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THE NASA HIGH-SPEED RESEARCH PROGRAM

by

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Abstract

For over 25 years NASA has been involved in research to develop a Supersonic Transport vehicle. The original research program was discontinued in the early 1970's due to inadequate technology to support such a program and public concern over the possible environmental effects from the aircraft. However, research on variable cycle engines and in atmospheric sciences continued and would eventually play roles in a new program.

About six years ago, NASA-sponsored studies conducted by Boeing and McDonnell Douglas provided forecasts for high economic growth rates in countries of the Pacific Basin by the turn of the next century. Market analyses translate the growth rates into increased demands for passenger transportation to and from this area. (fig. 1)

Since its inception, one of NASA's commitments has been to develop the technology to advance aeronautics. As such, a new High-Speed Research Program was activated to develop the technology for industry to build a High-Speed Civil Transport--a second generation SST.

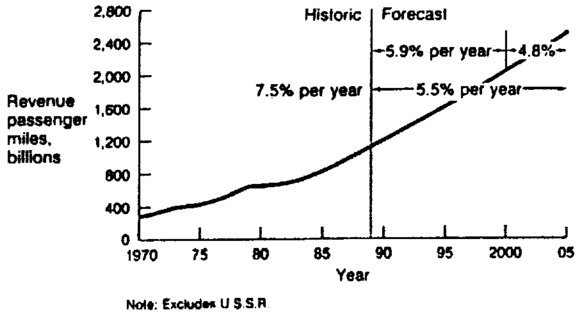
The baseline for this program is the British Concorde, a major technological achievement for its time, but an aircraft which is now both technologically and economically outdated. Therefore, a second generation SST must satisfy environmental concerns and still be economically viable. In order to do this, it must have no significant effect on the ozone layer, meet Federal Air Regulation 36, Stage 3 for community noise, and have no perceptible sonic boom over populated areas. These three concerns are the focus of the research efforts in Phase I of the program and are the specific areas covered this video report. If the results of the research show that an HSCT can built within these guidelines, Phase II will begin in earnest. The HSR program is being conducted at Langley, Lewis, Ames, and Dryden, and managed from NASA Headquarters in Washington, D. C. The design concept being used in these studies is a Boeing Mach 2.4 configuration, capable of carrying approximately 300 passengers and flying 6000nm. (fig. 2)

To date, scientists have been using both laboratory experiments and flight experiments on board an ER-2 and a DC-8 to measure atmospheric effects from NOx emissions. From NASA specifications, an independent firm is building an unmanned, remote-controlled aircraft--the Perseus--which will carry a payload of test instruments to take measurements in the upper atmosphere. Databases are being collected and maintained at Langley, where they can be accessed by the international community, which will eventually establish emissions regulations for aircraft. The emissions technology being investigated at Lewis indicates that it is possible to build an engine capable of operating supersonically well within recommended NOx guidelines. Two concepts are being tested--a Lean Premixed Pre-vaporized combustor, which mixes fuel and air upstream of the burning and allows sufficient time for the liquid fuel to vaporize completely. and a Rich Burn-Quick Quench-Lean Burn combustor, which mixes fuel with air in the first stage to reduce the NOx and completes the combustion process in the second stage. (figs. 3, 4)

To meet the FAR 36, Stage 3, researchers are involved in a multi-faceted effort to reduce source noise and yet improve aerodynamic efficiency. Different variable cycle engine candidates are being evaluated for their performance from subsonic through supersonic flight regimes, as well as their inherent noise levels. Since these engines produce a high-velocity jet exhaust flow, noise levels would be extreme; however, concepts are being studied which can entrain and mix outside air with the exhaust flow to reduce the velocity. (fig. 5) Different flap configurations are being designed and tested to improve high lift characteristics to allow the aircraft to take off and climb quickly away from the airport. Researchers at Langley and Dryden are using two F16-XL airplanes to conduct supersonic laminar flow experiments, which employ suction methods or a passive glove, in an effort to improve drag reduction. (fig. 6) Such a reduction would decrease the fuel levels and thus reduce the gross take-off weight.

As yet, researchers at Ames and Langley are unable to eliminate the sonic boom produced by an SST; however, they are testing model configurations for reshaping the N-wave and hence, the sonic boom. (fig. 7) Human-response studies in the lab, at home, and community-wide will eventually provide data for determining the acceptability criteria. In addition, flight corridors are proposed over non-populated or sparsely populated areas.

Originally, this project was conceived as a Langley-only report; however, given the scope of the HSR program, it was prudent to include research efforts at all participating centers. The change occurred about five weeks into the project, and subsequently, dictated numerous changes. Through meetings with the Langley project manager and information received from managers at the other centers, the primary areas of research were identified. Since there is interrelated research at different centers, it was necessary to travel to Dryden, Ames, Lewis, and Headquarters to conduct interviews with the specific researchers, videotape research efforts, and collect scientific visualization. Video support is being provided by both the Video Section of the Research and Information Applications Division and the Analysis and Computation Division. The technical video report will include actual soundbites from interviews with more than 30 researchers and managers, live video from wind tunnel tests, experiments--both real and simulated, illustrative graphics, comprehensive Computational Flow Dynamics, and scientific visualization. Every effort is being made to preserve the original quality of any visualization. The primary narrative will be provided by the researchers themselves. The final version will be approximately 30 minutes in length, and projected completion is November-December of 1992.



