Congress and the supersonic transport, 1960-1971
by John Marion Bell

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF ARTS in History
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Abstract:
Aviation state-of-the-art advances in the 1940's and 1950's paved the way for development of a commercial SST in the 1960's. Military aviation advances were translated directly into subsonic transports and it was felt that the next step in progress would be the SST.

Through military programs and basic research by NACA, the United States government aided the development of a commercial SST even before undertaking an active SST program in the 1960's. Foreign governments were also at work on SST's and when the British and French merged their development programs in 1962 the United States was spurred by their competition. President Kennedy announced an active program in June, 1963 a day following Pan Am's order of Anglo-French SST's. There was little opposition to the airplane at first; what little there was was based on the aircraft's unavoidable sonic boom.

A design competition was conducted by the FAA to select the best possible American design. Boeing was selected the winner in 1966 on the basis of a radical, swing-wing design. The program then entered a two-prototype development stage.

Boeing soon ran into development problems and in 1968 abandoned its swing-wing in favor of a conventional fixed-wing. The airplane's problems were also complicated by the great increase in cost of development as well as a growing opposition based on the possible negative environmental impact of the SST. The new environmental opposition questioned the need for an airplane which would possibly destroy solar radiation attenuating ozone in the stratosphere, possibly alter the earth's climate, and be excessively noisy on the ground.

After a decade of constant support for the airplane, Congress made an about face in 1970. The opposition began, to coalesce and the House narrowly passed the SST appropriation in May. During the remainder of 1970, an election year, the SST became a national political issue, and particularly an environmental issue. In December, the Senate cut all funds for the airplane. A compromise was reached between the two Houses funding the SST through March, 1971; there would be a separate vote on the SST before that time on whether or not to continue development.

During the first three months of 1971 the battle intensified.

The environmental issue was as strong as ever, but the fate of the airplane also hinged on economic factors. In March, the combined forces of economic and environmental opponents were,able to complete the destruction of the SST program, after nearly a billion dollars had been spent but before any American SST had flown.

To more clearly assess the reasons for defeat, a retrospective study was undertaken. Nearly 400 Congressmen, particularly those who. switched from support to opposition, were sent questionnaires soliciting their views on the program and on their votes. From questionnaire responses and from

contemporary reports, the conclusion was reached that neither economic nor environmental arguments and opponents alone were strong enough to shoot down the plane. Together, they were able to end a program which had been billed for over a decade as a necessary and inevitable form of progress.

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TABLE OF CONTENTS

ABSTRACT

Aviation state-of-the-art advances in the 1940's and 1950's paved the way for development of a commercial SST in the 1960's. Military aviation advances were translated directly into subsonic transports and it was felt that the next step in progress would be the SST. Through military programs and basic research by NACA, the United States government aided the development of a commercial SST even before undertaking an active SST program in the 1960's. Foreign governments were also at work on SST's and when the British and French merged their development programs in 1962 the United States was spurred by their competition. President Kennedy announced an active program in June, 1963 a day following Pan Am's order of Anglo-French SST's. There was little opposition to the airplane at first; what little there was was based on the aircraft's unavoidable sonic boom.

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To more clearly assess the reasons for defeat, a retrospective study was undertaken. Nearly 400 Congressmen, particularly those who switched from support to opposition, were sent questionnaires soliciting their views on the program and on their votes. From questionnaire responses and from contemporary reports, the conclusion was reached that neither economic nor environmental arguments and opponents alone were strong enough to shoot down the plane. Together, they were able to end a program which had been billed for over a decade as a necessary and inevitable form of progress.

INTRODUCTION

On December 3, 1970, the United States Senate voted to stop funding development of the American version of the Supersonic Transport (SST). Although there had been some opposition to the SST from the early 1960's this action represented the first time in a decade that opponents were able to halt the controversial SST program, a program that seemed to develop a life and justification of its own, regardless of its merits. During the 1960's the United States underwent tremendous changes, changes that had a great bearing on the success or failure of the SST program. At the beginning of that decade the SST represented just another step in the ongoing progress of mankind. By 1970, however, the nation had passed through a turbulent and eventful decade which resulted in the questioning of traditional values and concepts of progress. Instead of accepting any new development solely on the basis of its technological possibility, a significant body of Americans questioned programs such as the SST on the basis of what they would do to and for society.

The development of the jet engine in the 1930's paved the way for supersonic flight in the post-World War II era and by the early 1950's aviation state-of-the-art was sufficiently advanced to make civil supersonic flight a possibility during the 1960's. In addition to more powerful jet engines, new materials and materials fabrication techniques would allow flight at speeds greater than three times the speed of sound. Military aviation developments contributed directly to civilian subsonic aviation and also led to the use of aluminum alloy and titanium airframes for supersonic flight.

Achievement of supersonic flight capabilities represented a continuation of the historic trend of shortening travel time. In the past, any mode of transportation which promised to shorten the time required to travel from one place to another has invariably been received favorably by the traveling public. Thus the sailing ship gave way to the steamship; the horse and buggy gave way to the automobile; the stagecoach was supplanted by the railroad; and the railroad, steamship, and automobile were eclipsed by the airplane. Similarly, advancements in the speed capability of the airplane led to an ever-increasing use of air transportation. When pre-World War II transports such as the DC-3 were replaced by the four-engined piston transports of the post-war era, air travel sharply increased. When the first generation of jet transports became widely available in the early 1960's, air travel boomed. It was expected that the trend would be continued by the introduction of the SST in the 1970's.

In addition to aviation state-of-the-art advancements making supersonic flight possible in the 1950's and 1960's, international competition provided a strong impetus for SST development. Programs were initiated in Great Britain, France, the Soviet Union, and the United States in the 1950's. For all four countries an SST in its family of airplanes was thought to be a source of national prestige, much as Sputnik for the Soviet Union and the Apollo moon vehicle for the United States. Both Great Britain and France suffered status declines following World War II and felt an SST would help reverse those trends. Furthermore, an economically viable SST would provide its nation a product for export, thus contributing to a favorable balance-of-trade, and in the process stimulating its domestic economy. Many people, such as President Kennedy in 1963, viewed the SST as a "logical next step" in aviation, as well as a manifestation of progress, a view that was subsequently continued by Lyndon Johnson and Richard Nixon when they entered the White House. In the rush to reap the benefits of progress, however, many of the potentially harmful side effects of the SST were overlooked or assumed to be readily capable of solution.

