

- **Accordingly, it appears appropriate to carry out a generic R&D** program to preserve the supersonic option.** This program should be adequate to maintain the skills and knowledge from which a future development project could be effectively initiated and should produce more factual information to reduce the technical uncertainties. The objectives of this generic R&D program should be carefully defined to yield information that would facilitate a decision on whether or not to proceed with an AST at a later date. The financial risks also need to be more fully understood. **If Congress wishes to maintain the U.S. SST option, then the existing level of Federal support is not considered adequate to accomplish this. R&D, however, will not shed light on those external factors governing the viability of an AST—the increasing sen-**

‘Throughout, the abbreviation SST refers only to the U.S. supersonic transport program that was begun in 1963 and terminated in 1971.

● An analysis of these alternatives is reported in a soon to be published OTA report entitled “Financing and Program Alternatives for Advanced High-Speed Aircraft .“

•● In this report, generic R&D is that process of verifying and validating technologies leading to a state of “technology readiness” for development of a specific product. At a state of “technology readiness, ” R&D activities can move from the generic to the specific. Specific R&D is that part of the process where a product or a family of products is defined. When the term “research” is used in this report, it refers to generic R&D.



Illustrations Courtesy of McDonnell Douglas and Boeing Aircraft Co

Artists' concepts of advanced supersonic transport

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sitivity of the public to aircraft noise, the price and availability of adequate fuel supplies, and the availability of financing for such a major capital commitment.

DISCUSSION

This study examines the prospects for introducing new types of large, long-range aircraft—subsonic, supersonic, and hypersonic, beyond the next generation of scheduled aircraft such as the Boeing 767 and 757—into commercial service over the next 30 years and weighs the financial and other risks inherent in acquiring the technology for developing these advanced transports. Traditionally, the generic R&D from which subsequent generations of commercial aircraft have evolved has been supported by the Department of Defense, by NASA, and by the U.S. aerospace industry. In the subsonic field, this trend seems likely to continue, although NASA's role may become comparatively greater than the military's in the pursuit of more fuel-efficient and quieter transport aircraft to satisfy future environmental concerns.

Generic R&D leading to an AST that is safe, economical, and environmentally acceptable involves a different supporting structure. Because the military is not aggressively pursuing a supersonic cruise aircraft, no suitable engine or airframe is expected to emerge from the Department of Defense R&D programs. Since the cancellation of the U.S. SST program in 1971, technological development at a low level of effort has been carried out by NASA and the aerospace industry. It is generally agreed that considerable additional technological development would be necessary to reduce the technical risks of embarking on an AST to a level acceptable to private investors.

Therefore, a central purpose of this assessment is to identify for Congress the positive and negative impacts of future commercial supersonic transports. These will need to be taken into account in considering the level of Federal Government funding of NASA's generic R&D leading to possible development of an AST, a second-generation aircraft with performance capabilities beyond the British-French Concorde. In this perspective, our assessment is not a market study of the prospects for a specific supersonic aircraft design. It is rather an evaluation of whether technological research toward a class of possible future supersonic aircraft seems sensible in the long run and whether mastery of supersonic technology in this country will be an important factor in our international competitiveness in the future.

In looking at the overall issue of supporting further research into supersonic cruise aircraft—and what might be gained from it—this study assesses where the technology stands now and examines the directions it might take. The real issue now is whether the long-term promise of some kind of supersonic transport—to be designed perhaps in 5 to 10 years—is sufficient to justify getting the technology ready. If we keep with past practice, the burden of financing such research would fall in large measure on the public treasury, which is why the question was originally put to OTA.

CURRENT STATE OF TECHNOLOGY

Present supersonic technology is not likely to produce an aircraft during the time frame considered in this study that would be able to fly at supersonic speeds without producing a sonic boom. Although some theoretical work has been done on "shaping" the sonic boom, an aerodynamic or other solution to the present Federal ban on over land supersonic commercial flights appears to lie many years away. The question of "solutions" to the sonic boom is critical in looking at where technology is headed because restricting any proposed AST to supersonic flight over water also restricts the market—and possibly the overall viability of a supersonic aircraft program.

