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THE U.S. SUPERSONIC TRANSPORT PROGRAM 1961-1971

An Examination in Search of Lessons for Current Energy Technology Commercialization Projects

by

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PREFACE

This paper was written as a background paper in support of the M.I.T. Energy Policy Study Group's report, "Government Support for the Commercialization of New Energy Technologies; An Analysis and Exploration of the Issues" (M.I.T. Energy Laboratory Report No. MIT-EL 76-009, November, 1976). Like the other background papers, it examines a specific government program, historical or current, to draw lessons for present energy policies.

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1. INTRODUCTION

U.S. government subsidies for commercialization of advanced technology are not a new phenomenon. Current interest in commercialization of government-supported energy technologies can be better understood if seen in historical context. The Supersonic Transport (SST) program is a significant example with lessons for energy policy.

Research into supersonic flight, mostly for military purposes, has been supported by both government and industry since World War II. While government-supported feasibility studies for a commercial SST were started in August, 1961,* it was not until Pan American Airlines took options in June 1963, on six Anglo-French "Concorde" supersonic transports that the U.S. effort gained momentum. Within a few days President Kennedy announced that "The Congress and country should be prepared to invest the funds and effort necessary to maintain the Nation's lead in long-range aircraft."** The commitment had been made--but with some constraints. Design objectives limited airport noise and sonic boom, and a government funding ceiling was established at $750 million. This amount was to cover 75% of the cost of the program. Industry was expected to share the cost of the program by assuming the remaining 25%.

By August, 1963, the Federal Aviation Agency (FAA) sent out Requests for Proposals (RFP's) on the development of a supersonic transport. This was the beginning of Phase I (Initial Competition). Aerospace companies were to submit designs--at no cost to the government--by January, 1964. In June, 1964,

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*For a chronology relating to SST development, see Appendix.

**Superscripts refer to References.

six-month contracts (Phase IIA: Detailed Design Competition) were signed with Boeing and Lockheed for airframe designs, and with General Electric and Pratt and Whitney for engine designs. In June, 1965, after review of these designs (Phase IIB) it was decided to extend the Phase II contracts for eighteen additional months (Phase IIC), as no designs were found acceptable. On December 31, 1966, it was announced that Boeing and General Electric had won the design studies, and would get the Phase III (development) contracts. Phase III contracts were let with government's share of program costs increasing to 90% and also retroactively changing government's share of Phase IIC to 90%. The decision in favor of Boeing was mainly due to its swing-wing design and managerial expertise.[2]

On October 21, 1968, nearly two years into Phase III, Boeing finally had to abandon their swing-wing design concept for a fixed-wing design (B-2707-300) that looked very similiar to the original Lockheed proposal. This design change and the probable resultant 40% increase in sonic boom intensity significantly reduced the plane's popular appeal and were largely responsible for the subsequent increase in popular opposition to the SST on environmental and economic grounds. Despite such opposition President Nixon announced in September, 1969, that he had decided to continue the project. This decision was no doubt influenced in a major way by the imminent demonstration of the Anglo-French Concorde supersonic transport. The Concorde prototype achieved supersonic flight in October, 1969. Eighteen months after Nixon's decision, in March of 1971, the House and Senate voted to kill the SST program.

The SST project was unique in two aspects. Previously, commercial aircraft designs were the spin-off of government-supported technology for military aircraft or were inexpensive enough to be totally financed by the manu-

facturers because they were simple extrapolations of existing technology. There was only one large military aircraft designed for sustained supersonic cruise - the B-70.* However, only two prototypes were built and the aircraft was not designed to carry passengers and thus operating economics were unimportant. Since the SST was both faster than contemporary jet fighters and larger than existing jet transports, the development costs were considered far too high by any manufacturer. Thus the SST program was the first time the U.S. government had directly supported the development of a commercial aircraft, and a multitude of government agencies were involved in the process (e.g. FAA, DOD, CAB, NASA).

Large scale development projects in the 1960's and 1970's had come to require more sustained effort and greater capital outlays than previously. In many cases development of a new technology had come to involve the interaction of many industries, a complicated network of organizations and groups. In 1903 Ford needed $100,000 capital and four months' time to produce the first Model T's. In 1932 the DC-2 development program (for TWA) required $300,000 and 21 months.[2] By July 1963, it was estimated conservatively that the cost of design and prototype construction for the SST would be $1 billion and profits were not expected for 15 years. The SST program may thus provide heuristic principles for projects with (a) a long development phase, (b) enormous outlays of risk capital, and (c) a long period between initial development and initial return of equity.

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*The SR-71, an aircraft alsc designed for sustained supersonic cruise, was half the size of the B-70 and in addition was part of a top secret reconnaissance program that was not made public until February 1964.[19] It is possible that the data exchange program started in September 1965 in the Air Force Systems Program Office made some of the appropriate technology available to the ongoing SST program.

When it is deemed in the national interest, government can share the risk with industry in the hopes of providing the nation with a product more quickly than if industry waited and proceeded on its own. This was the rationale for government support of the SST program. Comparable national interests are frequently claimed today to be the justification for government support of the commercialization of energy technologies that the private sector is not currently pursuing. An examination of the SST program can provide insight to current or anticipated problems in such projects.

2. INITIATING THE PROGRAM

2.1 Industry

At no time during the SST program did private industry agree to finance the development on its own. The aerospace industry argued that the combined net worth of the designated SST airframe and engine manufacturers[+] was considerably less than the required outlay for SST development. Opponents of the project countered that this very argument demonstrated that the SST was an undertaking that involved high risks and did not have the assured profitability: therefore, the SST was said to not be worth having, at least compared to its alternatives (e.g. slower but more economical Boeing 747's and air busses).[3]

This situation was complicated by the fact that in the early 'sixties, the American air carriers were grossly undercapitalized, having just committed several billion dollars to the purchase of the latest jet equipment (Boeing 707 and Douglas DC-8).[*] Moreover, paying for the next generation of subsonic jet aircraft (especially wide-body jets such as the Boeing 747)[**]

[+] The net worth of the relevant division, not the whole company (e.g. G.E.'s Engine Division's net worth, not G.E.'s total net worth) is considered.

[*] Conversion to jet aircraft included much ground-based equipment costs, training, etc. in addition to the planes themselves. The first commercial jet in-service flight was Pan Am's B-707 in 1958.

[**] In April 1966, Pam Am contracted with Boeing for 25 747's, with options on 10 more. The first 747 prototype flew in 1968.[4]

would tie up that industry's capital for years. Finally, the problems of airlines were compounded by vigorous competition and a difficult fare structure. If left to themselves, the air carriers would probably have preferred to wait at least 10-15 years while amortizing their recent investments, before becoming committed to any SST program.[3]

The problems of a high-risk/long-term program for an already over-committed industry with the somewhat debatable value of the SST over its alternatives was definitely enough to keep the air industries from proceeding on their own, at least until the mid-70's.