The SST represented more than just a continuation of the phenomena of reducing travel time; it represented the whole-scale intervention of the government, unique for the United States at least, into a civilian aviation project. Although government participation in military developments had directly aided civilian projects before, the SST program was the first such civilian program to be sponsored and directed by the government. From late 1963 through the end of 1966 the Federal Aviation Administration (FAA) conducted a competition among interested manufacturers to determine the best possible design for America's supersonic entry. Boeing was eventually picked as prime contractor for the SST largely on the basis of a revolutionary swing-wing design, a design based on experimental work conducted by the National Aeronautics and Space Administration (NASA). But the development of the swing-wing proved to be more difficult than Boeing had envisioned, resulting in its abandonment in favor of a conventional fixed-wing design in 1968.

The SST was also unique in that it was one of the first major technological programs to be subjected to questions about its impact on the physical environment. From minor opposition in the early 1960's based primarily on the sonic boom, opposition broadened by the end of the decade to include charges that the aircraft represented an intolerable threat to the natural environment. Seemingly unavoidable side-effects of supersonic flight such as the sonic boom, atmospheric contamination, and excessive engine noise were cited by opponents as reasons for stopping development.

An SST is designed to operate in the rarefied region of the atmosphere known as the stratosphere, at higher altitudes than conventional airplanes. The stratosphere has relatively little verticle mixing and SST emissions would probably remain in the stratosphere for as long as several years. Thus the cumulative effect of emissions in the stratosphere would be more severe than at lower altitudes where there is extensive verticle mixing which results in a cleansing effect. Although initial opposition to the SST was based on its inevitable sonic boom, opponents became more concerned about the longer term effects of supersonic flight in the stratosphere by the latter part of the 1960's. Among the questions raised were those concerning the depletion of ozone, a vital force in the attenuation of harmful ultra-violet radiation, and the interaction of SST exhaust with elements already present in the stratosphere, interactions which could have profound effects on the earth's climate and surface temperature. Further questions were raised about the effect of engine noise in the immediate airport vicinity and in take-off and landing corridors.

During the period of controversy over the SST, many diverse opinions were expressed concerning the airplane's impact on the environment. Experts on both sides of the issue lent their professional prestige to arguments for or against the airplane. Amateurs and special-interest groups on both sides added their own opinions. Many of the arguments put forward were "iffy" in nature and therefore difficult to prove one way or another. As a result, the controversy often degenerated into a sensationalized "shouting match" as the decade of the 60's closed. It was in this atmosphere, highly charged with emotionalism and loud claims by both sides, that the Congress finally took steps to terminate the program in 1970 and 1971. There appear to be two critical factors involved in the termination of the United States SST program: economics and environment opposition. Over the course of a decade of development the airplane became much more expensive than originally envisioned, a characteristic common to most research and development projects which are conducted on the fringes of technological capabilities. The SST also elicited the opposition of the newly-powerful environmental movement in the latter part of the 1960's. Together, economics and the environment contributed to the downfall of the SST. It is doubtful if either factor was strong enough on its own, but in conjunction they were sufficiently powerful to terminate a program on which nearly a billion dollars had been expended, and in which thousands of jobs were at stake in an ailing economy.

CHAPTER I

BACKGROUND TO AMERICAN SUPERSONIC TRANSPORT DEVELOPMENT

From the end of World War II until the mid-1960's the United States maintained a commanding lead in commercial aviation. First its piston-powered transports and later its subsonic jet-powered transports captured the major share of the world's market. It was considered only logical that the development of a supersonic transport would follow. By the late 1950's aviation state-of-the-art advancements and military developments in jet flight made the development of an American SST even more probable. As a result the federal government undertook a series of low-keyed programs to aid in the eventual development of a commercial SST. By early 1963, however, this course of deliberate development was threatened by the decision of foreign manufacturers to build SST's using existing materials fabrication techniques and technology in order to be the first on the market. It was thus in an era of American aviation dominance that the United States undertook initial SST development, but it was not until the threat of foreign competition became serious that the United States undertook an active developmental program.

By the late 1950's visionaries in the aviation industry and the government had dreamed of commercial supersonic flight for some time. With the development of the jet engine in the late 1930's supersonic flight was within reach of aviation technology. In 1947, the rocket-powered Bell X-1 became the first airplane to "break the sound barrier," proving the feasibility of supersonic flight.[1] Clearly the airplanes of the post-World War II era had come a long way from the wood, wire, and fabric craft the Wright brothers first flew at Kitty Hawk in 1903. Lightweight aluminum and aluminum alloy airframes coupled with more powerful engines aided tremendously in the steadily increasing performance of airplanes. By the 1950's exotic alloys were developed which would allow flight at supersonic speeds greater than aluminum alone would permit.[2] The ultimate in supersonic capability was reached when titanium was perfected for use as the skin of supersonic aircraft. Although more expensive and more difficult to work with than aluminum, titanium offered the capability of flight in the Mach III range at close to 2,000 miles-per-hour, whereas aluminum-skinned aircraft were limited to 1,450 miles-per-hour or just slightly above Mach II.[3]

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[1] Don Dwiggins, The SST: Here It Comes Ready or Not (New York: Doubleday & Co., 1968), 105.

[2] Examples of new alloys were Alcoa's aluminum-lithium alloy and Armco Steel's PH15-7 Mo alloy steel. Alcoa's product could be utilized by aircraft flying in the 1,600 miles-per-hour range. The advantages of this alloy were that it was lighter than previous aluminum alloys and reportedly adaptable to standard industry fabricating processes. New York Times, October 1, 1957, 52; Armco Steel's 2,700 miles-per-hour PH 15-7 Mo (15% chromium, 7% nickel, 2.5% molybdenum, phase hardened) alloy supposedly presented advantages of low cost ($2,000-2,200/ton average for mill products compared to $30,000/ton for titanium alloy products) and ease of fabrication with existing stainless steel processing equipment, New York Times, September 11, 1957, 45.

