

# The Supersonic Transport: A Case History in the Politics of Technology

*Never in my experience has the "big lie" technique, popularized by Adolf Hitler's propaganda minister in World War II, been used more effectively to describe a needed program of research and development. . . .*

*It was not only amazing but downright frightening to see the number of prominent scientists who were willing to lend their names to far-fetched and hypothetical possibilities. . . .*

*The scare techniques used against the SST are similar to the ones that were used by some of the same people to oppose the A-bomb tests in Bikini in 1946, the development of an H-bomb in 1949, and even to such beneficial humanitarian projects as building a dam across the Colorado River in the Grand Canyon.<sup>1</sup>*

—Senator Barry Goldwater

In 1970 and 1971 a major national debate raged in the United States over the federally funded project to develop a commercial supersonic transport (SST)—a new aircraft which could carry passengers long distances at speeds greater than that of sound. Senator Goldwater's remarks testify to the intensity of that debate and to the great impact of scientists in it—although his assessment of the nature of their impact is surely idiosyncratic.

From 1963, when President Kennedy committed the federal government to

the SST project, until 1971, when Congress finally killed it, nearly a billion dollars were spent on SST development and design. During the course of three Presidential administrations, the project successfully survived a number of technological setbacks and adverse governmental reviews. What finally halted the SST was the growth of widespread public opposition based on a popular impression that the taxpayers' money was being wasted building an economic white elephant whose operation would constitute a serious public nuisance.

In this chapter we will trace the contributions of scientists as advisors to the government in the repeated reviews of SST development and as advisors to the nation as a whole in focusing attention on the aircraft's economic problems and potential for environmental degradation.

## *Sonic Boom, Engine Noise, and Economics*

Two of the major environmental problems associated with the SST—sonic boom and engine noise—were already generally recognized within the government by the time President Kennedy made his decision to go ahead with the project. These problems were considered in the feasibility studies which were conducted or funded by the government during 1960-1963, they were discussed publicly in Congressional hearings on the subject during the same period,<sup>2</sup> and they were taken explicitly into account in the design objectives specified for the SST in the proposal which Kennedy sent to Congress in 1963.<sup>3</sup>

Any object traveling through air faster than sound produces a supersonic shock wave, much like the bow wave of a motor boat. When this shock wave reaches the ground it is felt as a loud, explosive noise: the sonic boom. The SST's sonic boom was to be limited, according to President Kennedy's proposal, to an overpressure during acceleration of less than 2 pounds per square foot (psf) and during cruise of less than 1.5 psf. The hope was expressed that the public might tolerate booms of these intensities. A sonic boom of one psf was, according to the proposal, expected to be "acceptable" to the public. "Some scattered public reaction" was expected at 1.5 psf, and "probable public reaction—particularly at night," was expected at 2 psf. Sonic booms with intensities of 2.5 psf were likened to "close range thunder or explosion" to which the proposal, not surprisingly, expected "significant public reaction."<sup>4</sup> The acceptability of more intense booms was not even considered. (It is important to realize that the sonic boom from a supersonic aircraft is felt on the ground in a "boom carpet" tens of miles wide extending over the *entire* supersonic flight path of the plane, not just when it accelerates past the speed of sound or when it is flying below its cruise altitude.)

President Kennedy's proposal also included the design objective that the engine noise of the SST be no greater than that of "current international subsonic jet transports."<sup>5</sup> The noise of subsonic jet operations was already

disturbing populations even at considerable distances from metropolitan airports, so it was recognized that particular care would be required in the design of the powerful engines required for the SST.

The other design objectives, as Kennedy presented them to Congress, called for an aircraft weighing 350,000 pounds, with a payload of 35,000 pounds and a range of 4,000 statute miles. Its cruise speed was to be better than 2.2 times the speed of sound,<sup>6</sup> considerably faster than that of the Concorde, the SST being developed jointly by Britain and France. As a result, the aircraft surface would be heated up by friction to such high temperatures that aluminum, the standard material used in subsonic aircraft and in the Concorde, would have to be replaced by titanium, a metal both more expensive and more difficult to work. Finally, the SST was to be able to operate from existing international airports at operating costs comparable to subsonic jets.

These last requirements were essential if the SST was to compete successfully with existing airplanes. There was little doubt that the technical objectives could be met, but whether they could be met in an economically competitive aircraft was the crucial question. Even the manufacturers who were vying for the federal contract were unable to present more than a marginal case that the SST would compete successfully with large subsonic jets. In fact, the Stanford Research Institute, whose market estimates were used in President Kennedy's proposal, had come to the flat conclusion that "there is no economic justification for an SST program."<sup>7</sup>

### *The Political Decision*

The initial advocates of a federally funded SST project were the aircraft industry, the federal agencies concerned with aviation, and the U.S. Air Force. The program obtained full federal commitment as a result of a general conviction in these circles that the supersonic transport represented the next inevitable advance in commercial aviation and the fear that Soviet or Anglo-French domination of the SST market would be a terrific blow to American prestige, the U.S. balance of payments, and the competitive ability of one of the country's strongest industries.

In early June 1963 a special review committee composed of administration officials and headed by Vice-President Lyndon Johnson submitted recommendations to President Kennedy for an American supersonic airliner project. The British and the French had already three years before agreed to collaborate on developing their own SST, the Concorde, and their effort was being taken very seriously, particularly after Pan American World Airways announced that it had acquired options on six Concorde. Within a few days after receiving the review committee's report, President Kennedy announced, in a commencement speech at the Air Force Academy, his decision to proceed with the project, adding:

"The Congress and the country should be prepared to invest the funds and effort necessary to maintain this Nation's lead in long-range aircraft."<sup>8</sup> The circumstances of the announcement allowed it to serve another purpose as well: it reassured the Air Force that the technology of sustained supersonic flight by large aircraft would be developed despite the administration's recent cancellation of the B-70 supersonic bomber. (Sitting perpetually in an underground limbo next to a missile silo waiting for doomsday seemed to the Air Force a far cry from the "wild blue yonder.")

From this brief description of the origins of the United States' SST project, it is evident that the dynamics are analogous to those which have become classic in the strategic weapons race. Other nations had responded to the American dominance of the long-distance subsonic transport market by planning to develop a faster aircraft. The Americans then felt compelled to rise to this challenge by developing an even faster aircraft. The government officials involved appeared to realize that these developments were technologically premature and might well result in less economical air transportation and a substantial degradation of the human environment. But they felt that there was no way to escape the logic of international competition.