2.2 Government

On June 30, 1960 a report on "Supersonic Air Transports," was submitted by the Brooks Committee, the Special Investigating Subcommittee of the House Committee on Science and Astronautics. The committee recommended that an SST development program begin immediately.[4] The justifications proposed for such a program were: 1) Enhancement of the national prestige of the United States, 2) Retention of U.S. world leadership in aviation (Britain, France, and the USSR were considering SST programs which could be threats to American preeminence comparable to the British Comet* and Sputnik I.), 3) Benefits to U.S. industry, especially in stimulating the aircraft industry, which might otherwise face a serious slump when orders for subsonic jets had

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*The British began funding the Comet in 1948. It was noted that the jet engine was the engine of the future. Therefore, in an effort to regain the position of leadership in commercial air enterprise, lost due to the severe cost of the war, Britain pushed ahead with the Comet. On May 2, 1952, the Comet made its first commercial in-service jet flight. However, this effort was met with difficulties. There had not been adequate test flights with pressure cabins at very high altitudes. They discovered, painfully, the catastrophic effects of metal fatigue on pressurized aircraft. It was not until 1958 that the first U.S. in-service commercial jet flight took place.[5]

been filled. Government assistance was, however, required because the Committee felt that the SST program was "beyond the financial competence of American Industry," 4) Technological advances, directly and through spin-offs to other areas, arising from scientific research essential to the SST, 5) Maintenance of economic stability by preserving a positive balance of payments. These justifications, as first evaluated in 1960, were influential throughout the program with dominant emphasis on balance of payments and beneficial effects to the aviation industry and leadership in aviation technology.

The Committee also recommended that NASA be placed in charge of the program because of its expertise and its "clear statutory mandate regarding development in the field of aeronautics." The U.S.A.F., despite its experience with supersonic aircraft, was not considered for the leadership role because of a desire to de-emphasize the military aspects of the program. At the time, however, NASA preferred to work mainly on astronautics rather than aeronautics and therefore suggested that responsibility for program leadership and budgetary matters be given to the FAA, research and development to NASA, and development management to the Air Force.[4] This proposal was adopted and the program leadership was given to FAA.

During 1960 and 1961, there was discussion of whether or not this should be a multi-government venture. "The most important question in 1961 was whether the U.S. should go it alone, in league with Britain, in league with France, or in league with both."[2] The decision was made to initiate a separate national program. The ultimate basis for the decision was the feeling that, if the U.S. were going to develop an SST, it should represent a substantial stride forward. Since designing any new aircraft is very expensive, the U.S. should aim towards a significant speed advantage and therefore an increased market potential. The English and French wanted a less exotic air-

plane--closer to the state-of-the art technology. Their proposal was that the first supersonic transport should be designed to operate near 1400 mph (Mach 2), close to the limit for aluminum aircraft because of aerodynamic heating. Experience with such aircraft would not provide a firm technological base for development of second generation transports operating in higher speed regimes, and therefore requiring the use of difficult materials. In keeping with the general technological confidence typical of the early 'sixties, the U.S. decided to proceed with an advanced technology SST, using titanium construction. Higher cruise speed (1800 mph) and greater capacity (298 passengers as compared to 112 in the Concorde) would give the U.S. SST an immediate competitive advantage, and its technical sophistication would provide the United States with a superior basis for development of future supersonic aircraft. Both the French and English would have preferred a U.S. partner, but once the U.S. decided to proceed alone, they joined together to try to beat the U.S. effort. On November 14, 1962, they announced their decision to proceed with a joint SST developmental program. The only multilateral efforts which the U.S. participated in were concerned with environemental issues. In February 1963, the U.S., France, and Great Britain agreed to collaborate over airworthiness requirements and the environmental and system fields in which supersonic aircraft would operate.

It was apparant that industry would not take the project on alone. Yet the government hesitated to become fully committed, funding only feasibility studies until 1963, partly because President Kennedy was not fully convinced by the arguments on the Brooks Committee. On June 4, 1963, Pam Am disclosed that it had taken options on the Concorde. This ended the period of government reluc-

tance to take on a full committment. On June 5, 1963, President Kennedy announced the beginning of the SST design and construction program. By June 14, 1963, he had sent letters to the House and Senate urging support of such a program.

Without the stimulus of foreign competition, the U.S. could have hesitated for some time. The U.S. program was throughout paced in response to the progress of the Concorde and a similiar Soviet SST, the TU-144. In April 1965, when the British cancelled their TSR-2 supersonic fighter program that was to have provided support for the Concorde, it was felt that the U.S. could slow down its effort somewhat. Even today, were the present Concorde program an obvious economic success, U.S. efforts on a second generation SST would have greater support.

2.3 Management Problems of the SST Program

As NASA recommended in 1960, the FAA was given SST Program leadership. As early as June 1961, Najeeb Halaby, then head of the FAA, had established a DOD-NASA-FAA SST Steering Group (The group was eventually expanded to include representation from private industry). This group established policy and handed down guidance on the feasibility study program, and reviewed proposals and funding allocations. The FAA Administrator had the final decision on contractor selections. In September 1961, the FAA established the SST Management Office which was to remain fairly isolated from the rest of the FAA activities for a long time. There was a great deal of debate concerning the sort of organization the SST Program should have. In the first half of 1963, there was some discussion of forming a COMSAT-type organization* to develop the SST,

*The Communications Satellite Corporation (COMSAT) is a corporation inititated by an Act of Congress but owned by private shareholders. It is principally concerned with operating communications satellites, which were developed initially at government expense.

but the private corporation route was highly disliked. Feelings were that ". . . the core of the government's supersonic technology, acquired over a great many years, at considerable cost to the American taxpayer, was about to be handed over to private interests for private gain. . ." as some believed had been done with satellite technology.[2]

The program was also plagued throughout its duration with constantly changing leadership. In February 1963, President Kennedy established a Cabinet Commitee to help Halaby prepare a report on the economics of SST and generally review SST policy. Vice President Lyndon Johnson was Committee Chairman with Robert McNamara (DOD), James Webb (NASA), Najeeb Halaby (FAA), Jerome Weisner (OST), Luther Hodges (Commerce) and Alan Boyd (CAB) as members. This Committee established a precedent for a Presidential committee to be involved with FAA in major decisions on the SST. When President Kennedy was assassinated, McNamara took over Johnson's position of Committee Chairman, and power shifted from Halaby to McNamara. In April 1964, President Johnson established the President's Advisory Committee (P.A.C.) on Supersonic Transport, with McNamara as it head. Although FAA was to retain "leadership" of the program, SST policy was made henceforth from P.A.C.[2] This of course meant that policy would be very sensitive to changing administrations.