[3] Dwiggins, The SST, 195.

The mainstay of most civilian airlines from the 1930's until after World War II was the DC-3, a sturdy and dependable airliner, but limited in range, capacity, and speed because of its size and its twin-engined power plant. Immediately following World War II airframe manufacturers who had produced powerful four-engined bombers during the war turned their bomber experience into the multi-engined commercial transports of the post-war era. Thus with the introduction of larger, faster, and more productive airliners such as the Douglas DC-6, the Lockheed Constellation, and the Boeing Stratocruiser, commercial aviation made great advances. The next obvious step in commercial aviation was the introduction of the jet transport.

Jet fighter development and more particularly jet bomber development led to the first generation of subsonic transports. The first civilian jet transport to be produced was the de Havilland Comet. This British aircraft became the first jet transport to enter commercial service on May 2, 1952. The Comet beat the Boeing 707 into airline service by over six years.[4]

The second and more successful jet transport to be developed was the Boeing 707. Boeing was the builder of the subsonic B-47 Stratojet and B-52 Stratofortress bombers, experience that was intimately tied in with development of their jet transport prototype now

[4]F. G. Swanborough, Turbine-engined Airliners of the World (London: Temple Press Books, 1962), 14 and 45.

known as the "Dash Eighty." Boeing commenced design work on the "Dash Eighty" in 1946 without a government contract for a military version. Even when Boeing announced publicly on August 30, 1952 its intention to build a prototype jet transport the U. S. Air Force had not yet defined its need for a high-performance jet tanker capable of refueling the B-47 and the B-52. Nevertheless, the Air Force publicly announced its intention to acquire a jet tanker less than a month after the "Dash Eighty" first flew on July 15, 1954. Development of the tanker version then took precedence, with the first KC-135 accepted by the Air Force on January 31, 1957, and the first delivery of a commercial 707 to Pan American World Airways on August 15, 1958. Many refinements that were subsequently incorporated into the commercial version were first tested and proven in the military model.[5]

The Douglas and Convair Aircraft Corporations followed Boeing's lead and produced similar jet transports with the Douglas DC-8 entering airline service with United Airlines and Delta Airlines on September 18, 1959, and the Convair 880 entering service with Delta Airlines in May 1960.[6] Across the Atlantic, Sud-Aviation drew on its Mirage bomber experience and produced the medium range, rear-engined Caravelle. The

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[5]For a discussion of the development of the KC-135 see F. G. Swanborough, Military Transports and Training Aircraft of the World (London: Temple Press Books, 1965).

[6]Swanborough, Turbine-engined Airliners, 37 and 55.

Caravelle entered airline service with Air France on May 12, 1959. The development of the French jet was subsidized by the government in an attempt to revitalize the French aircraft industry. The specific size and design was chosen so as to not compete head on with the longer range jet aircraft then under development in the United States.[7]

During this period the Russians were not marking time in jet transport development. But instead of using bomber technology to produce transports specifically designed for civilian service, the Russians simply modified existing jet bomber designs. Thus they were able to place jet transports into service by September, 1956, but because of their hybrid design, a lack of familiarity with, and questions about the reliability of Russian aircraft on the part of the world's airlines, none of their jets were utilized outside the Communist bloc.[8]

World-wide air travel boomed following the introduction of subsonic jets in the late 1950's. Although the subsonic transports went into service well ahead of many forecasts made in the early 50's, visionaries looked ahead to the SST as the next step in the progress of commercial aviation. It was widely expected in the United States in

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[7] Ibid., 85 and 87.

[8] Ibid., 92. Russia's first jet transport, the TU-104, was a modification of the Badger TU-16 jet bomber. Although some attempts were made to sell the TU-104 outside the Soviet Union, only four of the aircraft were purchased by non-Russian airlines, and those by the Czechoslovakian state airline.

the 1950's and well into the 1960's that military development of supersonic bombers would provide the necessary technological background for a commercial supersonic transport. In the early 1950's the Air Force began to develop what was expected to be its next generation of manned bombers. The first replacement for the subsonic B-47 and B-52 was the supersonic dash bomber, the B-58 Hustler. The Hustler, however, was not designed for missions at sustained supersonic speeds but was expected to cruise subsonically to the vicinity of its target and then dash supersonically during its bombing run.[9] When the government began thinking seriously about building an SST in 1960, the builder of the Hustler, Convair Aircraft Corporation, proposed to modify their airplane to convert it into a medium-range, moderate capacity, interim supersonic transport. Before a House Committee in 1960 Convair's Vice President for Engineering argued that such a course would utilize existing technology and a proven basic design, and would therefore enable the United States to enter the commercial supersonic field years ahead of any potential competitors. The advantages gained in time required to develop an operational SST would be in addition to savings over the cost of developing a Mach III SST directly, without the benefit

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[9] Dwiggins, The SST, 108.

of an interim development such as a modified Hustler.[10] Nevertheless, Convair was not able to gain government backing for this proposal and did not attempt to secure private financing for its "instant commercial SST."