In view of the many risks and uncertainties involved in the enterprise, however, President Kennedy tried to delineate in his proposal certain decision points in the development program at which the project could be redirected or even terminated. In his message to Congress later in June 1963, he described the major dangers as follows:

1. That technological problems cannot be satisfactorily overcome,
2. that a supersonic transport will not have satisfactory economics, [or]
3. that sonic boom overpressures will result in undue public disturbance.<sup>9</sup>

In retrospect, this list appears to have been prophetic.

### *"We Are All-Out For Economics Now"*

It had been anticipated in Kennedy's proposal that the design competition phase (in which manufacturers bid for the government contract) and the detailed design phase of the SST project would be completed by 1965. In fact, the Federal Aviation Administration (FAA), which had been made responsible for overseeing the project, did not accept a final design from the Boeing Company until 1969, during the Nixon administration. Boeing's variable-geometry ("swing-wing") design had finally been chosen in 1967 over Lockheed's fixed-wing design. The FAA hoped that with this design a moderate-size SST with a tolerable sonic boom might be economically viable. But after another year of trying to perfect the design, Boeing finally admitted to the FAA that the swing-wing idea was impractical: the machinery necessary to hold and move the

wing was simply too heavy. A choice was therefore necessary among a less economical plane of the original size, a larger plane with a more intense sonic boom—or the cancellation of the project.<sup>10</sup>

The FAA opted for a large plane. The aircraft grew to have a gross design weight of 750,000 pounds—as great as that of the Boeing 747 jumbo-jet and more than twice the maximum weight which had been set as a design objective in Kennedy's original proposal. The expected average sonic boom overpressure grew correspondingly to 2 psf during cruise and 3.5 psf during acceleration—even greater than the sonic boom intensity that Kennedy's original proposal had compared to “close range thunder or explosion.” An (anonymous) administration official put the new FAA position succinctly in an interview with the *New York Times*: “We are all-out for economics now and to hell with the boom.”<sup>11</sup>

The decision on the SST engine went much the same way. A 1960 report on the SST by the National Aeronautics and Space Administration (NASA) had concluded:

It is obvious that noise considerations will have an important bearing on the choice of structure, the power plant, the aerodynamic configuration, and the operating practices. These noise problems should thus be considered early in the design stage of the airplane.<sup>12</sup>

A few years later, however, when SST designers were fighting to pare every extra pound off the aircraft design, this admonition had been forgotten. Although the engine design competition could readily have been arranged to permit a direct comparison of noise levels, environmental considerations were pushed so far into the background that noise was forgotten as a serious consideration in the selection of the SST engines.<sup>13</sup> The result was that Pratt and Whitney's relatively quiet duct-burning turbofan design was rejected in favor of General Electric's afterburning turbojet design. The General Electric engine would have given the SST a sideline noise far greater than that of any modern jet aircraft.

### *The Citizens League Against the Sonic Boom*

Even though the government had given the sonic boom problem a low priority, it proved to be difficult to ignore. In 1964 the FAA conducted a major test of public acceptance of sonic booms. In this test, the 300,000 citizens of Oklahoma City were subjected to booms averaging 1.3 psf overpressure eight times daily for five months. At the end of the test only 73 percent of the Oklahoma City residents polled felt that they could learn to tolerate booms of this intensity, even during working hours. More than 15,000 persons filed complaints, and almost 5,000 filed damage claims for broken glass and plaster which resulted in compensatory payments and awards totaling \$218,000.<sup>14</sup>

As a result of the Oklahoma City test and other data, government science

advisors were becoming increasingly skeptical of the possibility of commercial supersonic flight over populated areas.<sup>15</sup> The FAA remained persistently optimistic, however. The director of the SST project, Gen. Jewell C. Maxwell, stated in 1968: “We believe that people will come to accept the sonic boom as they have the rather unpleasant side-effects of other advances in transportation.”<sup>16</sup> And the FAA continued to base many of its economic analyses and market assessments upon the assumption that the SST would be permitted to fly supersonically over land.

In 1967 the first serious attempts were made to take the SST sonic boom issue to the public—mainly as a result of the efforts of one remarkable individual, Dr. William A. Shurcliff, a soft-spoken, white-haired Bostonian of refined and gentle appearance. During the Second World War Shurcliff had served as an administrative assistant to Vannevar Bush, Director of the Office of Scientific Research and Development, acting as the office's liaison to the Manhattan Project (which developed the atomic bomb). Later he worked at the Polaroid Corporation, and for the next ten years he assisted in the administration of the Harvard-MIT Cambridge Electron Accelerator. He has been retired since 1973.

Early in 1967, Shurcliff decided to try to organize and strengthen public opposition to the sonic boom, his interest in the issue having been aroused by an article in the *Bulletin of the Atomic Scientists* by the Swedish aeronautical expert and SST opponent Bo Lundberg.<sup>17</sup> Somewhat later, the *New York Times* published a letter expressing opposition to the SST from John T. Edsall, an eminent Harvard biologist. Shurcliff went to see Edsall and, after determining that no organized opposition to the SST existed, they founded the Citizens League Against the Sonic Boom (CLASB) in March 1967.

During the period from 1967 through 1971, Shurcliff devoted almost all of his spare time to the job of running the League. He recalls that he spent four or five hours most weekday evenings at it—and most weekends as well. At first he hired a secretary, but soon he found that it was faster for him to compose his letters and press releases at the typewriter in his home office and send them off as they came out. He had a similar experience with a rented addressing machine that he used for addressing his frequent newsletters to the membership of CLASB, which soon grew to number some 4,000. After having continual problems keeping the rented machine adjusted, Shurcliff built his own addressing machine in his attic. It is simplicity itself, its parts including assorted pieces of wood, a couple of hinges, some rubber bands, and an old rubber bicycle handlebar grip. With the assistance of his son, he can use this ingenious device to address 4,000 newsletters in four hours.

