NASA Facts

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NASA's High-Speed Research Program
The eXternal Visibility System Concept

Imagine flying a supersonic passenger jet (like the Concorde) at 1,500 mph with no front windows in the cockpit - it may one day be a reality. NASA engineers are working to develop technology that would replace the forward cockpit windows in future supersonic passenger jets with large sensor displays. These displays would use images, enhanced by computer-generated graphics, to take the place of the view out the front windows.

The envisioned eXternal Visibility System (XVS) would guide pilots to an airport, warn them of other aircraft near their flight path, and provide additional visual aides for airport approaches, landings and takeoffs.

Currently, supersonic transports like the Anglo-French Concorde droop the front of the jet (the "nose") downward to allow the pilots to see forward during takeoffs and landings. By enhancing the pilots' vision with high-resolution displays, future supersonic transport designers could eliminate the heavy and expensive, mechanically-drooped nose.

Eliminating the drooped nose could lower the overall weight of the aircraft, lowering the cost of each flight. In addition, a fixed nose design with an XVS would allow for a longer nose, reducing drag and resulting in additional fuel and weight savings. An XVS also could provide safety and performance capabilities that exceed those of unaided human vision.

A future U.S. supersonic passenger jet, as envisioned by NASA's High-Speed Research (HSR) program, would carry 300 passengers more than 5,000 nautical miles at speeds more than 1,500 miles per hour (more than twice the speed of sound). Traveling from Los Angeles to Tokyo would take only four hours, with an anticipated fare increase of only 20 percent over current ticket prices for substantially slower subsonic flights.

XVS Flight Tests

Flight and ground vehicle tests of XVS technologies are being conducted as part of the HSR Flight Deck research project. Two series of flight tests, to investigate the various aspects of the XVS concept, have already been completed. During these flight tests, pilots performed 'windowless' landings from two preliminary representations of possible XVS displays.

XVS Flight Test Series I

From November 1995 to January 1996 a NASA Boeing 737, equipped with a windowless research cockpit in the passenger cabin, and a Westinghouse BAC 1-11 avionics test aircraft, conducted approximately 20 test flights from NASA Langley Research Center and NASA's Wallops Island Flight Facility, Va.

The first series of XVS flight tests were made in two phases. During the first phase (for

sensor data collection), the NASA 737 and BAC 1-11 flew typical airport landing approaches, cruise flights, and airport holding patterns to test the suitability of the XVS sensors to detect other airplanes and ground objects. During the second phase (the 'piloting' phase), pilots flew approximately 90 approaches and landings from the NASA 737's windowless research cockpit. These flights tested the pilot's ability to control and land the aircraft relying only on sensors and computer-generated images (including various symbols) on the XVS display.

In addition to providing valuable real-time sensor data for subsequent analyses, the first XVS flight test series gave researchers confidence that a future supersonic passenger jet could indeed be flown without forward facing windows in the cockpit.

XVS Flight Test Series II

The second series of HSR XVS flight tests were flown from April to June 1997 using the NASA 737 aircraft with an XVS display in the forward cockpit.

One of the primary missions of the second series of flight tests was to determine how well an XVS display would work in an aircraft that had sidewindows in the cockpit. Researchers found that the "artificial" view from the XVS display, combined with the "real-world" view out the side window, presented no significant difficulties for the pilots.

Researchers also investigated the effects of the position of XVS sensors in relation to the pilot's eye position. The second series of flight tests included landings where sensors were mounted both to the rear and to the side of the pilot's eye position. Both sensor positions produced negligible difficulties for the pilots.

In addition to these two 'pilot-in-the-loop' experiments, data was collected for three other XVS-related experiments:

- **Ambient Lighting:** Data was gathered to determine how to control the amount of light falling on the XVS display through the cockpit's side windows.
- **Object Detection:** Data was gathered to help develop methods for detecting other aircraft or objects on the ground.
- **Object Detection via Radar:** Additional data was gathered on the use of X-band weather radar for detection of other airplanes in the air.

Ongoing XVS Research

When pilots taxi the future supersonic passenger jet they will do so sitting nearly sixty feet in front of the forward landing gear. To better understand any difficulties this distance may cause in steering the jet on the ground, engineers are testing a full-scale, ground test vehicle called the Surface Operations Research/ Evaluation Vehicle (SOREV). SOREV will help engineers determine what sort of XVS visual aids a pilot will need to get the jet safely from the runway to the gate and back to the runway.

Researchers are also continuing studies on XVS display technologies using various flight simulators at NASA Langley.

The XVS Research Team

The HSR XVS Flight Deck research team includes NASA Langley Research Center in Hampton, Va.; NASA Ames Research Center in Mountain View, Calif.; The Boeing Company in Seattle, Wash., Long Beach, Calif., and St. Louis, Mo.; and Honeywell Inc. in Phoenix, Ariz. Other companies that have supported the XVS flight tests include Rockwell Collins in Cedar Rapids, Iowa; FLIR Systems in Portland, Ore.; and Northrop-Grumman in Baltimore, Md.

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