North American Aviation's B-70 Valkyrie, capable of sustained supersonic flight at Mach III, was expected to be the Air Force's ultimate replacement for its subsonic bombers as well as for the limited performance Hustler. Because the B-70 would utilize titanium for its airframe in order to be able to withstand the temperatures generated at Mach III, it was widely expected during the late 1950's and early 1960's that it would provide a technological base for a Mach III transport. In 1960 the House Science and Astronautics Committee recognized the importance of B-70 technology to a commercial SST and recommended continuing development of the B-70 . By this time, however, the Eisenhower Administration had made a decision to cut back on develop-

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[10] U. S., Congress, House, Committee on Science and Astronautics, Supersonic Air Transports, Hearings, before a Special Investigating Subcommittee of the Committee on Science and Astronautics, 86th Cong., 2d Sess., 1960, 117-122. Convair proposed building a dozen B-58's modified as commercial SST's and powered with J-58 engines which would give them a top speed of Mach 2.4. By taking this approach valuable hours of supersonic flight time would be built up rather quickly and this would provide supersonic experience comparable to the 25,000 hours of jet bomber experience accumulated prior to the development of the 707. In pushing this proposal Convair noted that even their B-58 had only accumulated 500 hours of flight time above Mach 1.5 (out of a total 10,000 hours) between 1956 and 1961, a very small number of hours on which to base a full-scale SST development program.

ment of the supersonic bomber in response to the budgetary demands of the growing missile force. The B-70 subsequently became a victim of the missile age and only two prototypes were built. The House Committee Report in 1960 was in part an attempt to forestall this development, claiming that the B-70 could be justified on the basis of national security, maintaining in addition that the program was "so closely tied in with the possible future development of a supersonic commercial transport that it [development of the B-70] appears to be the most satisfactory way to accomplish it."[11]

In response to the serious overcrowding of the nation's airways in the late 1950's the Federal Aviation Administration (FAA) was established on August 23, 1958. At this time airlines had made orders for many of the subsonic jets that would be coming off the Boeing, Douglas, and Convair assembly lines in the next several years. But the four-engined piston transports had already made the airways unsafe due to overcrowding a system designed for the slow (less than 200 miles-per-hour) DC-3. A number of tragic mid-air crashes from 1956 to 1958 prompted Senator Mike Monroney of Oklahoma to introduce a bill to establish the FAA and make it primarily responsible for developing a

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[11] U. S., Congress, House, Committee on Science and Astronautics, Special Investigating Subcommittee, Supersonic Air Transports, H. Rpt. 2041, 86th Cong., 2d Sess., 1960, 23-24.

safe airway system.[12] In addition, the FAA was given the responsibility to "encourage and foster the development of civil aeronautics and air commerce in the United States and abroad . . . ."[13] When the Department of Transportation was established in 1966, various functions of the FAA were transferred to it. The authorizing act vested in the Department the responsibility for "development and construction of a civil supersonic aircraft."[14]

In carrying out its charter obligations, the FAA began active governmental support for a commercial SST in 1959 with the establishment of an SST study group.[15] The first Congressional hearings on the SST were held by the above-mentioned House Committee on Science and Astronautics in May, 1960. In addition to strongly recommending continuation of the B-70 bomber program and the establishment of a commercial SST program, the House Committee recommended placing any SST

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[12]Dwiggins, The SST, 41-43. On June 30, 1956 a TWA Super Constellation and a United DC-7 crashed while circling the Grand Canyon in partly cloudy skies. One hundred twenty-eight people lost their lives in that collision. In early 1958 three major disasters occurred within a period of 3 1/2 months. On May 20, 1958, a day prior to the introduction of Senator Monroney's FAA bill, a civilian jet trainer collided with a civilian transport above Brunswick, Maryland, killing twelve persons.

[13]Federal Aviation Act of 1958.

[14]U. S. Code, Vol. XLIX, Section 1655, Subsection C.

[15]"Federal Steps to Date on SST Development," Congressional Digest, December, 1970, 292.

program under the control of NASA, an agency over which the Science and Astronautics Committee exercised legislative oversight.[16]

Soon after taking office President Kennedy established an SST steering group composed of the FAA Administrator, the Assistant Secretary of the Air Force for Research and Development, and the NASA Director of Aeronautical Research. The steering group proposed that a Supersonic Transport Authority be established to coordinate development.[17] Simultaneously, the President's Task Force on National Aviation Goals produced a study entitled "Project Horizon" in 1961 in which it noted that it was "no longer possible for civil aviation to progress mainly by reliance on the by-products of military-related research and development programs." It was further observed that aeronautics was "running a poor second to space technology in the time, talents, facilities, and funds expended on it within NASA," and recommended upgrading the national commitment to a program which would result in the continuation of world aviation leadership by the United States.[18]

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[16] U. S., Congress, House, Committee on Science and Astronautics, Supersonic Air Transports, Report, 23-24.

[17] "Federal Steps," 292.

[18] U. S., Task Force on National Aviation Goals, "Project Horizon," Report of the Federal Aviation Agency, September, 1961, 48-49.

The first Congressional appropriation specifically for the SST was passed in 1961 when the FAA received $11 million for development during fiscal 1962.[19] An SST Program Management Office was opened at Wright-Patterson AFB in Ohio and in November, 1961 Initial Requests for Proposals (RFP) for research contracts were issued.[20] Congress appropriated $20 million for SST research in 1962.[21] In January, 1963, President Kennedy established a cabinet-level committee under the chairmanship of Vice President Johnson to coordinate development of the SST.[22] From the above discussion of governmental support for the SST it is obvious that the United States government was committed early to SST development. But this commitment did not lead to development decisions reached in a vacuum; rather, competition from abroad played a significant role in pushing the United States into full-scale development earlier than it perhaps otherwise would have without any outside pressures.

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[19] SST development funds for fiscal 1962 were included in the FAA appropriation in PL 87-141.

[20] "Federal Steps," 292.

[21] SST development funds for fiscal 1963 were included in the FAA appropriation in PL 87-741.

[22] "Federal Steps," 292.

Great Britain and France began SST development independently in 1959. Great Britain intended to build a commanding lead in supersonic jet development, thus accomplishing a feat similar to that which had almost been accomplished with its first generation subsonic jet, the Comet I. Unfortunately, the early Comet was plagued by problems and after several spectacular, and at first inexplicable, crashes it was taken out of airline service.[23] By the time the Comet's problems were solved, the 707, and later the Douglas DC-8 and Convair 880, came on the scene. From then on United States airframe manufacturers have dominated the supply of commercial aircraft to the non-Communist world. As of 1971, 84 per cent of the free world's commercial aircraft were made in America.[24]

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[23] On the Comet see Swanborough, Turbine-engined Airliners, 45-50. The early Comet I was susceptible to structural failure where the wings joined the fuselage. After four similar crashes in less than a year and a half, the entire fleet of Comets was grounded in April 1954 and an exhaustive investigation undertaken. When the cause of failure was determined Comets were subsequently modified for use as British military transports; but it was not until October 4, 1968 that updated Comet 4's were put into commercial service, becoming the first jet airliners to provide commercial service across the Atlantic.