The Concorde represents proven technology dating back to 1960. This aircraft has shown that a supersonic airliner can be operated safely from existing airports. Its major deficiencies are small size (about 100 seats), high fuel consumption, and engines designed before noise regulations were imposed.

Since 1971, NASA's SCR program has generated knowledge that could realize sizable gains over the Concorde. Among other advances, the work has yielded a new wing configuration that wind tunnel tests indicate would result in much improved aerodynamics and a lift-to-drag ratio in the range of 9 to 10, approximately 20 percent more efficient than the Concorde in supersonic cruise. Advanced computational and finite-element modeling techniques have been developed, reducing the structural design time for *major* aircraft components from 3 months to 1 week and offering promise of lower development costs.

NASA's studies indicate that major weight reductions (10 to 30 percent) and cost savings (up to 50 percent) in aircraft structures may be achieved through superplastic forming and concurrent diffusion bonding of titanium. Various forms of high-temperature polyimide composite structures with further weight-cutting possibilities also have been investigated.

Variable= Cycle Engine

In the propulsion area, a concept has been proposed for a variable-cycle engine which may

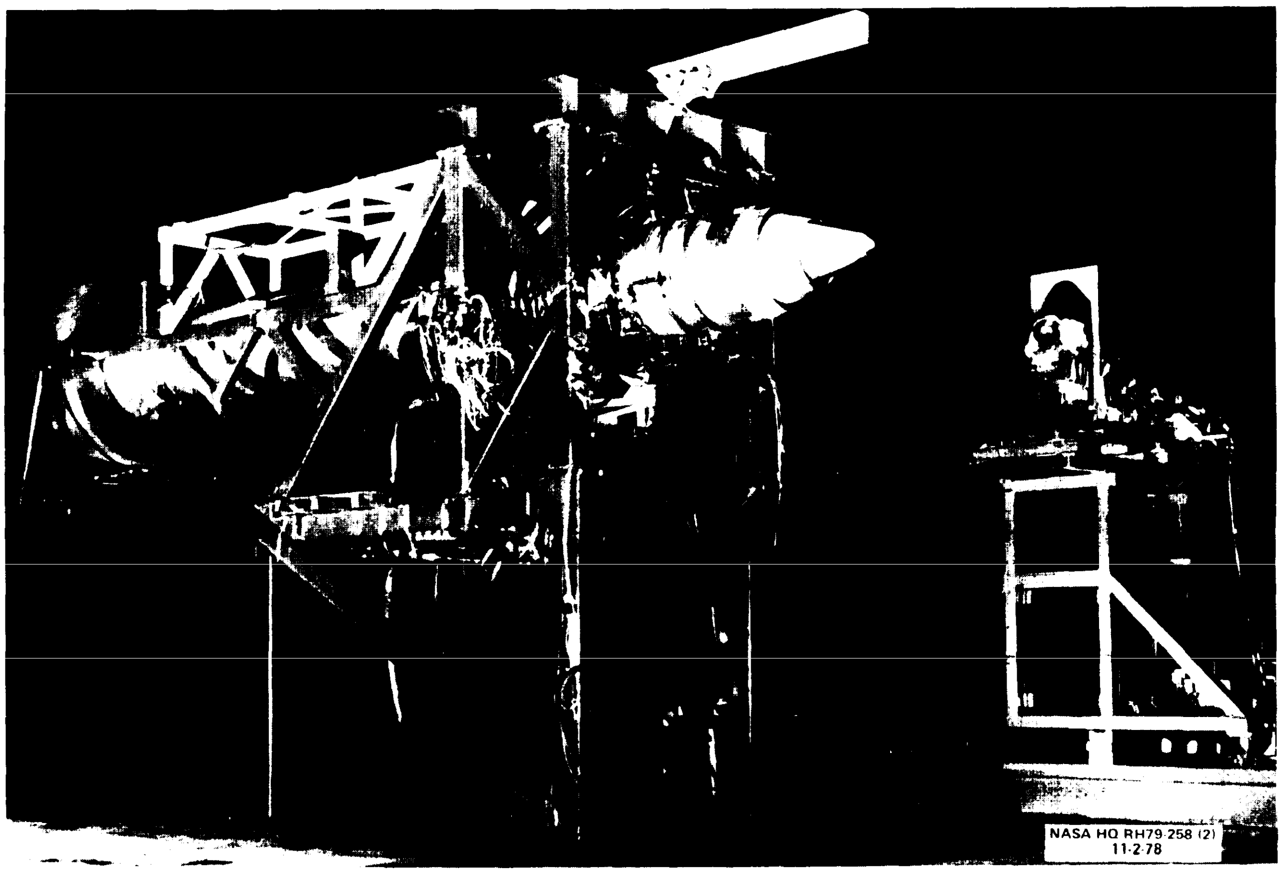


Photo credit. National Aeronautics and Space Administration

Variable-cycle experimental engine testing be able to operate at nearly optimal fuel efficiency while cruising at either supersonic (turbojet) or subsonic (turbofan) speeds. Moreover, the internal configuration of the engine would permit changes in the exit nozzle velocity profile that may lower the sideline noise at takeoff and landing.

A body of opinion within the aviation industry holds that, should the variable-cycle engine prove itself in a development and test program, it would be a significant factor in designing a viable AST. The engine's promise is this: if able to operate optimally at both subsonic and supersonic speeds, the engine would enhance the possibility that an AST could be integrated into regular airline route structures. For example, it would be possible to originate AST service to London or Tokyo from Chicago, Denver, or Dallas. The over land legs would be flown subsonically and the over water legs supersonically.

Technology Validation Program

In August 1979, in response to a request from the House Science and Technology Committee, NASA outlined possible plans which were identified as focused initiatives in a number of aeronautical fields. In supersonic cruise research, NASA concentrated on propulsion, airframe, and aircraft systems technology. In the propulsion area, the program would be broadened to include research on a variable-flow propulsion system and an advanced core engine system that would be integrated with the variable-cycle experimental