Market Forecast for World Air Travel Through the Year 2005

fig. 1

Rich-Burn Quick-Quench Lean-Burn Combustor

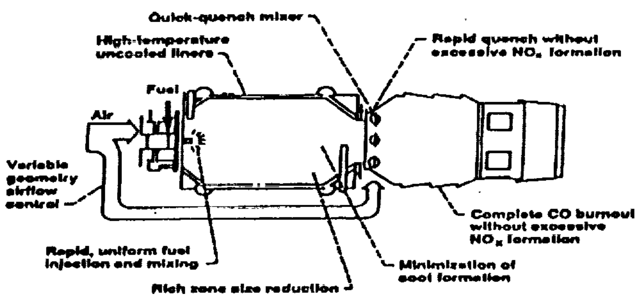


fig. 2

Lean Premixed Prevaporized Combustor

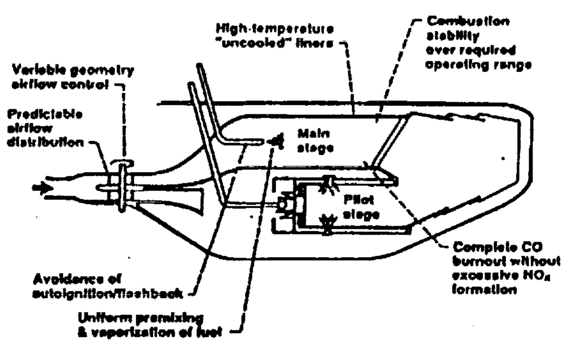
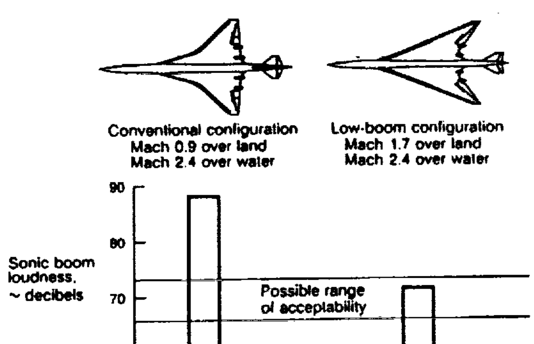


fig. 3



Design for Reduced Sonic Boom

fig. 4

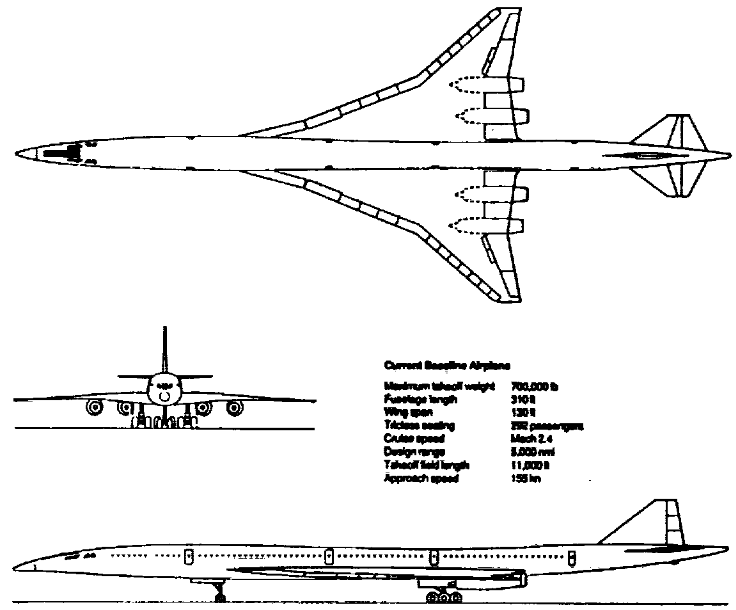
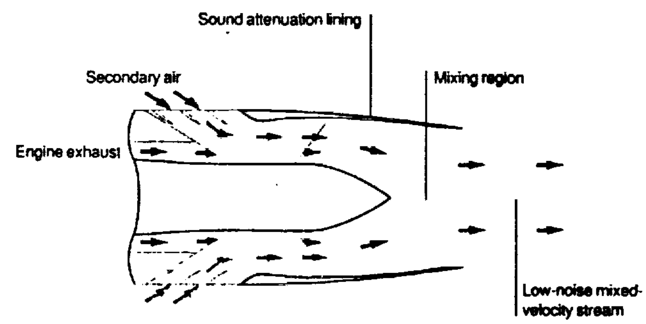
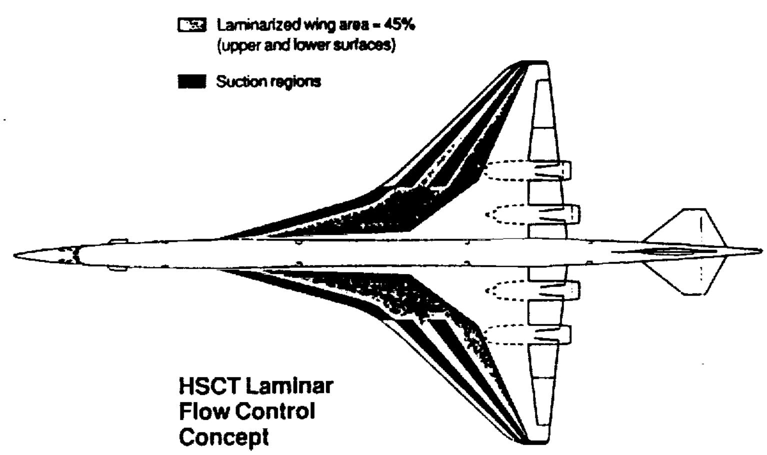


fig. 5



Internally Mixed Ejector-Suppressor Nozzle Concept

fig. 6



HSCT Laminar Flow Control Concept

fig. 7