In the course of his campaign against the SST, Shurcliff distributed more than a score of press releases to some 200 newspapers. These releases received good coverage (appearing in an average of five newspapers a day in 1967 and 1968). This was no doubt partly because CLASB was the only group distributing such material at the time, but it was also because the press releases were generally accurate and well written. Shurcliff's “bang zone” maps, showing typical areas

### Background

of the United States and the Atlantic Ocean which would be subjected to regular sonic booms, were widely reproduced. Shurcliff also compiled the *SST/Sonic Boom Handbook*, which was later expanded and published as a Ballantine paperback in 1970 in collaboration with the newly formed Friends of the Earth organization. The *Handbook* is a model of informative and responsible advocacy. More than 100,000 copies were sold to the public. Shurcliff bought an additional 10,000 copies for CLASB at sixteen cents each and mailed them to Congressmen, airline officials, and whomever else he thought should be confronted with the powerful arguments against the SST.

One of the principal factors in the success of Shurcliff's fight against the SST was his considerable faith in people—as well as in the rightness of his cause. For example, Shurcliff and a few other SST opponents put together \$7,000 for two half-page advertisements in the *New York Times* attacking the SST and inviting readers to join CLASB. Among the responses was an anonymous donation of \$10,000.

Shurcliff feels that the personal touch is very important. Whenever he mailed out some special material to a member of CLASB, he made sure to write a personal note at the top of the first page in red pencil "to make sure that they don't miss it." When asked if he stopped sending mailings to CLASB members who did not contribute, Shurcliff replies emphatically: "Never!" He then explains that some "poor" members who have contributed nothing at all helped the effort in other ways by frequently writing their Congressmen or by forwarding him useful clippings from their local papers. Shurcliff's dedication and personal loyalty to the CLASB membership was well reciprocated. Once or twice a year as required he would add a note at the bottom of a newsletter: **CLASB NOW NEEDS MONEY**. Invariably the response would be on the order of \$10,000. The funds raised through CLASB provided the majority of the financial support for the effort against the American SST, and CLASB provided about one-third of the support for the anti-Concorde effort in Britain.

More than anyone else, Shurcliff deserves the credit for having made it impossible to fly SSTs over the United States.

### President Nixon Reviews the SST Program

January 15, 1969, was the final deadline for Boeing to submit a revised SST design to the FAA. The failure of the swing-wing idea and Boeing's continuing design difficulties had resulted in a delay of several years, during which substantial opposition to the sonic boom had developed. When President Nixon took office in January 1969, he therefore announced that he would reassess the SST program. He immediately commissioned two comprehensive reviews of the SST's economics and environmental impact. One of these was undertaken by the sub-cabinet-level interdepartmental ad hoc SST Review Committee and one by a

### The Supersonic Transport

panel of outside technical experts headed by a member of the President's Science Advisory Committee, Richard Garwin.

The SST Review Committee members included Undersecretary of the Interior Russell Train; Hendrik Houthakker of the Council of Economic Advisors; Lee DuBridge, Director of the Office of Science and Technology and science advisor to the President; and other officials of similar stature. The committee thus appears to have been as high-level and broadly based a working committee as one could expect to have assembled within the executive branch. It divided into working panels which considered different aspects of the issue. A month later the panels returned with reports which were highly unfavorable to the SST project.<sup>18</sup>

The Panel on Balance of Payments and International Relations concluded that the threat of foreign competition, which had originally triggered the American SST program, was not materializing:

The viability of the Concorde is very much in doubt—particularly because of landing and take-off noise, range limitations and prospective high operating cost per seat mile.<sup>19</sup>

Based on the other panel reports, the United States' SST seemed to be in similar trouble. Thus, the Economics Panel reported that there was "a large element of doubt" on the subject of the SST's ability to compete economically with subsonic jets.<sup>20</sup>

Perhaps the most important conclusions, however, were those of the panel studying the impact of the SST on the human environment, which reported that "all available information indicates that the effects of the sonic boom are such as to be considered intolerable by a very high percentage of people affected."<sup>21</sup> The same panel also concluded that

Noise levels associated with SST operations will [be such] that significant numbers of people will file complaints and resort to legal action, and that a very high percentage of the exposed population will find the noise intolerable and the apparent cause of a wide variety of adverse effects.<sup>22</sup>

The environment panel's report also mentioned the possibility that the water vapor in the SST exhaust gases might have serious effects on the upper atmosphere and weather.

Finally, the panel studying the impact of the SST program on the aerospace industry concluded that the impact was "difficult to assess, but it appears small,"<sup>23</sup> supersonic technology having already been developed for military applications.

The other comprehensive review commissioned by President Nixon resulted in a report (the "Garwin Report") which was even more unfavorable. Unlike the government officials on the SST Review Committee, this panel of technical experts capped their criticisms of the American SST program with a very explicit recommendation:

We recommend the termination of the development contracts and the withdrawal of Government support from the SST prototype program.<sup>24</sup>

On September 23, 1969, half a year after receiving these reports, President Nixon announced his decision to go ahead with the program. He gave as his primary reason the one President Kennedy had given six years before: "I want the United States to continue to lead the world in air transport."<sup>25</sup> As usual, the executive branch attempted to keep the unfavorable reports on the SST confidential. Nixon's only concession to SST critics was a statement, issued through Transportation Secretary John Volpe, that the SST would not fly at supersonic speeds over the United States.<sup>26</sup> But there were some indications that the administration continued to believe that the SST would eventually be allowed to fly domestic routes.<sup>27</sup> The government continued to equivocate on the matter until 1972 when the FAA issued a rule prohibiting commercial jets from producing sonic booms over land.

All three of the eventualities which President Kennedy had listed as grounds for termination or redirection of the SST program had come to pass: the technological problems involved in making a small, quiet, economical aircraft had not been overcome; the proposed SST did not have satisfactory economics; and its sonic booms would be intolerable to the public. Yet President Nixon gave the program his blessing. Whatever the reasons for his decision to continue to support the SST project, President Nixon's announcement effectively terminated debate on the SST within the executive branch. The focus of the national debate shifted to Congress.

### *The Battle for Congress*

The appropriations for the SST program which President Nixon had requested in 1969 were passed by Congress within a few months by lopsided votes which differed little from those of 1966 or 1967 (no additional appropriations had been requested in 1968).<sup>28</sup> The vote was essentially unaffected by the fact that the SST Review Committee documents had by then become available as a result of the strenuous efforts of Representative Henry Reuss (D.-Wisc.).<sup>29</sup> (The Garwin Report remained secret until long after the end of the SST debate.)