engine. The aim would be to produce design options for an array of supersonic aircraft applications, plus potential military applications. The airframe technology program would concentrate on nacelle/airframe integration and acoustic suppression design methods and high-temperature structures problems, including the selection, fabrication, and testing of titanium and composite materials. The aircraft systems technology effort would identify those portions of the engine and airframe programs requiring inflight investigation and validation. NASA estimates it would take up to 8 years to accomplish these objectives. If successful, the program would lead to a state of "technology readiness," which would be a decision point for the aerospace industry on whether further development of an AST appears feasible.

The proposed NASA program would cost $662 million (1981 dollars) over an 8-year period, as opposed to an alternate program offered by NASA in **1978,** which was priced at $561 million (1979 dollars) over a similar 8-year period. In addition to these two plans, again in response to a request from the House Science and Technology Committee, NASA prepared a plan leading directly to "technology readiness" in industry. This plan would sustain full competition in the U.S. industry and would require as much as $1.9 billion (1977 dollars). The three widely different plans have raised a question for Congress as to what is the appropriate level of Federal support for supersonic research, because a decision to embark on any one plan would mean a substantial increase over the approximately $10 million a year that has been invested in SCR since 1971.

Fuel Considerations

In the event an AST is eventually developed, the aircraft would be designed for a service life of about **20** to **25** years. This means that when the time for decision on development arrives, in the late 1980's by NASA's timetable, future fuel supplies for the aircraft and confidence in fuel price stability must be assured from the onset,

The impending petroleum shortage has prompted the Federal Government to support a large-scale program to develop alternate energy sources. These efforts may begin to bear fruit in the late 1980's, putting the Nation on a different energy track. If that track is synthetic petroleum, resulting in Jet A fuel with characteristics similar to Jet A from petroleum, only minor modifications would have to be made in aircraft systems to use it. But if liquid hydrogen, methane, or a fuel dissimilar to Jet A should become the track, radical changes might be required in future aircraft design concepts including fuel systems and engines. Thus, uncertainty hangs over what fuel a future aircraft should be designed to use. While that design decision does not have to be made now, it is a reason for adopting a cautious approach in both the funding and the content of the technology program and in continued examination of possible alternative fuels.

