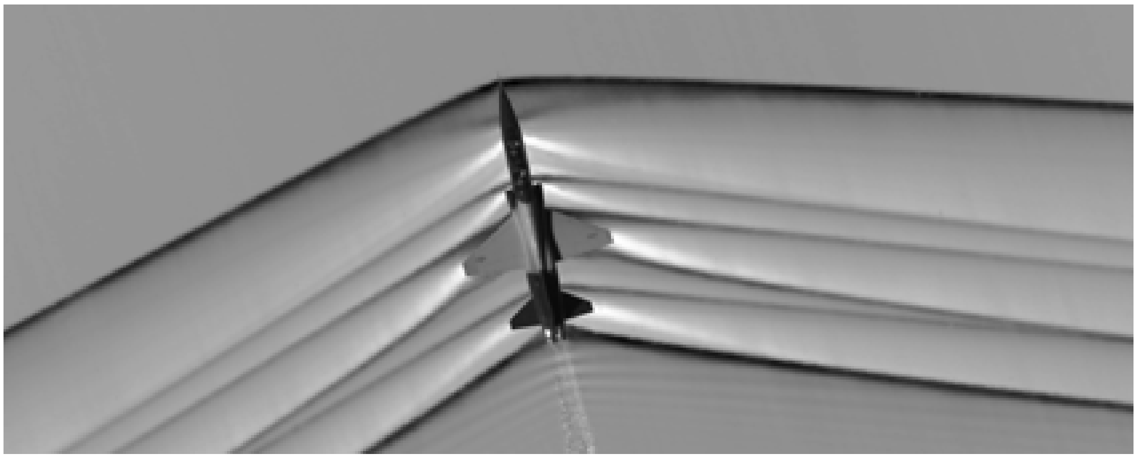
National Aeronautics and Space Administration

NASAfacts

Commercial Supersonic Technology Project



This schlieren image dramatically displays the shock wave of a supersonic jet flying over the Mojave Desert. Researchers used NASA-developed image processing software to remove the desert background, then combined and averaged multiple frames to produce a clear picture of the shock waves.

The Commercial Supersonic Technology (CST) project focuses on sonic boom reduction methods and approaches. Its primary goal is to develop and validate tools, technologies and concepts to overcome the barriers to practical supersonic commercial aircraft.

The project's scope includes design tools for vehicles with low sonic boom, and defines the necessary approaches and techniques for objectively assessing the levels of sonic boom acceptable to communities living in the vicinity of future commercial supersonic flight paths. Knowledge and data from this work will inform the efforts of both national and international regulatory organizations in the development of design standards for future supersonic commercial aircraft.

In addition, CST research lays the groundwork for overcoming other challenges facing commercial supersonic flight including energy efficiency, reduced pollutants emitted into the atmosphere, and acceptable noise levels in the airport area.

Although primarily focused on sonic boom mitigation, the CST conducts research into other barriers to commercially viable supersonic vehicles including: cruise efficiency, airport noise, emissions, aeroelastic behavior, and airspace integration. To achieve its objectives, the project is organized around research themes necessary to advance the state-of-the-art:

- Integrate design solutions for revolutionary high-speed aircraft
- Understand and measure sonic boom community response
- Minimize the airport community noise impact of high-speed aircraft
- Reduce or eliminate the impact of high-altitude emissions
- Maximize the cruise efficiency of high-speed airframes and propulsion systems
- Develop multi-discipline solutions to the impact of aeroservoelasticity on high-speed aircraft
- Develop flight systems technologies to maximize the capabilities of high-speed aircraft in the National Airspace System

Technical challenges for the 2013-2017 timeframe are drawn from the project's focus on a design for a low-sonic-boom airframe and on developing an understanding of community response to sonic booms with the intent of preparing for a potential flight demonstration of low-boom technology and acceptability. Additionally, the project will capitalize on previous success in the airport community noise research theme.