FAA "leadership" also had many flucuations. When Halaby resigned in 1965, General William McKee was nominated as FAA administrator. His nomination was not accepted for several months, because many people were concerned that as a retired Air Force general, he might becmme an instrument of military dominance of the FAA. This problem together with the difficulties in getting industry to accept the 75/25 cost-sharing basis (see Section 3.1),

caused a delay for funding. The program had to use FAA contingency funds before the supplemental was approved.

Turnover in the SST office at a critical time also hurt. The appointment of Air Force Brigadier General Jewell Maxwell as Director of the FAA SST Office when Gordon Bain, Deputy Administrator for SST Development, quit in September 1965 caused another uproar--and another delay. Bain had been appointed to the office by Halaby in July 1963.

One major management problem, data exchange, was solved in September 1965. With the multiplicity of government agencies and industries, there was need for some coordination in order to avoid duplication of effort while safeguarding both proprietary and classified material. To aid this problem, ninety people from both FAA and industry were given access to the data and an Air Force Systems Program Office was designated as the point of information exchange.

3. CONTRACTUAL ARRANGEMENTS

3.1 Initial Program Arrangements

Even as far back as the feasibility studies, the contractors were required to pay a share of the costs incurred, the percentage being negotiated on a case to case basis. In May and June of 1962 the bulk of the contracts for the feasibility study were let (forty total for the study). The contracts were concerned with identified gaps in the understanding of supersonic technology, and were not a complete design study. At that time, the contractor's share ranged from 10% of total costs to 50%. Halaby, head of FAA, had insisted on cost-sharing. He wanted to emphasize that this was a government-industry program. Also, he felt that regardless of whether or not the contractors got the development contract, they would benefit from the studies. Cost-sharing was a way of protecting the government against loose spending by the contracting

companies. And, of course, cost-sharing was useful in stretching the $11 million appropriated for Fiscal Year 1962 SST studies as far as possible.

In June 1963 President Kennedy announced the SST Design and Construction Program. The government would issue requests for proposals (RFP) for this program with a submission date of January 15, 1964. Kennedy's announcement of the SST Program set a $750 million limit for government spending and specified that industry should cost-share the program with government by taking on 25% of the costs. Within two weeks General Electric, North American Aviation, Pratt and Whitney, and Curtiss Wright told the FAA they did not think they would be able to participate with a 75/25 formula tied to a $1 billion program (very conservative estimate). The program was high-risk and long-term (see Section 2). Payoff would not come in the lifetime of many of their stockholders. Most aviation manufacturers found the program too restrictive for the risk involved. Industry had been very surprised by the fixed 75/25 cost-sharing formula and preferred a cost-plus-incentive-fee arrangement. Their complaints had some effect in that when the RFP's went out on August 15, 1963, it said manufacturers "may suggest alternative bases for financial participation." Halaby himself was against fixed cost-sharing, preferring a more flexible formula.[2] But in fact, the issue was perceived to be of such political significance that in practice there was very little flexibility possible.

The argument for cost-sharing was that besides being the best means of gauging industry's faith in the project and preventing loose spending by the companies, it was a useful concept for selling the program to Congress and the public. The cost-sharing was particularly important as a recent Stanford Research Institute report had claimed the economics of the SST to be very questionable.

The August 15, 1963 , RFP defined some inflexible financial points: 1) The government's share would not exceed $750 million except for 25% of the first $100 million in overruns; the rest would be the responsibility manufacturers. 2) The initial royalty payment required of air carriers, was $200,000 for each order placed for the SST within six months after the end of Phase II. Thereafter, the royalty would be $500,000 for each order. The Royalty was included in the initial manufacturer's price of the aircraft. 3) The airlines were required to give government 1.5% of the gross revenues of the aircraft during the first 12 years of operation. 4) Development was to be split into three phases: Phase I was initial competition--manufacturers should work on and submit designs and cost estimates at no cost to the government. Between January 15, 1964, and May 1, 1964, the government would review and select the winning design(s). If a single engine/airframe manufacturer had a greatly superior design to the rest, Phase II could be skipped, otherwise two combinations would go into Phase II--a twelve month detailed design competition, including related mockups. One of these two would be chosen for Phase III development. For prior FAA-contracted research by contractors and subcontractors which was done on cost-shared basis, contractors could credit this amount to the 25% participation for Phase II and III. Also, two design objectives were set: sonic boom less than 2 pounds per square foot (psf) overpressure during transsonic acceleration; 1.5 psf during cruising and deceleration; and engine noise (in and around airports) less than 112 EPNdB* on takeoff (less than then current subsonic jets on landing).

Upon transfer to the government of all rights in Phase II design information, data, hardware, and patents conceived or reduced to practice under

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*Effective perceived noise, in decibels

Phase II contracts, unsuccessful bidders would receive reimbursement for all allowable costs shared by contractors on Phase II work.

Due to the inflexible points in the RFP--especially the cost-sharing--some companies who had participated in the feasibility studies dropped out of competition. McDonnell and Douglas, who had been awarded the most feasibility contracts, did not compete in Phase II. Curtiss-Wright and North American Aviation (developer of the B-70) were eliminated in the Phase II competition, leaving only the Boeing and Lockheed, developer of the SR-71, (airframe designs) and G.E. and Pratt & Whitney (engine designs) in competition.

After Phase IIA there was a debate on whether or not to keep the competition for Phase IIC (Boeing vs. Lockheed, G.E. vs. Pratt & Whitney) or have Boeing and G.E. in a one-year non-competitive design. The competition concept for Phase IIC won out.

3.2 Modifications in Cost-Sharing

Management structure and cost-sharing provisions remained highly contentious and debilitating issues for the fledgling SST program. In August, 1963, Eugene Black and Stanley Osborne were appointed financial advisors on the SST to President Kennedy. On December 19, 1963, the Black and Osborne Report to the White House suggested a 90/10 cost-sharing formula and more generous overrun provisions; they felt the existing cost-sharing requirements were an unreasonable burden on industry. Also, their report suggested giving the airlines a larger voice in proceedings, and that the U.S. should not join the Anglo/French program, that the U.S. should not try to keep up with the Concorde, and that the program should be taken from the FAA and a temporary agency be created (to end when the aircraft was certified). This report was public knowledge by mid-February, although not officially released until

March 2. In February, the Bureau of the Budget circulated the Black and Osborne report for comment among executive agencies, and a week later, Aviation Week published an accurate summary. In April 1964, Gordon Bain, Director of Office of Supersonic Transport in the FAA rejected the Black and Osborne proposal. He recommended instead that manufacturers cost-share 25% of a total $50 million ceiling for Phase II and "in the order of 15% for Phase III" with government guaranteeing interest-bearing production loans[2]

Although industry had grudgingly accepted the 75/25 formula for both IIA and IIC, it continued fighting strongly for a change for future phases. They claimed that they could barely handle this formula for Phase II, but the future phases seemed out of the question. The Black and Osborne report provided strong support for this position. During Phase IIC negotiations, the manufacturers managed to get a concession--if their rate of cost-sharing for Phase III was lower than 25% set for Phase IIC, the lower rate would become, retoractively, the effective cost-sharing rate for Phase IIC. Thus the Phase III contract, as finally agreed to, was to change the 75/25 formula of Phase IIC.