FINANCING CONSIDERATIONS

Even if the energy picture becomes clarified, manufacturers still may be hesitant to embark on a full-scale development program because of the cost of design and development, estimated to be around $2 billion in 1979 dollars. An additional estimated $5 billion to $7 billion would be needed to tool up and start production. Such sums are far beyond the present financial resources of any one U.S. aerospace company. This situation could change over the next several years. But it remains questionable whether the industry and private capital markets would be able on their own at the point of "technology readiness" to initiate activities leading to full-scale production.

However, alternative financing arrangements beyond the generic R&D phase, may be possible without direct U.S. Federal Government support. These options include formation of domestic or international consortia involving two or more manufacturers and creation of a COMSAT-type public corporation to assume responsibility for producing the aircraft. These management and financing options are examined and reported in a soon to be published volume on the "Financing and Program Alternatives for Advanced High-Speed Aircraft ."

FOREIGN COMPETITION

The more advanced a supersonic aircraft is economically and environmentally at the time of introduction, the better its chances in the marketplace. The level of technology available at the time of design makes the difference. While this may be a truism, it needs to be kept in mind in deciding the pace of a research program designed to keep our options open in the supersonic transport field. The main reason for maintaining options is the size of the potential AST market and the threat of losing some or all of it to foreign competition.

Our assessment indicates potential aircraft sales of about 400 for an AST that could fly supersonically only over water. This would amount to expected sales totaling $50 billion in 1979 dollars in the 1990-2010 period—or approximately one-third of the value of all sales of long-range transports anticipated over the next 30 years. This amount would be a significant sum for the U.S. aircraft industry to lose to foreign manufacturers.

How great is the threat of foreign competition? Though we were unable to collect information on the Russian TU-144, manufacturers in France and England are now engaged in generic AST research and have the same doubts as the U.S. industry. They also believe rising fuel prices and the expense of hurdling the technical barriers of an AST—restrictions on aircraft noise and increasing total operating costs—make the development and production of an AST too risky at the present time. Thus, it appears that the threat of foreign competition is not close at hand or at a point where it might dictate the pace of technology development by the United States.

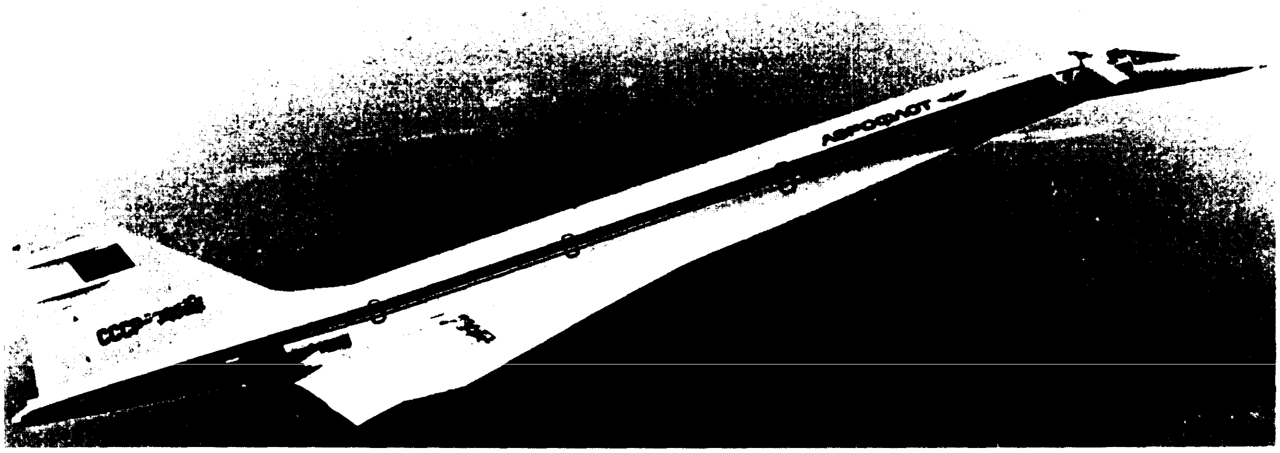


Photo credit: National Aeronautics and Space Administration

Russian supersonic transport (TU-144)