[24] New York Times, July 20, 1970, 53.

An aspect of France's entry in the supersonic race was Charles de Gaulle's attempt to restore French grandeur.[25] By 1962, however, Britain and France sought the advantages of pooling their resources and signed an agreement to jointly develop the SST now known as the Concorde.[26] The Anglo-French SST was to be built of aluminum using existing aviation technology, a decision which limited its top speed to just over Mach II. The Concorde's range was to be slightly in excess of 4,000 miles with a passenger capacity of 128.[27] During the same period the Soviet Union was engaged in developing the TU-144, an SST

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[25] On aspects of French grandeur see especially W. W. Kulski, De Gaulle and the World (Syracuse, New York: Syracuse University Press, 1966), 25-27 and 79-92. See also Robert Aron, An Explanation of De Gaulle (New York: Harper & Row, 1966), and Alexander Werth, De Gaulle: A Political Biography (New York: Simon and Schuster, 1965). The France in which de Gaulle was returned to power in 1958 suffered under the cumulative burden of its past two centuries of history, but particularly the two world wars, the loss of Indo-China, the great turmoil in French Algeria, and constant domestic political strife. When de Gaulle established the Fifth Republic, one objective, in addition to creating stability, was to restore Gallic pride and grandeur. The nascent SST program was felt to be admirably suited to such a task.

[26] New York Times, November 30, 1963, 65. This historic agreement to jointly undertake such a major technological development came at a time when Britain was negotiating with France and the other members of the European Common Market for British entry into the market. Because of misunderstanding and obstinance on both sides, however, Britain's bid for entry was not successful. Less than two months after the two nations agreed to jointly produce the Concorde, de Gaulle announced to a January 14, 1963 press conference his veto of British entry.

[27] Dwiggins, The SST, 195.

strikingly similar to the Concorde with nearly identical range, speed, and capacity.[28] In opting to build a first-generation SST, the British, French, and Russians hoped to capture the initial market for supersonic commercial aircraft and later develop a more advanced airplane to capture the second-generation market.

The approach eventually taken by the United States was entirely different. Instead of using aluminum for the airframe, the American SST was to be built with a skin of titanium which could withstand significantly higher temperatures than either the Concorde or the TU-144 and which would subsequently be able to fly at close to Mach III, or greater than 1,800 miles-per-hour. It was to have a range of 4,000 miles and a passenger capacity of 298, more than double that of its foreign competitors. While it was understood that the Concorde would be the first on the market, American backers of the SST fully expected to eventually capture the lion's share of the market on the basis of a superior design, just as the subsonic Boeing 707 proved to be superior even to the rebuilt Comet.[29]

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[28] "Comparison of U. S. and Foreign SST's," Congressional Digest, December, 1970, 294.

[29] Dwiggins, The SST, 195. Titanium technology was relatively new but by the time a commercial SST became a reality it had already been proven in the building of military craft such as the Lockheed SR-71, capable of Mach III, and the experimental X-15 rocket plane built by North American.

When Concorde development was fully underway in 1963, airlines from the United States felt that in order to maintain a competitive position vis-à-vis foreign airlines which were expected to utilize the Concorde and TU-144 they would have to purchase foreign SST's, since availability of the United States version was obviously a number of years in the future. Thus on June 4, 1963 Pan American World Airways ordered six Concordes.[30] At the Air Force Academy Commencement the following day, President Kennedy announced the intention of the United States to build the "prototype of a commercially successful supersonic transport superior to that being built in any other country of the world."[31] Not only did this announcement follow Pan Am's order of Concordes, it preceded by five days his American University détente speech and took place during a period of delicate negotiations and maneuvering which eventually resulted in the signing of the Nuclear Test Ban Treaty.[32] In the spirit of the Apollo space project just then gaining momentum, JFK proposed the SST as a multi-purpose vehicle

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[30] New York Times, June 5, 1963, 41.

[31] U. S., President, Public Papers of the Presidents of the United States, 1963 (Washington, D. C.: Government Printing Office, 1964), 440-441.

[32] On the June 10 American University speech in which President Kennedy proposed working with the Russians for peace in order to "make the world safe for diversity" see Theodore C. Sorensen, Kennedy (New York: Harper & Row, 1965). On the subject of the atmospheric Nuclear Test Ban Treaty see Sorensen, Kennedy, and Piérre Salinger, With Kennedy (New York: Doubleday & Co., 1966).

"essential to a strong and forward-looking Nation."[33] By building an SST, the United States would be able to maintain aviation technological leadership, demonstrate what could be accomplished under a democracy with free enterprise, expand international trade, and provide employment.[34]

President Kennedy proposed the creation of a government/industry partnership to produce a superior SST, an aircraft viewed as aviation's "logical next development." The project, however, was not to be open-ended. Manufacturers were to provide 25 per cent of development funds and the government's share was not to exceed $750 million. In addition, if the resultant aircraft should not prove to be commercially viable, the program would be halted.[35] Few people expected this to happen, however, and there was little opposition to the SST when it was first proposed. For it was then viewed by President Kennedy and many other Americans as a form of progress and a necessary and inevitable technological development in addition to the national prestige it was expected to bring to the nation developing a superior SST.

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[33] Public Papers, 1963, 441.

[34] Ibid., 476.

[35] Ibid.

By the time of President Kennedy's announcement in 1963, the United States was well-prepared to undertake active development of an SST. Technological knowledge gained through the production of jet bombers, including supersonic bombers such as the B-58 Hustler and the proposed B-70 Valkyrie, was expected to aid immeasurably in the development of a commercial SST. Basic research into the problems of supersonic flight had taken place within various agencies of the federal government since at least the 1950's and state-of-the-art advancements in jet engines and airframes made Mach III flight a reality by the beginning of the 1960's. In addition, foreign competition posed serious threats to the continued domination of commercial aviation by American airframe manufacturers. Thus the United States government made the not too surprising decision to begin active development of an SST in 1963. The first phase in that development was a design competition to decide which airframe and engine manufacturers would receive the final contracts to build the proposed SST.