How can we understand the lack of impact on Congress of these documents and other adverse information? The answer seems to be that the SST project had become part of the intricate network of political arrangements by which Congressmen protect the interests of their corporate constituents. The stability of the voting pattern was enhanced by the fact that the chief Senate proponents of the SST were Senators Warren Magnuson and Henry Jackson, both Democrats of Washington—not coincidentally the home of the Boeing Company. These Senators chaired committees and subcommittees which allocate and pass upon billions of dollars of program funding and were therefore in a much better position to do favors, collect debts, or retaliate against other Senators than the much less advantageously positioned Senators who led the opposition: Senators William Proxmire (D.-Wisc.), J. William Fulbright (D.-Ark.), and Gaylord Nelson

(D.-Wisc.). After the 1967 Senate vote on the SST appropriations, Magnuson bragged to a newsman: "What'd Proxmire get? Nineteen votes? I could have had half of those if I'd needed them."<sup>30</sup>

It was only half a year after the "business as usual" 1969 vote, however, that the House of Representatives barely passed the SST appropriations by a vote of 176 to 172. Then, on December 3, 1970, the Senate voted down the appropriations by a vote of 52 to 41. The SST died officially four months later, when both Houses agreed to terminate the project. In the intervening year, a full-scale national debate had developed, making the SST program one of the major political issues of the Congressional election year 1970. An aide to Senator Magnuson later tried to explain the Senate reversal:

[Magnuson and Jackson] called upon every Senator they thought they could influence this time. They called. They cajoled. They persuaded. They arm twisted. They did everything they could. But you can't push something down the throats of the Senate. The SST became a big national issue, and it was just beyond the power of the Senators to turn around.

Vote trading and arm twisting is effective when the issue is not that big, when it isn't a glaring national issue. But it doesn't work when you've got the full focus of national attention on it. Then the pressure is on, as Senators will say, to "vote right."<sup>31</sup>

By 1969 Shurcliff, Representatives Reuss and Yates, Senator Proxmire, and others had made the opposition to the SST visible. The newspapers were eager to feature any new developments in the debate, and national political figures became involved. Senators Edmund Muskie (D.-Maine) and Charles Percy (R.-Ill.) joined the political mavericks in the Senate opposition, and New York's Governor Nelson Rockefeller vowed to keep the SST out of his state. In Washington, the lobbyists of major conservation and environmental groups worked with sympathetic Congressional aides to provide arguments with which the aides could sway their bosses and which the Congressmen could later use to explain their change of mind. And in many states environmentalists injected the SST into the 1970 Congressional campaigns. Many Senators who had previously voted for SST appropriations were boxed into a corner by their opponents and forced to make anti-SST statements to satisfy their constituents. It has been suggested that many of these Senators may have comforted themselves with the thought that their votes would not be needed by the pro-SST forces, since Proxmire's previous attempts to stop the SST had always been defeated overwhelmingly.<sup>32</sup>

### *Selling the SST to Congress*

Although many political currents and countercurrents flowed in the national debate over the SST, the Congressional hearings which were held to establish the facts of the SST's economic prospects and environmental impact were crucial. It

was in these hearings that most of the information which was carried by the news media was developed.

In these hearings, administration officials tried to present the strongest possible case for the SST; and in the process they generally overstated its advantages and understated its disadvantages. For example, the Department of Transportation, defining aircraft "productivity" as cruising speed times the number of seats, claimed that the SST would be twice as "productive" as a Boeing 747.<sup>33</sup> This comparison obviously ignored the SST's comparatively short range, negligible cargo capacity, and high fuel consumption per seat-mile compared to subsonic commercial jets, as well as the larger proportion of time each trip that the SST had to spend on the ground. (Although the SST could fly three times as fast as a conventional jet, it would take just as long to taxi, load and unload passengers, and be serviced.) The Department of Transportation also stressed the balance-of-payments advantages of exporting SSTs instead of importing Concorde, but it refused to consider other, probably equally serious balance-of-payments consequences of developing the SST.<sup>34</sup> Meanwhile, advertisements placed by the lavishly funded pro-SST lobby prematurely proclaimed the imminent entrance of the Soviet supersonic airliner into commercial service.<sup>35</sup>

In speeches and in Congressional testimony, the new FAA Administrator, John Shaffer, insisted that the SST's sonic boom is "not destructive," despite readily available evidence to the contrary—for example, the damage caused in the Oklahoma City sonic boom acceptability tests. Summing up the administration's view of the SST's environmental impact, William M. Magruder, Director of the Department of Transportation's new Office of Supersonic Transport Development, stated:

According to existing data and available evidence, there is no evidence of likelihood that SST operations would cause significant adverse effects on our atmosphere or our environment. This is the considered opinion of the scientific authorities who have counseled the government on these matters over the past five years.<sup>36</sup>

It is very difficult to see how this statement can be squared with the technical advice available to the Nixon administration—for example, that summarized in the SST Advisory Committee report.

Those officials and technical experts who had opposed the project within the administration were generally silent. In April 1970, however, Senator Proxmire wrote to the members of President Nixon's SST Advisory Committee to ask them whether they had learned anything in the intervening year to change the views which they had expressed in their report. With one exception, they replied that their views had not changed substantially.<sup>37</sup>

The exception was Lee DuBridge, the President's science advisor. In March 1969 he had written to the chairman of the SST Review Committee:

Granted that this is an exciting technological development, it still seems best to me to avoid the serious environmental and nuisance problems and the

## The Supersonic Transport

Government should not be subsidizing a device which has neither commercial attractiveness nor public acceptance.<sup>38</sup>

In April 1970 DuBridge replied to Proxmire's question:

Needless to say, the President has a broader view of the whole problem after he has studied all the facts and opinions which have been brought to his attention. Thus, while each of the several of us may have, from our own restricted points of view, recommended against further federal involvement in the SST project, I, for one, believe that the President, in taking a more comprehensive view than any of us could have, came to a sound decision. . . . The President recognizes, as we pointed out, that there are still technological and environmental problems to be solved. But he has the faith, which I now share, that the ingenuity of the American industrial system can eventually solve these problems satisfactorily.<sup>39</sup>

After assuming this undignified posture, the former president of Caltech hardly had to explain to Representative Sidney Yates (D.-Ill.): "Congressman, I am a soldier. The President has made up his mind, and I am going to support the President's decision."<sup>40</sup>