Despite a body of opinion in Congress that government funding should be greatly decreased with the end of Phase IIC, federal agencies with an interest in the SST (e.g. DOD, FAA, NASA) were in agreement that the government would be by far the largest financial participant in Phase III. The only argument was over how little the industries' contribution should be. The November 1965 P.A.C. recommendation to the President was that the government contribute "approximately 80%" of the costs of prototype development, and included a provision for the government to pay the manufacturers a 10% fee. The net result would be a manufacturers' contribution of 10%. The FAA accepted this concept for Phase III and the Phase IIC retroactive credit. Phase III con-

tracts were awarded on December 31, 1966, to Boeing and G.E., the competition winners.

The decision to give Boeing and G.E. the contract was based primarily on their swing-wing design and managerial expertise. Despite some discussion in the FAA of maintaining competition in a dual prototype development program, the FAA felt that the Boeing/G.E. combination was superior and that one prototype design was enough.[2]

By the time Phase III contracts were let, with a decrease in industry's share of the costs, complaints on the economics of the program were rising in Congress. The cost of each aircraft had risen from the 1963 estimate of $10-15 million to $37 million.[6]

The FAA felt that the U.S. airlines should get involved in the financing--mostly as an indication of their faith in the SST. In February 1967, despite the fact that the airlines had already begun contracting for delivery of 747's, the FAA asked the twelve U.S. companies on the SST delivery list to contribute $1 million per delivery position to the cost of prototype construction. Ten of the twelve U.S. airlines, holding a total of 52 positions agreed. The $52 million was risk capital investment and was to be paid directly to Boeing, to be used in the program in lieu of government funds. The airlines were to recover this risk investment with interest through a royalty on SST sales. One of the ten airlines, Airlift International, with one delivery position did not follow through, and thus $51 million was received.

By June 1967, there were a total of 112 SST positions assigned to 26 airlines: 57 positions to 12 U.S. companies and 55 to 14 non-U.S. companies. The original policy on SST delivery positions, established in November 1963 applied to those positions. It required the airlines to deposit with the U.S. Treasury a total of $200,000 for each delivery position reserved

($100,000 initially and $100,000 six months after the start of prototype construction.) The $200,000 remained on deposit with the Treasury and was not used in the development program. No interest was to be paid on the money, but it was refundable in the event the program was terminated prior to aircraft certification. Six months after the end of Phase II the price of a delivery position was to be raised to $500,000. On June 5, 1967, the FAA and Boeing jointly announced that the cost of reserving future delivery positions for the SST would be increased to $750,000 each, and from then on all payments were made directly to Boeing to be used in lieu of government funds for SST development. Also, the money for new delivery positions would be at risk and no interest would be paid on it. The airlines were to recover their investment through a royalty on SST sales. Previously, the FAA had assigned delivery positions. At this time, Boeing assumed full responsibility for the allocation of new positions.[15]

Table 1, derived from references 10, 17, 18 is a breakdown of the U.S. and foreign airline positions taken and risk money given by each airline. Non-risk positions, Column A, taken between November 1963 and June 1967 were $200,000 per position. The total dollars for these positions are not shown, as this money was returned without debate when the program was cancelled. Risk-positions, Column B, those taken after June 1967, were $750,000 per position. The cost of risk-positions for the relevant airlines is indicated in Column C1. The 51 U.S. airlines who each gave risk-investment equal to $1 million times the number of non-risk positions they had previously taken, i.e. taken before February 1967, are shown in Column C2. No foreign airlines were asked to give risk-investment. Only one foreign airline, KLM, had taken any risk positions.

An FAA, August 1968, estimated account of SST program funding participation can be seen in Table 2.[9] The Phase III & total figures are higher than the actual amount spent on the SST as the program was killed before completion of Phase III.

Airline "risk" money eventually totaled $58.5 million: the nine U.S. airlines contributed $1 million per delivery position on the 51 positions they already had. The rest was money received for delivery positions after June, 1967. The risk money was returned, after considerable debate, after the SST program ended.

3.3 Recoupment Formula

Going into Phase III negotiations, the manufacturers wanted a royalty formula that returned the government's investment at commercial rates but that did not include a profit. In the FAA royalty plan, the amount of royalty paid was determined by dividing government investment by an agreed to number of airplanes and this payment should begin when a pre-set number of aircraft are sold. PAC didn't care for the FAA royalty idea. The Bureau of the Budget began arguing for a pooling system in which the government and the contractor would share revenues in proportion to their investment and would begin when the production break-even point was reached, with a limit on production and ongoing R&D costs.[7] It was finally decided that the FAA must decide on the formula and what the formula should try to recoup.

Recoupment as defined in the Phase III contract required a) that the contractor make a royalty payment of 15% of (non-government) sales and/or leases after gross sales and/or leases reached a production break-even point (to be determined by mutual agreement) so that the contractors would recover ex-

U.S. Airline	A 11/63-6/67 # of Non-risk Positions	B 6/67-5/71 # of Risk Positions	C1 $ Million for Risk Positions	C2 $ Million for Risk Investment	C3 $ Million Total Risk
1 Pan Am	15			15	15.0
2 TWA	10	2	1.5	10	11.5
3 American	6			6	6.0
4 Northwest	4	2	1.5	4	5.5
5 United	6			6	6.0
6 Eastern	2	3	2.25	2	4.25
7 Delta	3			3	3.0
8 Continental	3			3	3.0
9 World	3				
10 Trans American Aero	2				
11 Braniff	2			2	2.0
12 Airlift Int.	1				
Total U.S.	57	7	$5.25	$51.0	$56.25
Foreign					
1 Air Cananda	6				
2 Air France	6				
3 Alitalia	6				
4 BOAC	6				
5 KLM	3	3	2.25		2.25
6 Quantas	6				
7 Japan Air	5				
8 Canadian Pacific	3				
9 Iberia	3				
10 Lufthansa	3				
11 Air India	2				
12 EL AL	2				
13 Irish Air Lines	2				
14 Pakistan	2				
Total Foreign	55	3	$2.25	0	$2.25
Total All Airlines	112	10	$7.5	$51.0	$58.5