CHAPTER II

DESIGN COMPETITION AND PROTOTYPE DEVELOPMENT, 1963-1970

In order to select the best possible design for America's supersonic sweepstakes entry, the Federal Aviation Administration sponsored a design competition beginning in August, 1963 among the various airframe and engine manufacturers interested in developing an SST. In the early phases of the competition the FAA hoped to speed up development and catch up with the Concorde; such haste on a major technological development was due in large part to the head start that foreign competitors enjoyed. As the competition progressed without resulting in a clearly superior design by mid-1964, and as Concorde and TU-144 development neared the prototype stage, it became obvious that the United States would not be able to beat the Europeans into the air. Thus in 1964 President Johnson committed the United States to the development of an SST capable of outperforming its foreign opposition.

On the basis of a radically new, swing-wing design Boeing was selected in December, 1966 to build the American SST. In payload and speed the American craft would be clearly superior to both the Concorde and the TU-144. And even though delivery to the airlines was at best expected to be two to three years after the foreign airplanes would be in commercial service, backers of the Boeing aircraft expected it to capture the bulk of the market. However, the Boeing SST ran into serious design problems in 1967 resulting in the abandonment of the swing-wing the following year. The slow-down in development necessitated by the significant design change also coincided with growing opposition to the aircraft from the Congress and the public on financial and environmental grounds. As the SST became more and more expensive, and as serious environmental questions were raised, the successful completion of the program became less and less assured as the decade of the 60's came to a close. By the end of the decade the completion of Boeing's prototypes was near, but by then the opposition coalesced with sufficient strength to bring about the defeat of the SST in 1970 and 1971. The selection of a radical and unproven airplane in the design competition played no small part in the ultimate demise of the SST.

I

Two months following President Kennedy's Air Force Academy announcement of an American SST program, the FAA issued a Request for Proposals (RFP) for SST designs. Interested airframe and engine manufacturers were expected to reply to the RFP by January 15, 1964.[1] Although expecting the American SST to be superior to foreign designs (in the manner that the 707 proved to be superior to foreign opposition in the subsonic jet field), at the time it issued the RFP the FAA did not envision a final design radically different from that of the Concorde. Its range would be 4,000 statute miles, sufficient to fly

[1]Dwiggins, <u>The SST</u>, 130-131.

non-stop from New York to Paris with a margin of reserve fuel to allow continuation to Rome if necessary. Capacity would be 125-160 passengers in addition to 2.5 tons of cargo and mail. The aircraft would cruise at Mach 2.2 and would be expected to be as quiet as subsonic jets when in the vicinity of airports. The FAA also set sonic boom overpressure limits of 2 pounds per square foot during acceleration and 1.5 pounds when cruising supersonically.[2]

A day prior to the issuance of the Request for Proposals, President Kennedy appointed former World Bank director Eugene R. Black and Olin Mathieson Company chairman Stanley de J. Osborne as special financial advisors to the President on the SST.[3] Before Black and Osborne had an opportunity to complete a study of the SST Kennedy was assassinated in Dallas, Texas on November 22, 1963. Thus the special advisors presented their report to the new President, Lyndon Baines Johnson, on December 12, 1963. The SST program did not suffer under the new Administration. Being from Texas, a state with a large aerospace industry (General Dynamics and NASA, for example), President Johnson had long been an enthusiastic supporter of aviation and space

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[2] New York Times, August 17, 1963, 46. Manufacturers were then expected to bear 25 per cent of an estimated $1 billion in prototype development costs. See also Dwiggins, The SST, 131.

[3] New York Times, August 15, 1963, 58.

programs. Johnson had also chaired a cabinet-level committee formed by Kennedy in January, 1963 to coordinate SST development. As chairman, Johnson favored greater government participation in financing the SST but was not able to convince the other members of the cabinet-level committee to go along. In particular Secretary of Defense McNamara, Chairman of the President's Council of Economic Advisors Walter Heller, and Budget Bureau Director Kermit Gordon would not agree to increased government financing. Although McNamara was adamantly against spending Pentagon money for the civilian project since he did not expect the military to have any need for the SST, Johnson insisted that the high risk involved would inhibit private investment.[4] Johnson thus came to his new job with a history of interest in and support for the SST and continued that support while in office.

In his State of the Union message on January 12, 1966 President Johnson listed three roads along which he claimed his Great Society Program led: growth and justice and liberation. "First is growth--the national prosperity which supports the well-being of our people and

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[4]Rowland Evans and Robert Novak, Lyndon B. Johnson: The Exercise of Power (New York: The New American Library, 1966), 20-21. In his memoirs, The Vantage Point: Perspectives of the Presidency, 1963-1969 (New York: Holt, Rinehart and Winston, 1971), Johnson devotes a full chapter to his space program activities but does not mention his role with the SST. It is possible that the success of the space program and the demise of the SST program prompted the omission, since as Senator, Vice President, and President, Johnson played an influential role in the development of the SST.

which provides the tools of our progress." The road to liberation utilizes "our success [growth] for the fulfillment of our lives. A great nation is one which builds a great people. A great people flow not from wealth and power, but from a society which spurs them to the fullness of their genius. That alone is a Great Society."[5] Johnson viewed the SST as one of many means of achieving the Great Society as well as maintaining leadership in aircraft design and manufacture.[6]

In his Air Force Academy speech President Kennedy had limited government support for SST development to $750 million, and in his message to Congressional leaders on June 14, 1963 he proposed that manufacturers be required to supply 25 per cent of prototype development costs.[7] The Black and Osborne report presented to President Johnson on December 19 recommended government financing of 90 per cent and manufacturer financing of 10 per cent of prototype development costs rather than the 75-25 split envisioned by President Kennedy. Given the high cost of developing an SST the aviation industry was not happy about investing a quarter of a billion dollars in such a massive undertaking that was not assured of a favorable return. Black and Osborne

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[5] U. S., President, Public Papers of the Presidents of the United States, 1966 (Washington, D.C.: Government Printing Office, 1967), 4 and 6.