In September 1970 DuBridge was replaced as Presidential science advisor by a physicist from Bell Laboratories, Edward David, Jr. David continued DuBridge's refusal to release the Garwin Report. He also actively campaigned for the SST: in December 1970 he issued a pro-SST statement, co-signed by thirty-four prominent scientists and engineers, which contended that the Senate vote against the SST "represents the wrong approach in dealing with new technology."<sup>41</sup>

## Testimony against the SST

A serious break in administration ranks occurred when Russell Train, now Chairman of the Council on Environmental Quality, appeared before Senator Proxmire's Joint Economic Committee in May 1970, accompanied by Dr. Gordon J. F. MacDonald, a geophysicist and fellow Council member. Train emphasized in his testimony the seriousness of the SST airport noise problem and also discussed the possible impact of pollutants from the high-flying aircraft on the Earth's stratosphere. He characterized stratospheric pollution as

. . . a potential problem which has not received the attention it deserves. The supersonic transport will fly at an altitude between 60,000 and 70,000 feet. It will place into this part of the atmosphere large quantities of water, carbon dioxide, nitrogen oxides and particulate matter.

A fleet of 500 American SSTs and Concorde flying in this region of the atmosphere could, over a period of years, increase the water content by as much as 50 to 100 percent. . . . First, [this] would affect the balance of heat in the entire atmosphere leading to a warmer surface temperature. . . . Second, water vapor would react so as to destroy some fraction of the ozone that is resident in this part of the atmosphere. The practical consequences of such a destruction

could be that the shielding capacity of the atmosphere to penetrating and potentially highly dangerous ultraviolet radiation is decreased. . . . Finally, the increased water content coupled with the natural increase could lead in a few years to a sun shielding cloud cover with serious consequences on climate.

Clearly the effects of supersonics on the atmosphere are of importance to the whole world. . . . The effects should be thoroughly understood before any country proceeds with a massive introduction of supersonic transports.<sup>42</sup>

According to a Proxmire aide, Train's testimony gave the "stamp of seriousness" to concerns about the potential impact of a fleet of SSTs on the stratosphere—concerns that had previously been dismissed as far-out scare stories. The exact nature and extent of this problem remains uncertain—recent work suggests that the nitrogen oxides problem may be much more serious than it was thought to be in 1969 and the water vapor problem perhaps less important—but it seems clear that Train's final conclusion quoted above has lost none of its force.<sup>43</sup>

Train was the only important administration official who publicly gave testimony damaging to the SST project. However, another witness who appeared in opposition to the SST had been a confidential advisor to the Executive Office on the matter: Richard Garwin.

Garwin did not volunteer to testify on the SST, but was invited to appear before several Congressional committees after DuBridge, the President's science advisor, had publicly mentioned the Garwin Report. In his testimony, Garwin detailed how each time that Boeing had failed to meet the specifications of the SST contract, the FAA obligingly issued new ones specifying a considerably less desirable airplane. He summarized:

The development contract won by Boeing on the basis of the swing-wing design and requiring the prototype to be very close to the actual version, as well as to have outstanding takeoff and landing characteristics, has been successively modified to the point at which it is problematical whether the SST will fit on existing airfields, and to a point where the airport noise is far beyond the maximum acceptable for jet aircraft now.<sup>44</sup>

Perhaps Garwin's most widely quoted observation was that "at 125 PNdB of airport noise, the SST will produce as much noise as the simultaneous takeoff of 50 jumbo jets satisfying the 108 PNdB subsonic noise requirement."<sup>45</sup> Once he had thus made public his opposition to the program, Garwin wrote letters to the editors of newspapers and appeared on television; he also went in person to present the arguments to individual Congressional supporters of the SST—and was reportedly quite effective.<sup>46</sup> Garwin's testimony and the administration's increasing emphasis on the jobs which the SST program would provide deepened the suspicion held by many observers that the SST project had become, to a great extent, an expensive form of welfare for the depressed aerospace industry.

Laurence Moss, a young engineer on the staff of the National Academy of Engineering, was another technical expert who played an important role in the SST debate. Moss had become disenchanted with the SST while serving as a White House fellow assigned to the Department of Transportation. He

then participated as an individual in the effort to stop the SST project both as an organizer and as an expert witness before Congressional committees.

In early 1970, Moss advised Senator Muskie on the SST issue. When Muskie's staff was approached by a wealthy schoolteacher who wanted to make a major contribution to the anti-SST campaign, they therefore put him in contact with Moss. With this financial backing, Moss was able to bring the anti-SST groups together to organize the Coalition Against the SST.<sup>47</sup> The Coalition was very effective in organizing lobbying and in the popularization and wide distribution of statements and information which had been prepared by SST critics such as Shurcliff. One of its coups, in collaboration with two of Senator Fulbright's aides, was to persuade fifteen prominent economists, ranging in philosophy from Milton Friedman to John Kenneth Galbraith, jointly to publish statements explaining their opposition on economic grounds to the SST.<sup>48</sup> After its founding contribution, the Coalition received a substantial fraction of its funding from the Citizens League Against the Sonic Boom.

Moss excelled in translating numbers into tangible quantities. In Congressional testimony he presented the noise problem as follows:

The disturbance at 1 mile from a subsonic jet is about the equivalent of the disturbance at 15 miles from the SST. . . . In other words, the "sideline noise" implied by SST proponents to be an airport, not a community problem, will be highly objectionable at distances of over 15 miles from an airport intensively used by the SST.<sup>49</sup>

This point was reemphasized in October 1970, when the Federation of American Scientists, a Capitol Hill lobbying group dominated by prominent scientists, distributed to every Senator a set of maps which showed the Senators that all or most of the metropolitan areas of New York City, San Francisco, Seattle, Honolulu, Anchorage, Boston, and Los Angeles would be affected by the SST engine noise.