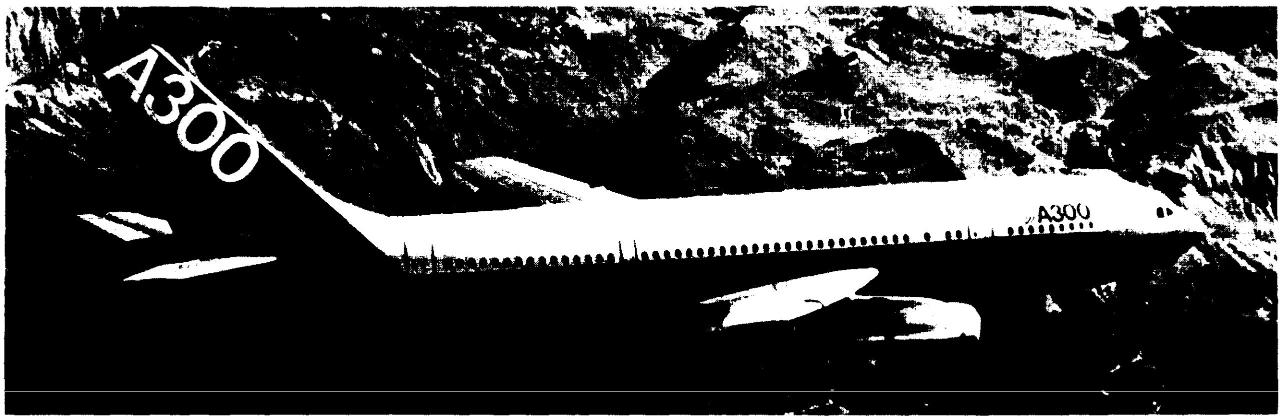


Photo credit: Airbus Industrie

Airbus Industrie's A 300

Photo credit: National Aeronautics and Space Administration

British Airways and Air France Concordes, Dulles Airport, May 24, 1976

ENERGY ISSUES: AVAILABILITY AND PRICE OF FUEL

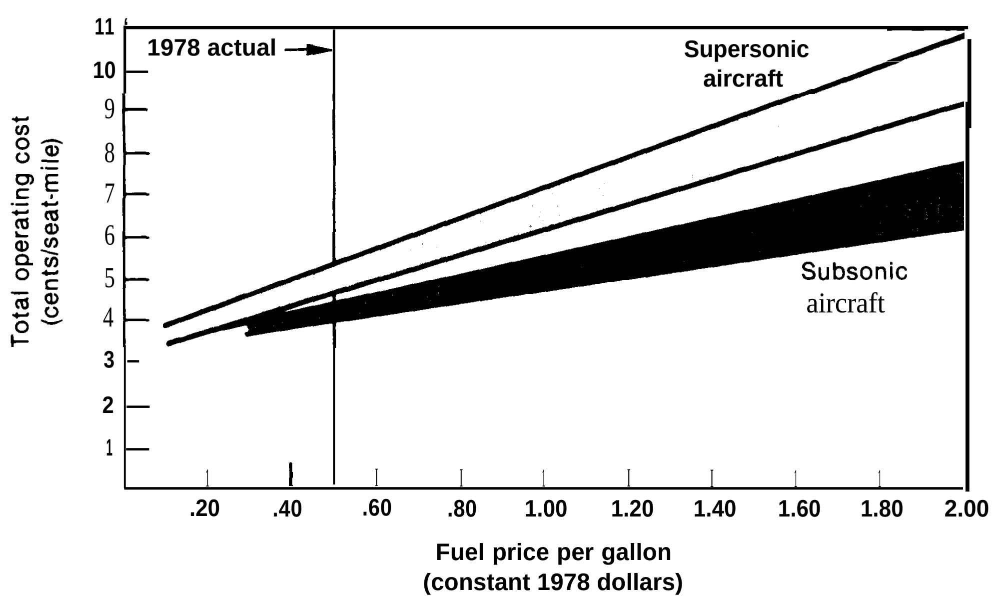
Projections of steadily rising airline traffic over the next 30 years may be optimistic. An expanded market for both advanced subsonic and supersonic aircraft may not materialize. If the market does not materialize, the questions dealing with the impact of advanced aircraft are moot. The controlling factors could be the rising cost and limited availability of fuel. Today, the world's commercial aircraft fleet, excluding the Soviet Union and the People's Republic of China, uses approximately 1.5 million barrels per day (MMbbl/d) of fuel.