[6] Ibid., 260.

[7] Public Papers, 1963, 476.

were sympathetic to the industry's concerns and recommended the higher percentage of government funding, noting that even 10 per cent of a billion dollars was still a very significant sum. Even while conceding the risk involved in producing an SST Black and Osborne also recommended recovering the government's investment through some form of royalties on each airplane eventually sold, should the SST reach the production stage. The specifics recovering the government's investment were to be left to the future.[8]

In addition to their financial recommendations, Black and Osborne seriously questioned the approach that was being taken by the FAA on SST development. Arguing that it would not make sense to build a Mach 2.2 SST similar to, and certainly no more than slightly better than, the Concorde, Black and Osborne recommended following a more deliberate course that would result in a truly superior SST rather than tying the United States' effort to the Concorde.[9]

When engine and airframe manufacturers submitted design proposals in January, 1964, a Supersonic Transport Evaluation Group (STEG) was established and directed to commence evaluation of the proposals. STEG was composed of 210 members drawn from FAA, NASA, Civil Aeronautics Board, U. S. Air Force, U. S. Navy and the Department of

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[8] Newsweek, February 17, 1964, 77. See also New York Times, February 22, 1964, 1 and 9; March 12, 1964, 28.

[9] Dwiggins, The SST, 139.

Commerce. Subsequently, representatives from ten airlines also conducted their own independent evaluation. Representatives of the government and airlines teams reviewed their findings in March. The airlines group then independently issued a statement recommending further design work on "at least two different airframes and engines."[10]

While the airlines group's recommendation for further study was in part based on a conviction that further design study was necessary, it also expressed a lukewarm attitude toward the proposed airplane on the part of some of the nation's airlines. At this time the airlines had just recently recovered from their massive investment in subsonic jets. Not until 1962 had most of the American airlines managed to amortize their investments to a point where they were making a profit.[11] It is understandable that they would be reluctant to be forced to invest heavily in a supersonic transport before their subsonic jet investment was fully returned. Most airlines did not want to repeat their experience with subsonic jets in which perfectly serviceable, and in many cases nearly new, DC-7's and Constellations were made obsolete almost overnight. But not all American airlines were so hesitant about going ahead with SST development. The optimistic group was represented

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[10]"Federal Steps," 293.

[11]"Evolution of U. S. Commercial Aviation," Congressional Digest, December, 1970, 291.

by Pan Am and Trans World Airlines (TWA), both of which would be forced to compete directly with foreign SST's on long, primarily overseas, routes.[12] It would be to their distinct advantage for the United States to push ahead with a superior SST which could give them an edge in the potentially lucrative international SST trade.

At the LBJ Ranch in Texas on March 28, 1964, President Johnson noted that "substantial progress" had been made on the SST and that the government had received a number of orders. The President further observed that "we believe the technical challenge of the supersonic transport is manageable. We think the main problem lies in the financial area. We believe that Government and industry participating is the key issue and we have to work that out."[13] To help him with the impending decision on how to conduct further development, President Johnson established even another study group on April 1, 1964, the President's Advisory Committee on Supersonic Transport. The Committee was composed of the Secretary of Defense (who was also the chairman), Secretary of Commerce, NASA Administrator, and FAA Administrator. The Committee was enjoined to study and then advise the President on all

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[12]New York Times, October 15, 1963, 1. When the FAA began taking orders for delivery positions for the American SST, TWA and Pan Am placed orders for six and fifteen SST's respectively, at a cost of $100,000 per nonexistent aircraft.

[13]U. S., President, Public Papers of the Presidents of the United States, 1963-64 (Washington, D.C.: Government Printing Office, 1965), 428.

aspects of the SST program, and to "devote particular attention to the financial aspects of the program. . . ."[14] At this point the chief concerns had been financial and technical; could the airplane be economically developed, and could the technical problems of supersonic flight be readily solved? As of 1964 there was little, if any, concern with possible environmental problems associated with the SST other than the question of public acceptance of the sonic boom.

The American SST program was at a critical junction. President Johnson was faced with a choice between a crash program to overtake the Concorde (the Black and Osborne report warned that such a course was not in the best interests of the nation and probably impossible anyway), and a more deliberate program to develop a clearly superior SST. In May the President directed the FAA to award design contracts to the two engine and two airframe manufacturers deemed best in the evaluation.[15] Noting that STEG found that none of the proposals met the requirements laid down in the RFP, Johnson nevertheless remained "convinced that it will be possible to develop an American supersonic transport which will be economic to operate, will find a substantial market among the airlines of the world, and will help to maintain

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[14] U. S., President, Proclamation, "Establishing the President's Advisory Committee on Supersonic Transport," Federal Register, XXIX, April 3, 1964, 4765.

[15] New York Times, June 3, 1964, 16.

American leadership in the air."[16] By taking this course of action President Johnson acknowledged that the French and British would get the first SST on the market; but committed the United States to building a model that would be clearly superior to the Concorde.

In June, 1964, Boeing and Lockheed were awarded six-month air-frame design contracts; General Electric and Pratt & Whitnery were awarded six-month engine design contracts.[17] The loser in the airframe contest was North American, the unlucky builder of the B-70. North American's design was little more than a civilian version of the B-70 whereas the Boeing and Lockheed designs were not directly related to any military aircraft. Lockheed elected to use a design somewhat similar to the Concorde with a fixed double delta-shaped wing. Boeing's entry was more revolutionary than either the North American or the Lockheed designs. Instead of a fixed wing, Boeing opted for a variable or swing-wing which could be pivoted in flight to obtain the best lift-drag configuration for any given flight condition.[18] Thus by mid-1964 the design competition was reduced to a contest between a conventional but proven design, and a radical, revolutionary, and

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[16] Public Papers, 1963-64, 551.

[17] New York Times, June 3, 1964, 16.