Moss also drew attention to the extravagant use of fuel by the SST:

An SST with 300 seats . . . consumes 0.33 pounds of fuel per seat-mile. This is about twice the fuel consumption per seat-mile of the Boeing 747. . . . A fleet of 500 SSTs, each flying the equivalent of three transatlantic round trips per day, will burn about 1.2 billion pounds of fuel per day. . . . This amount of fuel, by the way, is almost equal to the fuel consumed each day by all 105 million motor vehicles in the United States.<sup>50</sup>

George Eads, then a young assistant professor of economics at Princeton specializing in aircraft and airline economics, was another expert who participated effectively in the campaign against the SST. When the Transportation Department sent a map to each Congressman's office showing the amounts that his state could expect to receive in SST subcontracts, it was Eads who prepared a map for distribution by the Coalition Against the SST which showed that all but a few states would contribute more in taxes than they would receive in subcontracts. Eads also pointed out in Congressional testimony that Congress had once before been asked to fund a development project for a commercial air

transport.<sup>51</sup> This was just after World War II, when the British government-financed development of a commercial subsonic jet appeared to pose a competitive threat to the American aircraft industry. Eads did not have to remind his listeners that the British project had ultimately produced the notorious Comets, which not only were much more expensive to operate than contemporary propeller-driven aircraft, but also had the unfortunate habit of falling apart en route. (The midair explosion of the prototype Soviet SST at the 1973 Paris Air Show may presage a similar future for SSTs.)

### Summary

When the SST program was launched in 1963, the nation, in reaction to Soviet space successes and a supposed strategic missile gap, was much concerned with re-establishing the supremacy of American technology. An enormous program had been embarked upon designed to ensure that the first man on the moon would be an American. A tremendous buildup of American offensive strategic missiles was in process. Any area in which American science and technology was not the undisputed world leader was considered a potential source of threats to the national security.

Despite this technological hysteria, the SST project was not initiated blindly. Partly as a result of the SST's long gestation period, many of the economic and environmental constraints on the aircraft were clarified during the initial stages of the program. But these constraints—on aircraft size, sonic-boom intensity, engine noise, and performance characteristics—were then largely ignored when technological difficulties arose. And unanticipated data—low public tolerance of sonic boom and engine noise, possible serious impact on the stratosphere—were accepted grudgingly, if at all; SST proponents tended to regard these unforeseen problems as inevitable, imaginary, or avoidable through additional research.

By the late 1960s, the overriding concern with the national security had receded. The Vietnam War had taught its bitter lessons about governmental limitations and fallibility. It became possible to question how strongly the international position of the United States depended upon the SST project and to raise the issues of its environmental impact and economic viability. The Nixon administration thus received a fresh opportunity to conduct an assessment of the costs and benefits of the SST program and to act on what they found.

In retrospect it appears that, by the time this opportunity arose, virtually all those in the administration and in Congress with direct responsibility for reviewing the program were unwilling to contemplate seriously the possibility of its termination. An informal alliance had formed to protect the SST project, with key members being the Federal Aviation Administration, the Boeing Company, and the Senators from Washington State, Boeing's home.

Not only was the public interest excluded, but considerable efforts were

made to keep adverse information from the public and to soothe it with deceptive statements when important objections were raised by outside experts. Attempts, often largely successful, were made to suppress unfavorable reports on the program—and, when these attempts failed, to commission other studies which would criticize or "supercede" them. The public could not even depend upon the government to enforce the terms of the SST contract with Boeing.

The SST issue was ultimately "taken to the public" after governmental officials and agencies had repeatedly proven their unwillingness to act in the public interest. It is difficult not to be impressed by the effectiveness of the small number of Congressmen and scientists who dedicated a substantial part of their energies to criticizing the SST and leading the fight against it. Both "insider" and "outsider" scientists made indispensable contributions. Richard Garwin and Laurence Moss had acquired some of their expertise through service to the executive branch, a fact that helped bring attention to Garwin's views. But William Shurcliff, who was perhaps the most effective of the scientists who campaigned against the SST, informed himself about the project using only public information and fought against it entirely in his spare time.

In the public debate over the SST, the project's proponents tried to sell the *idea* of a supersonic passenger plane, emphasizing the possible dire consequences for the American aeronautics industry and the American economy if the SST were to be abandoned. Its critics, on the other hand, attacked the deficiencies of the *actual* aircraft whose construction Congress was being asked to fund and cited the possible disastrous environmental impact of the SST. This contrast—the promise of ideal technology vs. defects in actual designs—has become a common theme in debates on the exploitation of new technologies, as has the raising of the specters of foreign competition and of environmental disaster. If technological decisions are to be made responsibly, however, glib generalizations must be avoided and the proposed project evaluated on its merits. The Congressional hearings and debates on the SST provided the opportunity for such an evaluation.

Although Senator Proxmire and a small number of his fellow Congressional critics had opposed the SST since the project's inception, Congress as a whole did not seriously reconsider the SST until 1970. Indeed, until the antiballistic missile debate of 1969, Congress had never really challenged the administration on a major high-technology program. The SST issue was seriously examined by Congress only after it had become the subject of a full-scale national debate, led by environmental groups and largely informed by independent scientists. With the environment suddenly a major national issue and with the economy in poor health and the budget tight, it became increasingly difficult for Congress to accord high priority to annual contributions of hundreds of millions of dollars to the SST. Although the SST first attracted national attention because of its adverse environmental impact—noise, sonic boom, stratospheric pollution—in the end Congressional support was withdrawn mainly on priorities grounds. Expert testimony that the aircraft was technologically premature and economically marginal clinched the case against it.



The public battle over the SST was a landmark in the history of government and technology. It demonstrated that public opinion can, on occasion, play a crucial role in setting limits on what is acceptable public policy for technology. It established that the side effects of some technologies can be so serious that it may be better to leave those technologies unexploited. The SST fight also showed just how little scrutiny government programs receive from individuals who are in a position to learn the facts and are free to speak publicly. If the SST project had been subjected to serious, sustained, independent evaluation at an earlier stage, it might have been easier for the government to modify or terminate it. It seems quite possible to us that, given competent critics whose voices both the public and the government could hear, the SST program might well have been canceled sometime during the period 1964-1968. Studies that were done in 1963 had been forgotten three years later. It was during this period that it became clear how objectionable the SST's sonic booms would be to the public and how far short the SST design would fall of the initial program objectives. The fact that an administration official could state in 1966 that "we're all-out for economics now and to hell with the boom" dramatizes how insulated the government can become from social and technical realities.