Estimates indicate that by the year 2010 the world commercial air fleet fuel usage could represent about 3.5 MMbbl/d. The majority of airline consumption will continue to be for short- to medium-range service with the long-range aircraft using about 15 percent of the total. However, a fleet of 400 ASTs could increase the worldwide petroleum consumption of commercial aircraft by about 10 percent. Furthermore, if serious shortages occur, air traffic may be drastically reduced. This would favor more energy-efficient subsonic aircraft, because, by current estimates, they would consume approximately half the amount of fuel per seat-mile as future supersonic aircraft. The higher fuel consumption of an AST, associated with rising fuel price, would make the increased energy costs of supersonic aircraft greater than those of subsonic aircraft.

Over time, the cost penalty for improved productivity has been decreasing and, as previously shown in figure 2, the difference in the total operating cost of supersonic aircraft compared to subsonic aircraft has been shrinking. Further, if an economically and environmentally acceptable AST could be developed, it is reasonable to expect that this convergence would continue. However, rising fuel costs could offset the gains to be expected from improved AST technology and might actually cause the curves to diverge.

Figure 3 compares the estimated total operating costs (TOC) for an advanced subsonic transport (ASUBT) with those of an AST as a result of increasing fuel price, relative to all other costs. As can be seen, because of higher fuel

Figure 3.—Effect of Fuel Price on Aircraft Operating Cost



SOURCE: Office of Technology Assessment based on industry data usage, the supersonic aircraft is more sensitive to fuel price increases than a subsonic aircraft.

There is much disagreement over the future price and availability of fuel. If all other effects are held constant, figure 3 shows that the ratio of supersonic aircraft TOC to subsonic aircraft TOC would rise from about 1.2 at $0.50 per gallon to approximately 1.4 at **$1.30** per gallon and 1.5 at **$2.00** per gallon. Fuel price could be a significant factor in determining the economic viability of a future commercial AST.

On the other hand, labor cost could also have a major effect on TOC. Rising labor costs would probably be more detrimental to subsonic aircraft economics than to supersonics due to the higher productivity of flight crews in supersonic aircraft operations,

ENVIRONMENTAL ISSUES: NOISE, SONIC BOOM, AND ATMOSPHERIC POLLUTION

The most critical environmental issue facing future supersonic aircraft is the ability to meet increasing community sensitivity to airport noise. In the case of the Concorde, the principal controversy surrounding permission to operate at Washington's Dunes Airport and New York's John F. Kennedy Airport was the anticipated additional noise in neighboring communities. The Concorde was placed at a disadvantage because it had already evolved before noise rules were established for any class of aircraft. Since the start of operations, carefully controlled takeoff and landing procedures have minimized noise complaints. But, it should be recalled that the noise issue played a major part in the cancellation of the prior U.S. SST program in 1971 and most probably will be a major factor in the consideration of any future U.S. SST program.

The noise issue has to be looked at in the context of total aircraft operations expected in the future, If air traffic expands substantially and there is a major increase in the number of jet transports, communities will be exposed to more noise—even if future subsonic transports are made quieter. The number of operations by supersonic aircraft would be relatively small compared to the total. But nonetheless they would add to the total noise—and therefore be controversial. Furthermore, the public seems to be becoming less tolerant toward noise and more active in opposing environmental degradation.

Currently, it seems likely that communities will press for more stringent airport noise regulations. It may be some time before final standards are promulgated. Until the uncertainty over changes in the regulations is resolved, aircraft manufacturers may be reluctant to commit themselves to **a** new supersonic aircraft program. Their investment would be too large to risk failure of not meeting noise standards.

The sonic boom is another environmental concern that remains from the first SST program and the Concorde. Present Federal regulations prohibit civil aircraft from generating sonic booms that reach the ground. This effectively bars present and future SSTs from operating supersonically over land, forcing them to fly at subsonic speeds and at less efficient fuel consumption rates. Research indicates there may be ways to lower sonic boom pressures, but practical aerodynamic solutions appear to be many years off.