[18] Ibid., January 1, 1967, 38.

largely unproven design. The Air Force's swing-wing F-111 was then under development but its first flight did not take place until December, 1964.[19]

The four manufacturers submitted design proposals to the FAA in November, 1964. Again STEG and an independent airlines group studied the proposals while the manufacturers continued design work.[20] Following review by STEG and the airlines, the President's Advisory Committee began a study of the designs in March, 1965; in July President Johnson directed the FAA to award additional 18-month design contracts.[21]

In July, 1966, a Request for Proposals for construction of two prototypes and initial flight testing was issued to the four manufacturers still involved in the design competition. In September the government evaluation team and an enlarged airlines team composed of 28 domestic and foreign airlines began independent evaluation of the proposals.[22] On December 31, 1966, the selection of Boeing and General

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[19] John W. R. Taylor, ed., Jane's All the World's Aircraft (London: Sampson Low, Marston & Co., 1972), 321. The contract to build the swing-wing fighter-bomber was awarded to General Dynamics on November 24, 1962. The first flight of the F-111 took place on December 21, 1964 with wings locked in a partially swept-back position. The second flight took place on January 6, 1965 with full sweep action accomplished.

[20] "Federal Steps," 293.

[21] New York Times, June 3, 1964, 16; "Federal Steps," 293.

[22] "Federal Steps," 293.

Electric as prime contractors for construction of the prototype airframes and engines was announced by the FAA Administrator.[23]

The Boeing design won largely on the basis of its revolutionary swing-wing concept. Because an SST would operate under a wide variety of both subsonic and supersonic flight conditions, Boeing claimed that no single wing configuration would be optimum for all situations. For example, the high lift required at take-off would be best provided by a relatively large wing protruding from the fuselage in the manner of a conventional subsonic aircraft wing. But when traveling at supersonic speeds an SST relies more on thrust than on its wings for lift, thus a sharply swept-back wing would be best for supersonic flight. Boeing therefore proposed to utilize a wing which could be pivoted in flight to provide the optimum configuration for any given flight condition. Thus the Boeing design won over Lockheed largely on the basis of an advanced technological concept. Even though Boeing's proposal necessitated development taking place on the frontiers of technological capability (only the controversial Air Force F-111 had been designed and operated with a swing-wing, and that fighter-bomber was considerably smaller than the proposed SST and therefore less of a technological challenge), design evaluators from the government and from the airlines felt that the radical Boeing design would provide more stability and

[23] New York Times, January 1, 1967, 1.

less engine noise at take-off and landing speeds. They also felt that the Boeing design would provide better operating economics should the aircraft be forced to fly subsonically on lengthy overland flights. The Lockheed fixed-wing double-delta design was necessarily a compromise between optimum configurations and it was felt that the increased power required at take-off and landing speeds to supply needed lift would result in less fuel economy as well as greater airport noise.[24]

II

By opting for a larger and faster SST than those of foreign competitors, the United States gambled on capturing the bulk of the world market even while conceding the initial market to the Concorde (and to the TU-144 if the Russians could persuade foreign airlines to purchase their aircraft). This course would possibly have been a wise one in the absence of an attempt to build a revolutionary, swing-wing SST. But by attempting such a feat, Boeing was forced to solve complex technological problems as development progressed. Unlike the Concorde and TU-144 which were built using existing technology and materials and which even at that experienced significant problems, the success of the American SST was dependent upon continued breakthroughs on the frontiers of technological and technical capability. This was precisely

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[24] Ibid., 38.

what President Kennedy's other major nation-building project required. But in making good Kennedy's pledge to land Americans on the moon by 1970 and to return them safely, the Apollo program relied on a continuous parade of technological achievements from Commander Alan Shepard's sub-orbital flight on May 5, 1961, to the historic landing on the moon by Neil Armstrong and Edwin Aldrin on July 20, 1969. The major difference was that the Apollo program enjoyed a nearly unlimited source of funds from a Congress intent on ensuring the success of the popular, prestige-laden moon landing program. The SST program never enjoyed the unlimited Congressional backing that would have enabled Boeing to successfully produce a swing-wing SST. In addition, the American SST was in a race with the foreign SST's even though the United States conceded the initial phases of the race to its opposition. If the American program were to be successful it would have to result in a superior model before the builders of the Concorde and the TU-144 had the opportunity to parlay their experience with first generation SST's into second generation craft able to compete effectively with an SST such as the proposed Boeing aircraft. Because the American SST did not enjoy unlimited support in a manner similar to the Apollo program, and because the requirements of a race demanded production of a workable SST as soon as possible, Boeing's attempt to develop a swing-wing airplane was in trouble from the time the company won the airframe design competition in December, 1966.

After two years of prototype development Boeing recommended a delay in February, 1968 in construction of its two prototypes. At that point Boeing proposed the delay in order to incorporate design "improvements."[25] The "improvements" envisioned by Boeing eventually amounted to a wholesale revision of the aircraft, from a swing-wing to a fixed-wing design. A major problem with providing the SST with a swing-wing was weight.[26] Instead of a conventional and relatively simple wing design a swing-wing required stronger structural components in the wing and in the area where the wing joined the fuselage. The necessity of a large bearing assembly at the wing's pivot point also required further strengthening of the wing structure which added even more weight to the aircraft. Thus, while the use of a swing-wing would possibly have resulted in better low speed handling characteristics it would have resulted also in a substantial increase in the weight of the SST.[27] By 1968 Boeing designers were at an impasse; a steadily

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[25]"Federal Steps," 293.

[26]Fortune, October, 1968, 129.

[27]Dwiggins, The SST, 206. Lockheed's double-delta wing design was used in its Mach III reconaissance aircraft, the SR-71. By double-delta it is meant that a smaller, long, narrow delta wing extension is placed on the fuselage forward of the main triangular, or delta, shaped wing. The double-delta has the advantage of providing extra lift at subsonic speeds. In addition, the large wing area (three times the area of a subsonic jet on Lockheed's SST) provides a "ground effect" cushion to make landings softer and easier than with the swing-wing Boeing SST. The Concorde Ogee wing, so named for the similar curve of the medieval ogive arch, is very similar to the Lockheed double-delta and the final Boeing design.