Total All Positions = A + B = 122

Table 1

BREAKDOWN OF U.S. AND FOREIGN AIRLINE POSITIONS AND RISK MONEY

Table 2

SST FUNDING PARTICIPATION

$ In Millions	PHASE I & II		PHASE III				TOTAL			
	Allowable Cost		Allowable Cost		Allowable & Non-Allowable Cost		Allowable Cost		Allowable & Non-Allowable Cost	
	Amount	Share %	Amount	Share %	Amount	Share %	Amount	Share %	Amount	Share %
Government	$294.2	94.6%	$945.2	82.6%	$945.2	74.1%	$1239.4	84.9%	$1239.4	78.1%
Contractors	16.8	5.4%	139.0	12.2%	271.0	21.2%	155.8	10.7%	287.8	18.1%
Airlines	-	-	59.5	5.2%	59.4	4.7%	59.5	4.1%	59.5	3.7%
TOTAL	$311.0	100.0%	$1143.7	100.0%	$1275.7	100.0%	$1454.7	100.0%	$1586.7	100.0%

Notes:

1. R&D Administration funded entirely by government.
2. Phase II-A and B contracts shared 75/25 by government and contractors, Phase II-C 90/10.
3. Phase III contracts shared 90/10 by government and contractors up to overrun point, 75/25 thereafter. All airlines contributions reduce government participation only.
4. Non-allowable costs include such items as interest, facilities and selling expenses which are borne entirely by the contractors.

ceed government costs for Phase II and III amounts payable bearing a 4-1/2% interest of the unpaid balance compounded annually. The contractor's obligation was reduced by the amount the government received from airlines as deposit for reservation of preferential delivery positions.

3.4 Patents

In the Phase II stage--as stated in "Request for Proposals for the Development of a Commercial Supersonic Transport" (FAA, August 15, 1963), "A contractor completing the Phase II competitiion, but not chosen by the government for work under Phase II, will be reimbursed for all allowable contract costs shared by the contractor for Phase II work upon transfer to the government of all rights in the Phase II design information, data, hardware, and patents conceived or reduced to practice under the Phase II contract."

Under the Phase II contract agreements, the contracting officer had to be kept informed (in complete detail) of all patents taken out (or those inventions/concepts which could be patentable). The contractor "grants to the government an irrevocable, non-exclusive, and royalty-free license to practice and have practiced each Subject Invention," including unlimited right to sub-license others to practice such an invention royalty-free or on whatever terms the government considers reasonable at the time. The government could require transfer of the title of invention (but leaving the contractor with the same rights as the government had when the contractor had title). In the event, as in Phase II, that the contractor was repaid its cost-share, it would release its rights to the government.

Any results or conclusions made from the work performed by this contract could not be released without permission of the contracting officer, except as required to perform work under the contract.

There were no problems with the patent arrangements. However this must be viewed in light of the fact that the program was not a financial success. Had the SST been a financial success, there might have been considerable debate over what the government should consider "reasonable" at the time.

4. THE END OF THE U.S. SST PROGRAM

In October 1968, Boeing announced that they were abandoning their swing-wing concept for a fixed-wing design, the B-2707-300. This new design greatly resembled the original Lockheed proposal which had lost the competition. It had a 40% greater sonic boom intensity, and higher landing and takeoff speeds which led to longer runway requirements and difficulty in integrating the SST with other traffic in terminal control areas. The result of these changes was a severe restriction in popular appeal. In March 1969 the first Concorde prototype flew (although not supersonically until October 1969).

Despite several negative reviews of the program and an increasingly negative public attitude, President Nixon decided in September 1969 to continue the SST Program to "maintain U.S. world leadership in air transportation."[1] Lobbying efforts, both for and against the SST, were very intense in 1970. Environmentalists in particular, were becoming vocal concerning possible detrimental effects of a fleet of SST's. Their concerns included unacceptable noise pollution, both during cruise and in terminal areas; inadvertent climate modification due to dumping water from the SST exhaust into the stratosphere and perhaps changes in the albedo of the Earth; and depletion of the ozone layer in the upper atmosphere, leading to increases in the ultraviolet flux at ground level and consequently in the incidence of skin cancer.

In March of 1971, the House and Senate voted to kill the SST Program. The Senate's reasons for refusing funding were 1) possible environmental effects (on ozone and climate); 2) airport noise and sonic boom; 3) the dubious prospects of the SST being a commercial success; 4) the question about the propriety of devoting large sums of public money--even as a loan--to a project that would benefit only a small percentage of the people.[11]

However, the SST program was given a reprieve when on May 12, 1971, in a surprise move, the House voted to change "termination funds" to funds for continuing to June 30, 1971, and the Senate Appropriations Committee approved the vote on May 13. Debate then proceeded on whether or not it would cost more to build a prototype or terminate the program. Prototype completion cost estimates ranged from $200 million to $1 billion. On May 19 the Senate voted again to terminate the project. This time the action was final. Approximately $1 billion had been spent on the program to that point. The airlines' contributions of $22.4 million for the first 112 delivery position deposits of $200,000 each, was returned to the airlines without debate. The House held hearings to review the airlines' claim that they should be reimbursed for their "risk" money. The airlines wanted their "risk" money back also, their justification being that the government broke an implied contract to proceed with the program--even though their contract said there would be no return of "risk" money for any reason.[11]

The House appropriations bill, approved on May 24, gave $97.3 million to cover the costs of terminating the program, including $52.1 million to Boeing and $33.2 million to G.E. to cover their share of the contract costs. The risk money was not included in the bill.[16] The return of the $58.5 million risk money, including $7.5 million for 10 delivery positions taken

after June 1967, was authorized in July 1971. The SST was brought up for review again in Congress in March 1973. The report of the Joint Economic Committee's Subcommittee on Priorities and Economy, "The SST Again," stated that 1) SST development would proceed when private investors want it to (i.e. there should be no government subsidy--when technical progress permits a sufficiently attractive airplane, private venture capital will be found). 2) The Concorde is no threat to preeminence in the aviation industry nor to jobs or exports. 3) There will not be a balance of payments problems. 4) The U.S. should prohibit sonic booms over U.S. territory and supersonic jets should be required to meet the noise standards of subsonic jets. 5) The U.S. should wait for the views of the 1974 Climatic Impact Assessment Program (CIAP).* 6) The funds could be spent more usefully elsewhere. 7) The SST is an energy intensive mode of transportation which is contrary to conservation oriented public policy.

In addition the report stated "the difficulty in controlling and assuring quality in military procurement and in other government-financed and/or government-managed programs in advanced technology (witness the Concorde) should make us exceedingly wary about institutionalizing these procedures in the U.S. civil aircraft industry or any other civil sector."[13]

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*Congress had authorized the allocation of funds for research into possible modification of the stratosphere caused by high-flying aircraft. As a result, the Climatic Impact Assessment Program of the Department of Transportation was begun in 1971 and was to report of the Congress at the end of 1974. Their final report, Report on Findings on the Effects of Stratosphere Pollution by Aircraft. (#DOT-TSC-OST-75-50), was published in December of 1974.