## NOTES

1. This is an excerpt from a guest editorial by Senator Barry Goldwater (R-Ariz.) in the *New York Times*, December 16, 1970, p. 47. The editorial was based on a Senate speech by Goldwater [*Congressional Record* 116 (1970): 34766-69], and the speech was based in turn on a Library of Congress report "SST: Issues of Environmental Compatibility," by George N. Chatham [reprinted in the *Congressional Record* 116 (1970): 39749-58]. Chatham's report is marred by obvious bias and by a number of technical inaccuracies. Several of the "far-fetched" arguments against which Goldwater rails appear to have been invented by Chatham in a section of his report entitled "Scenarios of Doom."
2. The first hearings were held in 1960 [U.S. Congress, House, Committee on Science and Astronautics, *Supersonic Air Transports*, 86th Cong., 2nd sess., May 17-24, 1960]. They were intended chiefly to promote the SST. Nevertheless, a number of witnesses gave candid assessments of technical difficulties that the SST would face.
3. President Kennedy's message to Congress on the SST is reprinted in U.S. Congress, Senate, Committee on Appropriations, *Independent Offices Appropriations, 1964: Supersonic Transport Development Program*, 88th Cong., 1st sess., June 19, 1963, pp. 1978 ff.
4. *Ibid.*, pp. 2002, 2031.
5. *Ibid.*, p. 1994.
6. *Ibid.*
7. "Final Report: An Economic Analysis of the Supersonic Transport," Stanford Research Institute Project no. ISU-4266, p. II-1, quoted in Don Dwiggin, *The SST: Here It Comes Ready or Not*, (Garden City, N.Y.: Doubleday, 1968), p. 15. The Dwiggin book is a good general reference on the SST through 1967.
8. *Public Papers of the Presidents of the United States: John F. Kennedy 1963* (Washington, D.C.: Government Printing Office, 1964), p. 441. Reprinted in the *New York Times*, June 6, 1963, p. 25.

9. President Kennedy's SST message, Ref. 3, pp. 1982, 1987f.
10. Some good references on the confusing period of SST design competition and detailed design are Dwiggin, *The SST*; John Mecklin, "\$4 Billion Machine that Reshapes Geography," *Fortune*, February 1967, p. 113; Charles J. V. Murphy, "Boeing's Ordeal with the SST," *Fortune*, October 1968, p. 128; H. L. Nieburg, *In the Name of Science* (Chicago: Quadrangle, 1970), pp. 324-333; and William A. Shurcliff, *SST/Sonic Boom Handbook* (New York: Ballantine, 1970). An excellent survey of the entire SST history is Ian Douglas Clark, *Technical Advice and Government Action: The Use of Scientific Argument in the Ten-Year SST Controversy* (unpublished manuscript, dated June 1972, prepared in part for the Science and Public Policy Seminar at the John Fitzgerald Kennedy School of Government, Harvard University).
11. Quoted in the *New York Times*, October 31, 1966, p. 1.
12. U.S., National Aeronautics and Space Administration, *The Supersonic Transport, A Technical Summary*, NASA Technical Note no. D-423, June 1960, p. 21.
13. On neglect of noise in the engine design competition, see Michael Wollan, "Controlling the Potential Hazards of Government-Sponsored Technology," *George Washington Law Review* 36 (1968): 1125. Incidentally, it seems likely that if the SST program had been restarted in 1971, new engines would have been designed, probably of the quieter turbofan type; see *New York Times*, May 15, 1971, p. 60.
14. Shurcliff's *SST/Sonic Boom Handbook* summarizes the tests of boom acceptance and gives references; it also contains a good introduction to the causes and effects of sonic boom. The FAA's side of the story is told by John O. Powers and Kenneth Powers, *The Supersonic Transport—The Sonic Boom and You*, FAA Pamphlet, September 1968.
15. Technical advisory reports suggesting the unacceptability of SST sonic boom include one by the Office of Science and Technology, August 1967, and a three-part report by the National Academy of Sciences (NAS)-National Research Committee on SST-Sonic Boom. The former is discussed in the *New York Times*, August 8, 1967, p. 1; the latter is summarized in the *NAS News Report* 18, nos. 1, 3, and 6 (1968). Deficiencies in the NAS report are discussed in Chapter 4.
16. Quoted in Donald F. Anthrop, "Environmental Noise Pollution: A New Threat to Sanity," *Bulletin of the Atomic Scientists*, May 1969, p. 15. The contention that people accommodate themselves to the sonic boom is critically discussed in Karl D. Kryter, "Sonic Booms from Supersonic Transports," *Science* 163 (1969): 359.
17. B. K. O. Lundberg, "Supersonic Adventure," *Bulletin of the Atomic Scientists*, February 1965, pp. 29-33. Lundberg, director general (now emeritus) of the Aeronautical Research Institute of Sweden, has written and spoken extensively against the SST since 1960. (For references see, e.g., Shurcliff, *Handbook*, pp. 149-150.) It was he who developed many of the technical arguments used by Shurcliff and other SST opponents.
18. The ad hoc SST Advisory Committee report and related documents are reprinted in the *Congressional Record* 115 (1969): 32599-32613, and are partially reprinted as an appendix to Shurcliff, *Handbook*. The Garwin Report is reprinted in *Congressional Record* 117 (1971): 32126-29. In addition to these comprehensive assessments, analyses of special aspects which were more favorable to the SST were also received from the airlines [*Congressional Record* 115 (1969): 32611-13] and aeronautical experts.
19. *Congressional Record* 115 (1969): 32600.
20. *Ibid.*
21. *Ibid.*, p. 32601.
22. *Ibid.*, p. 32602.
23. *Ibid.*, p. 32603.
24. *Congressional Record* 117 (1971): 32129.
25. President Nixon's speech is reported in the *New York Times*, September 24, 1969, p. 1.
26. *Ibid.*
27. For example, President Nixon said, in a televised conversation with a group of

schoolchildren: "In 1980 you will go from Washington to Los Angeles in an hour and a half. That is how fast we'll be moving with the new planes that will be available then." (Quoted in the *New York Times*, August 26, 1970, p. 26).

28. Various Senate votes on the SST are tabulated in Harry Lenhart, Jr., "SST foes confident of votes to clip program's wings again before spring," *National Journal*, January 8, 1971, pp. 43-58. This useful article contains a detailed discussion of the 1969 Senate decision on the SST.