Research to ameliorate sonic booms should be emphasized because of its long-term importance to an economically and environmentally acceptable, AST. The capability of cruising supersonically over land would increase the market potential of an AST and might eventually permit it to replace most long-range subsonic transports.

In 1971 there was considerable concern that engine emissions from a fleet of supersonic airliners would deplete the ozone in the upper atmosphere. A reduction in this protective shield against the Sun's rays, it was feared, would increase the incidence of skin cancer. However, studies since then, including an FAA program now in progress to monitor the upper atmosphere, indicate that previous predictions of

Photo credit Environmental Protection Agency

Noise pollution

ozone loss through subsonic and supersonic aircraft pollution appear to have been substantially overstated. The science of atmospheric chemistry and physics is still growing and, as new data and models become available, it will be clearer whether the current outlook is justified.

WORLD REQUIREMENTS FOR NEW AIRCRAFT

If a solution can be found for the world's oil problem and national economies are stable and growing, the demand for air travel and for more aircraft—both additional and replacement—is likely to expand substantially in the next 30 years. Technical advances in subsonic jets could make them quieter and possibly more energy efficient. Greater energy efficiency could affect the cost of air travel favorably by permitting the real prices for air transport services to decrease.

Approximately **4,700** jet aircraft are in operation around the world today, excluding the fleets of the Soviet Union and People's Republic of China. Within the next **30 years,** the **total** requirements for new aircraft in the jet fleet could total 7,000 to 12,000 aircraft, as already presented in table 1, if projected demand for air travel materializes. The market for long-range aircraft, which could be on the order of $150 billion in 1979 dollars over this period, is expected to be dominated by continued production of existing widebody jets and by the introduction of new models, such as the Boeing 767 and 757 now under development.

In addition to increasing fuel efficiency, it may be possible to stretch further the body of subsonic jets, thereby increasing the payload, and thus improving productivity. Seating for up to 800 passengers is considered technically feasible. However, the demand for such large aircraft would be limited because of the small number of routes with travel densities sufficiently high to warrant putting them into service. The only other avenue to significantly higher productivity is increased speed. The relationship of