Although some effort was made in 1971 to continue the program on a purely commercial basis after government support was ended, insufficient interest could be generated among the airlines, the manufacturers or the financial community.[12] The U.S. currently has no formal program directed towards a second generation SST, but NASA and the FAA are continuing research into the problems of civil supersonic flight. FAA Administrator McLucas said in May 1976, that he expected an American SST to be a reality by 1990-1995.[14]

5. ANALYSIS

The lessons learned from the Supersonic Transport Program can provide useful criteria for the design of other large scale government research and development (R&D) programs in which commercialization is an important factor. In particular, there are some very basic issues of the SST program which have implications in the development of new energy technologies.

5.1 The SST Program

In retrospect, the demise of the SST Program can be explained by five factors: 1) Program leadership problems, 2) the uncertain commitment by the government (and hence uncertain funding), 3) the arbitrary, politically-motivated cost-sharing formula, 4) the lack of sufficient resources for fundamental technological studies, and 5) the opposition on environmental or sociological grounds.

1) The initial recommendation of the Brooks committee was that NASA should be in charge of the program. Having the FAA in charge of the SST program can be compared to having the Coast Guard design and build a nuclear submarine.

It is a credit to the FAA that the program survived for a decade under their management. Leadership should have been centralized in one agency - NASA - which was familiar with and in fact had a "clear statutory mandate regarding development in the field of aeronautics."[4] However, with Apollo starting two years earlier and with requirements for prototypes tied to production, NASA was not interested and refused program leadership. NASA should have been induced to take on the program. Giving the program to the FAA was totally inappropriate.

The FAA SST Office was separate from most FAA activities, which was beneficial - giving some autonomy from daily FAA affairs. According to the Federal Aviation Act of 1958, the FAA Administrator was not to be "bound by the decisions or recommendations of any committee . . . created by Executive Order."[20] In practice, however, this autonomy did not extend to the SST program. The multi-agency aspects of the project provided a rationale for ignoring this provision of the Federal Aviation Act: by 1964, leadership was in the hands of the President's Advisory Committee on the SST. Presidential advisory committees may be useful, "but a case can be made for the proposition that the center of gravity for the input of scientific advice into the policymaking process should be at a lower level than the White House."[21]

No firm leadership was provided, influence over the program shifting from one agency to another; and even within the agencies involved, there was a rapid turnover in program directors. The SST program needed people skillful in the are of bureaucratic politics - particularly in the research and development area - and the FAA was lacking. The FAA's difficult task was to coordinate the whole program, having 'authority' over NASA, DOD, and CAB. But coordination is not easy in the best of circumstances and this was not the best. "Defective machinery may contribute to the difficulties of coordinating multi-faceted

Federal programs which cut across traditional agency jurisdictions, but it is seldom if ever, at the root of the problem."[20]

2) At no time was the U.S. government fully committed to the SST program. Uncertainties about the program led to procrastination to Congressional funding authorizations. As a result, the program often subsisted on month-to month funding, and sometimes was kept alive only by the use of contingency funds. This caused program inefficiencies and especially a lack of confidence by industry. The resulting half-hearted efforts by both government and industry were very detrimental to the program.

During the early stages of the SST studies there was a general climate of technological optimism in the country. In the 1960's the Apollo program, a major technological project, was proceeding on schedule. It should be noted that the cost of Apollo was not very important - first, because it was perceived by most as an essential national goal, and second because it was not a commercial operation and therefore did not need to be economically justifiable. Progress in Apollo was limited primarily by the rate of technological development rather than funding availability. The SST, however, was not an unquestionable goal and <u>did</u> need to be economically justifiable. As a result, funding and management of the SST program were quite erratic.

3) Cost-sharing was to prove a major obstacle throughout the program. The motivation for the cost-sharing concept was political rather than economic, being designed to counteract complaints about government "handing profitable technologies over to private companies after development" (e.g. COMSAT). In general the private sector, motivated by economic considerations, was not prepared to increase investments in a high risk project merely to meet the political objectives of the government. The SST program suffered because of the attempt to use cost-sharing in lieu of stronger political support.

Cost-sharing resulted in the competition being cut down too quickly. McDonnell and Douglas and others who had participated in the feasibility studies dropped out of competition. Only four contracts were let for Phase II--from six proposals received--as compared with the forty let for the feasibility studies.

4) Insufficient time and funding were provided in Phase I to prove the feasibility of the required technologies. Presumably because of the perceived need to catch up with the Concorde and TU-144 programs, the decisions to proceed to Phase II and Phase III were taken too hastily. The contractors were thus forced to present preliminary designs which were, to some extent, based on optimistic extrapolations rather than hard data. An excellent example is the Boeing swing-wing, which won the competition, but which eventually proved impractical. It seems clear that, at the time of the design competition , available knowledge was inadequate for satisfactory analysis of the proposed aircraft. Due to changing designs, price estimates rose from the 1963 $10-15 million up to $60-80 million per aircraft when the program was killed in 1971.[6]

5) The SST program aroused controversy and serious opposition on ecological and social grounds. For example, objections to the sonic boom resulted in the limitation of supersonic flight to overwater route segments.* Environmental concerns such as ozone depletion and climate modification were very influential in the final termination of the program. There was considerable argument also over the propriety of spending public funds on a project whose initial users would be an elite group of international travelers. (Note: commitment to production also resulted in increased complaints on ecological

*This limitation is not accepted worldwide. The TU-144 is allowed to fly supersonically over some areas of the U.S.S.R.

grounds. It was the effects of a fleet of SST's which caused concern due to the possibility of atmospheric effects. Prototype development was not going to destroy the ozone, etc., but since the program was tied to production, opponents of the program felt that atmospheric studies gave enough indication of hazards to justify termination.)

5.2 Lessons for Energy Programs

In many cases, programs oriented towards solving the energy problem have similarities with the SST project. It is widely acknowledged that alternatives to imported petroleum must be found, and that the development of new energy sources is clearly an important national goal. In this respect, energy programs are less vulnerable to attack than was the SST. It may be in the national interest to fund long-term projects or those which entail high risk. It may be difficult to obtain government commitment to long-term projects because of the pressure of immediate demands on the budget, but it is frequently impossible to rely on private investments in such projects. The private sector will prefer to invest in programs which offer reasonably assured economic return in a reasonable time frame. The cost of research and production is going to be passed on to the consumer eventually, if not in taxes, then in the cost of the product. In the case of the SST the initial users were a small section of the population. This, of course, is not true with energy. When it is "in the national interest" for a certain project to proceed, it is not unreasonable for the general public to support it, par-

ticularly if a majority of the population will be using it. Government support buys time by encouraging early production. Assuming that reducing development time is in the national interest, it is quite logical for government to support such projects.