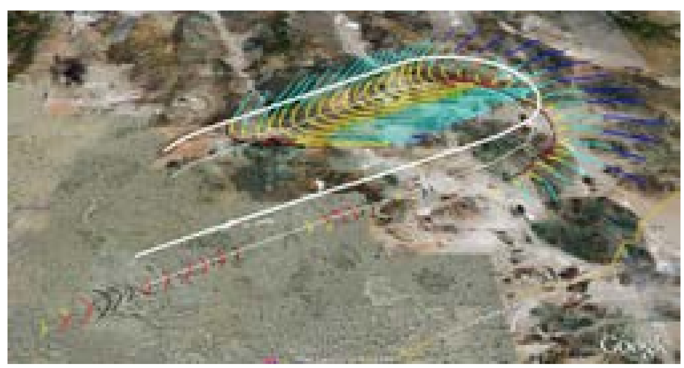
Scientists and engineers at NASA Armstrong Flight Research Center, Edwards, California, are working to understand the characteristics of sonic booms and how they might affect future designs for commercial supersonic aircraft. Past efforts included the Superboom Caustic Analysis and Measurement Project (SCAMP), Waveforms and Sonic boom Perception and Response (WSPR), and Farfield Investigation of No Boom Threshold (FaINT). SCAMP investigated focused sonic booms, which are produced when an airplane accelerates or maneuvers rapidly during supersonic flight, and create louder than normal booms. The WSPR project called upon 100 volunteers to share their impressions of booms made by a NASA F-18 flying overhead at Edwards Air Force Base. The FaINT investigation examined the phenomenon of evanescent shock wave fragments that produce a faint rumble.

Researchers have also used a technique called schlieren photography to create images of supersonic shock waves. Flow visualization is one of the fundamental tools of aeronautics research, and schlieren photography has been used for many years to visualize air density gradients caused by aerodynamic flow. This technique is usually used with a model in a wind tunnel. Capturing schlieren images of a full-scale aircraft in flight is much more challenging.

Two Armstrong projects, Air-to-air Schlieren Imaging System (ASIS) and Ground-to-Air Schlieren Photography System (GASPS), employed methods using the sun's edge as a bright light source. These produced adequate results, but only two observations of each shockwave could be made as the target aircraft crossed the left and right sides of the sun. Two other experiments used a speckled background upon which to observe shock wave patterns. Air-to-air Background Oriented Schlieren (AirBOS) involved using a high-speed camera on the underside of a NASA Beechcraft B200 King Air to capture images of a supersonic target aircraft passing underneath, using desert vegetation as a natural speckled background. A ground-based system called Background Oriented Schlieren using Celestial Objects (BOSCO) captured images of supersonic target aircraft with the sun's filtered disk providing the necessary background. Modern image processing methods proved key to revealing ever more detailed pictures, and researchers found ground-based methods to be significantly more economical than air-to-air methods.

Research has also led to development of a method to map sonic boom effects in real time. Cockpit Interactive Sonic Boom Display Avionics (CISBoomDA) is a revolutionary software system capable of displaying the location and intensity of shock waves caused by supersonic aircraft. Integrated into aircraft cockpits or ground-based control rooms, this technology could be used by pilots of future supersonic aircraft to place loud booms in specific locations, minimizing their impact in populated areas. This software application calculates an airplane's sonic boom footprint using vehicle and flight parameters and current atmospheric conditions. Processed data provides real-time information regarding location and intensity of the airplane's shock wave, enabling pilots to make the necessary flight adjustments to control the location and intensity of sonic booms. The CISBoomDA software can be used on current-generation supersonic aircraft, which generate loud sonic booms, but of greater interest are future-generation low-boom aircraft, anticipated to be quiet enough for flight over populated zones.

One of the instruments used for the WSPR project is the SNOOPI sonic boom recorder, short for Supersonic Notification of Over-pressure Instrumentation, mounted inside a commercial doghouse. SNOOPI records local sonic booms by date, time and intensity, 24-hours a day, seven days a week.



CISBoomDA software is used to integrate vehicle and environmental data with a real-time, local-area moving-map capable of displaying an aircraft's sonic boom footprint at all times and predicting effects of various maneuvers. This allows pilots to select a flight path or parameters to either avoid generating a sonic boom or to place the sonic boom in a specific location.

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