29. The ultimately successful efforts by congressmen and environmentalists to force the release of the ad hoc committee report and the Garwin Report are described in Chapter 4. The discussion of the ad hoc committee report before the Senate Appropriations Committee, November 1969, is notable for the Department of Transportation's strenuous attempt to rebut and denigrate it. The rebuttal appears in U.S. Congress, Senate, Committee on Appropriations, *Department of Transportation Appropriations for Fiscal Year 1970*, 91st Cong., 1st sess., pp. 663-783; see also pp. 586-587, 788.

30. Quoted in George Lardner, Jr., "Supersonic Scandal," *New Republic*, March 16, 1968, p. 17.

31. Quoted in "SST foes confident," Ref. 28, which also mentions some of the arm-twisting in question. For more, see the *New York Times*, November 30, 1970, p. 81, and December 4, 1970, p. 1.

32. "SST foes confident," p. 48.

33. This comparison appears in Department of Transportation testimony at several hearings. It was used in Chatham's report, and also by J. J. Harford, executive secretary of the American Institute of Aeronautics and Astronautics and a leading pro-SST spokesman, in a guest column in the *New York Times*, June 13, 1970, p. 30.

34. One DOT balance-of-payments estimate was a projected \$72 billion loss through 1990 if the SST were not developed; reported in the *New York Times*, August 28, 1970, p. 1. The adverse balance-of-payments effects of the U.S. SST, not taken into account in this estimate, included the increase in international air travel that the SST would need to stimulate in order to create a demand for a large enough number of SSTs to justify the industrial investment. More of these passengers would be Americans flying on foreign-owned SSTs than foreigners flying on American-owned SSTs, and these Americans would furthermore spend additional dollars abroad. On this basis, the balance-of-payments panel of President Nixon's SST Review Committee concluded that the overall balance-of-payments effect of an American SST would be negative [*Congressional Record* 115 (1969): 32599].

35. Advertisement by American Labor and Industry for the SST in the *New York Times*, March 8, 1971, p. 22.

36. U.S. Congress, Senate, Committee on Appropriations, *Department of Transportation and Related Agencies Appropriations, Fiscal Year 1971, Part 2*, August 27, 1970, p. 1336. Shaffer's statement that sonic booms are not destructive was made in a speech to an industrial group November 17, 1969, and repeated to the Senate [U.S. Congress, Senate, Committee on Appropriations, *Department of Transportation Appropriations for Fiscal Year 1970*, 91st Cong., 1st sess., November 25, 1969, p. 591].

37. Senator Proxmire's letters to the committee members and their replies are reprinted in U.S. Congress, Joint Economic Committee, *Economic Analysis and the Efficiency of Government, Part 4—Supersonic Transport Development*, 91st Cong., 2nd sess., May 1970, pp. 1017-1030. A final round of letters on the SST from various government departments in August 1970 are reprinted in U.S. Congress, Senate, Committee on Appropriations, *Department of Transportation Appropriations*, 91st Cong., 2nd sess., August 27, 1970, pp. 1291-1328. This time the letters were solicited by the White House itself, and the administration's back was to the wall as a result of the unexpectedly close House vote in May. As might be expected, these letters were SST endorsements. (See pp. 1601-1602 of these same hearings.)

38. *Congressional Record* 116 (1970): 32609.

39. *Economic Analysts* (Ref. 37), pp. 1029f.

40. Representative Yates recounted his conversation with DuBridge in U.S. Congress, House, Committee on Appropriations, *Civil Supersonic Aircraft Development (SST), Continuing Appropriations, Fiscal Year 1971*, 92nd Cong., 1st sess., March 1, 1971, p. 41.

41. Reprinted in the *Congressional Record* 116 (1970): 41594.

42. *Economic Analysis*, pp. 999f.

43. The stratospheric-contamination question was reviewed by two successive groups of scientists in MIT-organized summer workshops in 1970 (Study of Critical Environmental Problems—SCEP) and in 1971 (Study of Man's Impact on Climate—SMIC). The SCEP report was largely in agreement with Train's testimony and expressed "a feeling of genuine concern" about possible SST effects. See *Congressional Record* 116 (1970): 27382; Senate and SCEP, *Man's Impact on the Global Environment* (Cambridge: MIT Press, 1970), pp. 15-18, 64-74. The SMIC report, *Inadvertent Climate Modification* (Cambridge: MIT Press, 1971), reexamined the issue. In 1971, a University of California (Berkeley) chemist, Harold Johnston, pointed out that nitrogen oxides from the SST exhausts might have a much more destructive impact on the stratospheric ozone (*Science* 173 (1971): 517). The SMIC group does not appear to have been equipped to give this suggestion a serious review, and the matter will probably not be settled until much more sophisticated models of stratospheric dynamics are developed.

44. *Economic Analysts*, p. 913.

45. *Ibid.*, p. 909. Garwin's comparison between the SST and jumbo jet takeoff noise was unsuccessfully disputed by the Department of Transportation: the technical witnesses agreed with Garwin. See the Senate Department of Transportation Appropriation Hearings, August 1970, p. 1492. See also the *New York Times*, May 23, 1970, p. 44, and May 29, 1970, p. 28.

46. For example, according to Peter Koff, vice-president of the New England Sierra Club and assistant director of the Citizens League Against the Sonic Boom, the most influential factor in New Hampshire Senator Robert McIntyre's decision to vote against the SST was his ninety-minute conversation with Garwin.

47. John Lear discusses the history of the Coalition Against the SST in *Saturday Review*, January 3, 1971, pp. 63 ff. See also "SST foes confident" (Ref. 28). Moss's activities are reported further in *Technology Review*, January 1971, pp. 72-73.

48. The statements were inserted into the *Congressional Record* 116 (1970): 31674-31678, of September 15, 1970, by Senator Fulbright and also received good press coverage. Only Henry Wallich, of the sixteen economists contacted, did not favor termination of government support for the SST. Wallich, then chief consultant to Treasury Secretary Kennedy, said that "a strong case could be made" for banning SSTs, but that if the Concorde is viable, then the United States should proceed with the SST. However, he added: "A case can be made for postponing immediate construction of the plane in favor of continued development work. This may lose us some part of the market for the plane, but we might compensate by having a better plane later at lower cost to the government."

49. U.S. Congress, Senate, *Department of Transportation Appropriations Hearings*, August 1970, p. 1718.

50. *Ibid.*, p. 1719.

51. *Ibid.*, pp. 1736-1739.