Like the SST, the products of such energy programs must be economically competitive and a multitude of environmental, political and techical problems arise which must be added to the economic concern. The anti-sonic boom lobby had a significant effect in reducing the popular appeal of the SST program, and probably played a major role in its Congressional defeat; and analogous issues are already well developed in the energy area--e.g., the anti-nuclear lobby.

More efficient ways of handling this type of program should be investigated. Considerable efforts should be made to obtain strong and appropriate bureaucratic leadership. One possible way of managing the financial arrangements might have been to reduce greatly or eliminate initial cost-sharing (i.e. total government support), thus increasing competitiion. Then it would be necessary to require more stringent recoupment formulas, thus handling the "free technologies" problem. The SST recoupment formula raised many complaints. It seems that, in such a questionable economic situation, a pooling system gives a greater chance of some return of government investment. As seen above, "risk" money must be more carefully defined.

New technology is beneficial both to industry and the country in general, and it is essential to keep abreast of technical innovation. The U.S. could perhaps stay current most efficiently and economically by providing government support primarily for continuing design studies of advanced technological systems of national significance. In order to maintain realism in these studies, prototype production could be undertaken at intervals

(using public funds) when technical developments require operational testing. Commitment to full-scale production (with private funding, if the intended use is commercial) would then occur only if and when need and/or economic benefits are clearly apparent. With this approach, the United States would avoid undertaking 'a production line of Edsels,' while maintaining the technological expertise to move ahead rapidly when appropriate. Following this pattern results in a switch from long-term/high risk programs to shorter-term/lower risk ones, which industry can handle more readily. There would only be very minor delays in catching up with competing nations (e.g., U.S.S.R., Britain, etc.) if they began a particular type of project before the U.S. does. Some possible energy sources have a weak technological base and are in need of more research before their true competitive value can be judged (e.g., synthetic fuels, solar energy, nuclear fusion).

In order to avoid the same pitfalls, if a commitment is to be made, it should not be half-hearted. Funding should be well defined; aid should <u>not</u> be on an erratic basis. Commitment to production should be separate from commitment to prototype development. Fixed cost-sharing should not be used as support for commitment to prototype development. A strong but definitely temporary technical agency would best handle commercializations projects. Criteria for development can be politically determined, but once initiated, the program should be subject to as few political flucuations as possible. For example, an attempt should be made to retain the Director for the duration of the program. While provision must be made for possible re-evaluation of a program, firm commitment and funding should be provided on a stronger basis, but only up to specified milestones - for example - in 3 year stages. More efficiency and stability can thus be provided to <u>that</u> stage without making commitments to further stages. Had the U.S. put more money into the early

R&D stages of the SST program, it might have saved money in the long term. The technology was not well enough in hand to proceed with commercialization. If it is politically necessary to avoid the appearance of giving away "free technologies," it is possible to avoid disincentives to industrial participation by using a sound recoupment formula instead of imposing cost-sharing in the early phases of development.

The primary lesson for energy technology commercialization which may be learned from the SST program is that the government should provide strong support to the appropriate agency for fundamental and applied research and for prototype construction when indicated. A thorough investigation of the environmental, sociological, and national and international political implications of a particular technology should be an integral part of the R&D program. Once a promising technology has been identified and demonstrated, the production phase should in most cases be left to the private sector - subject to regulation (by taxation or other means) so as to take into account indirect societal costs.

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APPENDIX

CHRONOLOGY OF SIGNIFICANT EVENTS IN U.S. SST PROGRAM

DATE		EVENT
1947	--	Supersonic flight is achieved for the first time.
1952	--	The Comet (BOAC's) begins first in-service commercial jet flight on May 2nd--London to Johannesburg.
1954	--	A prototype 707 is flown (cost is $16 million).
1956	--	Britain's Ministry of Supply sets up an SST Advisory Commission.
1958	--	The Federal Aviation Act is approved. The Federal Aviation Agency is formed with Quesada as Administrator.
1958	--	Pan-Am owned Boeing 707 makes its first in-service flight. The 707 is the first U.S. commercial jet transport.
1958	--	Lockheed and Douglas are working on preliminary design for an SST.
1959	Dec.	FAA's Office of Plans and Requirements: an informal supersonic planning team is established.
1959	Dec.	NASA technical feasibility presentation to the FAA concerning the SST.
1960	March	FAA's Supersonic Planning Team is established. ("To initiate studies on special problems, make recommendations, and in general work to stimulate interest in the SST.")
	June	Brooks Committee Report on SST's recommends proceeding with B-70, and a federal SST program with Mach 3, steel/titanium design goals and NASA leadership. (House Committee on Science and Astronautics).
	July	Glennan, NASA Administrator, calls joint FAA, NASA, Air Force meeting.
	Sept.	FAA-NASA-DOD working group on the SST is formed by Quesada.
	Nov.	NASA Supersonic Transport Research Committee established.
	Dec.	Quesada obtains $100,000 from the FAA budget for a preliminary SST engine design study.

1960-61	Quesada and British authorities wanted cooperation on SST program. Britain wanted the U.S. as a partner, but U.S. wanted Mach 3, steel/titanium design, while Britain wanted the more conventional/less costly Mach 2 aluminum design.
1961 Jan	President Kennedy announces the appointment of Najeeb Halaby as FAA administrator.
June	Joint DOD-NASA-FAA document on an SST development program.
June	The DOD-NASA-FAA SST Steering Group is established by Halaby.
June	Two contracts are let: one to General Electric, one to Pratt and Whitney, both for six month studies of engine cycles. Both companies are later given new contracts to continue this effort under the FY 1962 program.
Aug.	FY 1962 appropriation of $11 million for first year of the two-year feasibility research program (with FAA leadership).
Summer/ Fall	USAF-SST Support Office is established within the Aeronautical Systems Division, Air Force Systems Command at Wright Patterson (Dayton, Ohio).
Sept.	Supersonic Transport Management Office is established under the Deputy Administrator for Plans and Development (the Supersonic Planning Team is disbanded).
Oct.	Halaby establishes the Airline Advisory Group, a high-level non-governmental group.
Dec.	The SST Advisory Group is established. It is a more prestigious group of prominent people from the aviation community.
Dec.	RFP's go out on contracts for the two-year feasibility study.
1962 May/ June	The bulk of the contracts for the feasibility study are let (40 total for the study). All the contracts are of a technical nature and all are let on a cost-sharing basis (ranging from 10% to 50% for contractors).
	Congress has approved $20 million for FY 1963 ($31 million total for 1962 and 1963).
Nov. 14	British and French announce their decision to proceed in a joint SST Development Program (based on Mach 2 aluminum transport).
Dec. 11	The SST Advisory Group recommends expeditious development of a commercial SST.
Dec. 26	Halaby sends a recommendation to the President that the U.S. begin a SST development program.
	Efforts on the SST program are stepped up, perhaps partly due to the Anglo/French move.