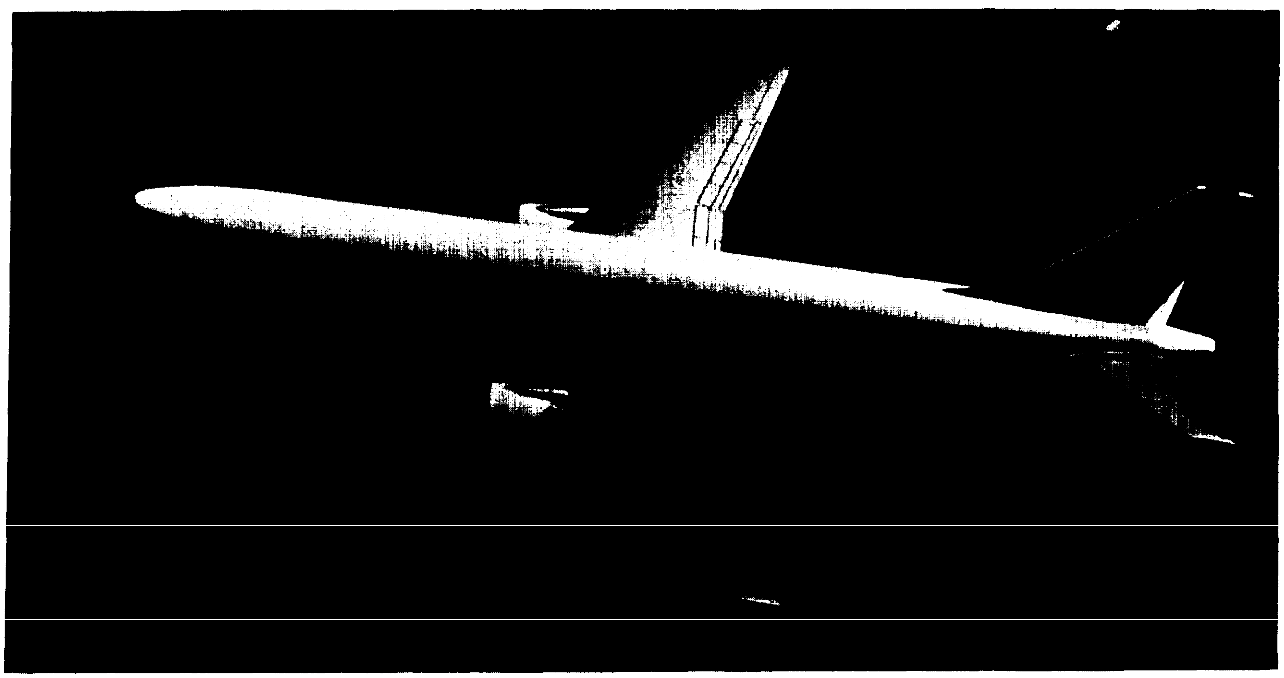


Photo credit' Boeing Aircraft Co

Model of the Boeing 757 now under development improved productivity resulting from increased size and higher speed was illustrated in figure 1.

Thus, in an expanding commercial air system, supersonic transports might satisfy a portion of the long-range market and complement subsonic service. The logic for an AST is that at twice the speed of sound it could carry about twice as many passengers per day as subsonic aircraft of equivalent size. As noted previously, the major drawback is the cost of developing an AST that is both economically viable and environmentally acceptable.

If the technological problems and uncertainties concerning fuel availability, fuel price, and noise are resolved, there could be a market for about 400 ASTs through the year 2010, with expected sales of about $50 billion in 1979 dollars. In arriving at this estimate, it was noted that the Concorde, despite its size limitation, has demonstrated both customer appeal and safe supersonic commercial operations. On its North Atlantic runs, the aircraft has operated at an average of 70-percent capacity, even though the fares are up to three times higher than the average coach fares on subsonic aircraft.

If the problem of sonic boom can be solved to eliminate the annoyance on the ground and further technical advances are made to lower total operating costs, there is a greater potential market for a third-generation AST that could fly supersonically over land. Thus, it is possible to regard continuing generic R&D on an AST as a promising direction in the continuing evolution of aircraft technology.

SOCIETAL CONCERNS

For most Americans, the question of pursuing research on a supersonic aircraft was rendered moot by the cancellation of the previous SST program in 1971. The inability of the Concorde to become a paying proposition in terms of aircraft sales can be expected to reinforce public attitudes that further Government support for research in this area is not warranted.

Furthermore, the Government may be subject to criticism for involvement in a program that may lead to eventual development of an aircraft perceived by some as being affordable only by privileged classes. In this connection, there also may be negative reactions to an aircraft that is a high user of energy in an era of rising fuel costs and dwindling energy supplies.

Another unknown that could affect the future of air travel is the continuing revolution in telecommunications. Over the next 30 years, improved electronic devices may make it easier to transmit more data, voice, and picture information and could substitute for many types of travel. At the same time, better electronic communication could also stimulate travel by making more people aware of new opportunities in other places, both for business and recreation. It is too early to say with certainty what the effect of telecommunications will be on future air travel.

The perceived impacts on society of an AST will be extremely important in determining its acceptability. Prospective concerns about ozone depletion, noise, and sonic boom were critical factors in the cancellation of the previous U.S. SST program. Undoubtedly they will continue to be major considerations in decisions on any future U.S. supersonic aircraft program—along with how much a program would cost and the level of Federal involvement in such a program.

STUDY FINDINGS IN BRIEF

In sum, the study of advanced high-speed aircraft has found:

- The long-term prospects for advanced supersonic transports are significant and **real.**

- **The uncertainties are also significant and real. Specifically:**
  —fuel price and availability,
  —noise, and
  —market size.

- **The potential threat from foreign competitors appears tempered by the same uncertainties.**

- Support of a generic R&D program appears appropriate. This would:
  —maintain the option for future development of an AST, and
  —clarify and reduce the technical uncer**tainties, however, it would not shed light on those external factors governing the viability of an AST: the increasing sensitivity of the public to aircraft noise, the price and availability of adequate fuel supplies, and the availability of financing for such a major capital commitment.**

- **If Congress wishes to maintain the U.S. supersonic option, then the existing level of Federal support is not considered adequate to accomplish this.**