1963 Jan. Kennedy requests information on the economics of the SST.

Feb. Kennedy establishes a Cabinet committee to help Halaby prepare the report on the economics (and review SST policy).

Feb. The FY 1963 Contract Program is basically the same as the previous year. The FAA begins the first sonic boom program at Edwards Air Force Base, California.

March Gordon Bain (former airline executive, then FAA's Assistant Administrator for Appraisal) appointed by Halaby as SST "Task Force Commander."

June Pan American places orders for the Concorde. President Kennedy announces the SST Design and Construction Program.

July Halaby appoints Gordon Bain Deputy Administrator for SST Development.

Aug. Eugene Black and Stanley Osborne are appointed financial advisors to Kennedy.

Aug. FAA releases RFP for the Development of a Commercial Supersonic Transport.

July/Aug. More airlines order Concordes (T.W.A., American consider taking Corcorde options).

Sept. NASA has a Conference on the SST Feasibility Studies and supporting research.

Oct. Halaby testifies before the Senate Independent Offices Subcommittee. (The Committee report released on November 13 tied the $60 million appropriation to the cost-sharing formula).

Oct. Reservations placed on 29 delivery positions on the U.S. SST (e.g. TWA, American, etc.).

Nov. Congress votes $60 million for FY 1964 budget for SST design.

Nov. 22 President Kennedy is assassinated. Halaby influence shifts to McNamara (in the Cabinet Committee).

Dec. The financial advisors Black and Osborne submit their report to the White House.

1964 Jan. Phase II Preliminary Design proposals are submitted by three airframe and three engine manufacturers.

April Johnson establishes the President's Advisory Committee on Supersonic Transport (P.A.C.) with McNamara as its head.

April The Government Evaluation Group, which included 210 people, 82 from FAA, 80 from DOD, 39 from NASA, 6 from CAB, 3 from Commerce, found no proposals adequate, although Boeing and G.E. were the best.

May Johnson calls for further design proposals.

June Six month Phase IIA contracts were given to Boeing and Lockheed (airframe design) and G.E. and Pratt & Whitney (engine design).

June FAUSST (French, Anglo, U.S.-SST) group meeting held in Paris: co-operation on environmental problems is possible.

1965 Jan Phase IIB: Review of Phase IIA designs.

April Halaby resigns. General William McKee is nominated.

April British TSR-2 supersonic fighter program is cancelled.

July Phase IIC, 18 month contracts, are let for continuation of Phase IIA contracts. McKee is sworn in as FAA head.

Aug. Johnson requests $140 million for FY 1966 as a supplemental to the FY66 budget. It is necessary to use $10.5 million in FAA contingency funds to keep the program going through September due to the delays.

Sept. Gordon Bain quits and is replaced by Air Force Officer Brigadier General J. C. Maxwell. The SST office title is changed from "Deputy Administrator" to "Director".

Sept. The SST continuing resolution for funding is approved until the supplemental is passed.

1966 April Pan American contracts with Boeing for 25 747's for delivery between the end of 69 and May 1970, with options on 10 more.

June One of two B-70 prototypes is lost in a crash at Edwards Air Force base. It is the one heavily instrumented for studying high speed aerodynamics. This causes another delay due to lack of information expected from the B-70 program to aid the SST program.

Dec. 31 Boeing and G.E. win the Phase III contracts. The decision for Boeing is primarily due to their swing-wing design and managerial expertise.

1967 Feb. Risk financial participation by airlines was agreed to.

April Federal Aviation Agency becomes Federal Aviation Administration under the newly formed Department of Transportation (DOT). Alan Boyd is Secretary of Transportation.

	April	President Johnson approves PAC proposed program for Phase III. Cost was estimated at $1,144 million for government to carry one engine and one airframe through four years of prototype development and flight testing.
	June	FAA and Boeing jointly announced the cost of reserving future delivery positions for the SST will be increased to $750,000 each. (Investment to be recovered on a royalty on SST sales; no interest and the money is at risk).
1968	--	The first prototype 747 flies.(By May 1969, Boeing has 196 orders).
	July	McKee resigns as FAA Administrator.
	Oct.	Boeing reluctantly abandons their swing-wing design for fixed wing design (B-2707-300).
1969	Jan.	Nixon takes office and appoints John Volpe as the new Secretary of Transportation.
	March/ April	The first French and British Concorde prototype flies, although not supersonic until October, reaching Mach 2 in November.
	March	Office of Science and Technology's SST Review Committee's views (generally adverse) are presented to Nixon, along with other inputs from FAA, and a report of a technical committee headed by Dr. R. Bisplighoff. (The Review Committee's report, Garwin report, is not disclosed publicly until August 1971--after the program is killed.)
	Sept.	Nixon announces that he has decided to continue the SST program. His reasons were that the U.S. needed to maintain its world leadership in air transportation.
	Dec.	Senate and House conferees agree that $85 million should be provided for the Boeing SST program in FY 1970 (10% less than requested).
1970	Jan.	Pan Am flies their first commercial 747 flight--New York to London.
	May	The House voted to provide $290 million for FY 1972. Major lobbying efforts, both for and against, are very heavy at this time.
1971	March	The House (3/18/71) and Senate (3/24/71) vote to kill the SST.
	March 30	DOT requests $97 million to terminate the SST program. $58.5 million for airline "risk" money still debated.

May 12 The House votes to change "termination funds" to funds for continuing to 6/30/71.

May 13 Senate Appropriations Committee accepts the House vote.

May 19 Senate votes to terminate the project.

May 20 The House Hearings--Subcommittee of the Committee on Appropriations. Airlines want to be reimbursed for their risk money.

May 24 House approves appropriations bill with no SST development funds, only $97 million to cover termination expenses.

July Airlines reimbursed for all of their risk money.

Aug. 17 The Garwin Report, Ad hoc Supersonic Transport Review Committee Final Report, March 30, 1969, is released by the U.S. government.

1972 Jan. Possibility of second generation SST with 25% greater range discussed.

1973 March The Joint Economic Committee's Subcommittee is Priorities and Economy report, "The SST Again," is issued--dismissing present need for SST.

1976 Jan. The first commercial Concorde flight.

May FAA administrator McLucas said in Paris that he anticipates the entry of a joint U.S./European SST on the air transport market between 1990 and 1995. He said he expected an American SST to be a reality by 1990-1995, but there was an equally strong probability that there could be a joint program.