NASA Facts

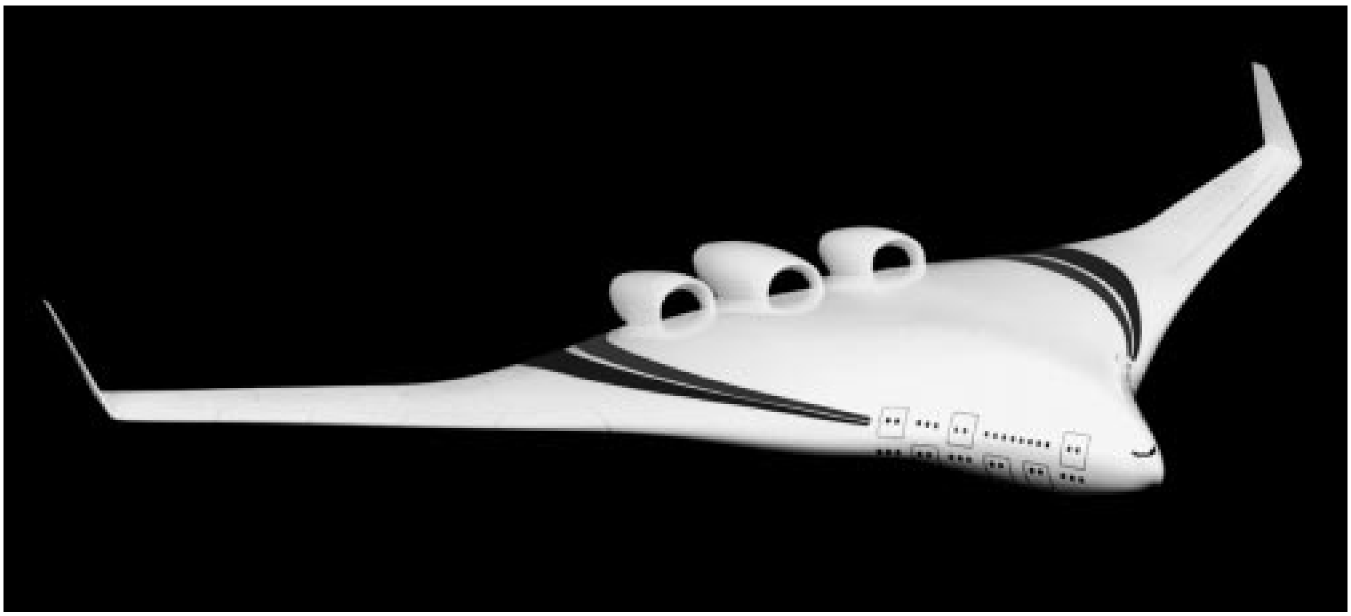
National Aeronautics and
Space Administration

Langley Research Center
Hampton, Virginia 23681-0001

FS-1997-07-24-LaRC July 1997

The Blended-Wing-Body

SUPER JUMBO JET CONCEPT WOULD CARRY 800 PASSENGERS



The Blended-Wing-Body concept may be one of the solutions to tomorrow's aviation challenges.

Air travelers of the future may step onto a double-deck jetliner that resembles a flying wing, a radical departure that researchers think may carry up to 800 passengers to the far reaches of the globe both economically and efficiently.

NASA, U.S. industry, and academia have teamed together to investigate the technologies that may make this possible. The effort is part of NASA's commitment to developing high-payoff technologies for a new generation of environmentally compatible, economical, safe, and highly productive aircraft. A broad range of new aircraft concepts are being studied as part of the Advanced Concepts for Aeronautics Program initiated by NASA Headquarters.

Team members studying the Blended-Wing-Body (BWB) concept are McDonnell Douglas, Stanford University, the University of Southern California, Clark Atlanta University, the University of Florida, and NASA Langley and Lewis Research Centers.

Radically Efficient

This revolutionary configuration, called BWB for short, was conceived by the McDonnell Douglas Corporation. Its flying-wing shape has a thick airfoil-shaped fuselage section.

The idea behind this design approach is to maximize overall efficiency by integrating the engines, wings, and the body into a single lifting surface. The BWB concept houses a wide double-deck passenger compartment that actually blends into the wing. Adjacent to the passenger section is ample room for baggage and cargo.

Preliminary analyses indicate that the BWB would outperform all conventional aircraft. It is conceived to carry 800 passengers over 7000 miles at a cruise speed of approximately 560 mph. This is almost twice the passenger capacity of the Boeing 747-400. It would reduce fuel burn and harmful emissions per passenger mile by almost a third in comparison to today's aircraft. Other potential benefits of the BWB include increased aerodynamic performance, lower operating cost and reduced community noise levels.

While the idea for "flying wing" airplanes is not new, no commercial transport of this type has ever been created. The issues of high speed aerodynamics, propulsion integration and noncircular pressurized cabins have yet to be addressed by today's aircraft designers. Many challenges exist that will involve complex solutions requiring a multidisciplinary design approach.

Flying Wing Challenges

Cabin pressurization is one of several design challenges facing the BWB. Current airliners have a cigar-shaped fuselage ideal for maintaining cabin pressurization. The BWB, however, has a unique shape that requires a novel approach to satisfy pressurization and structural needs.

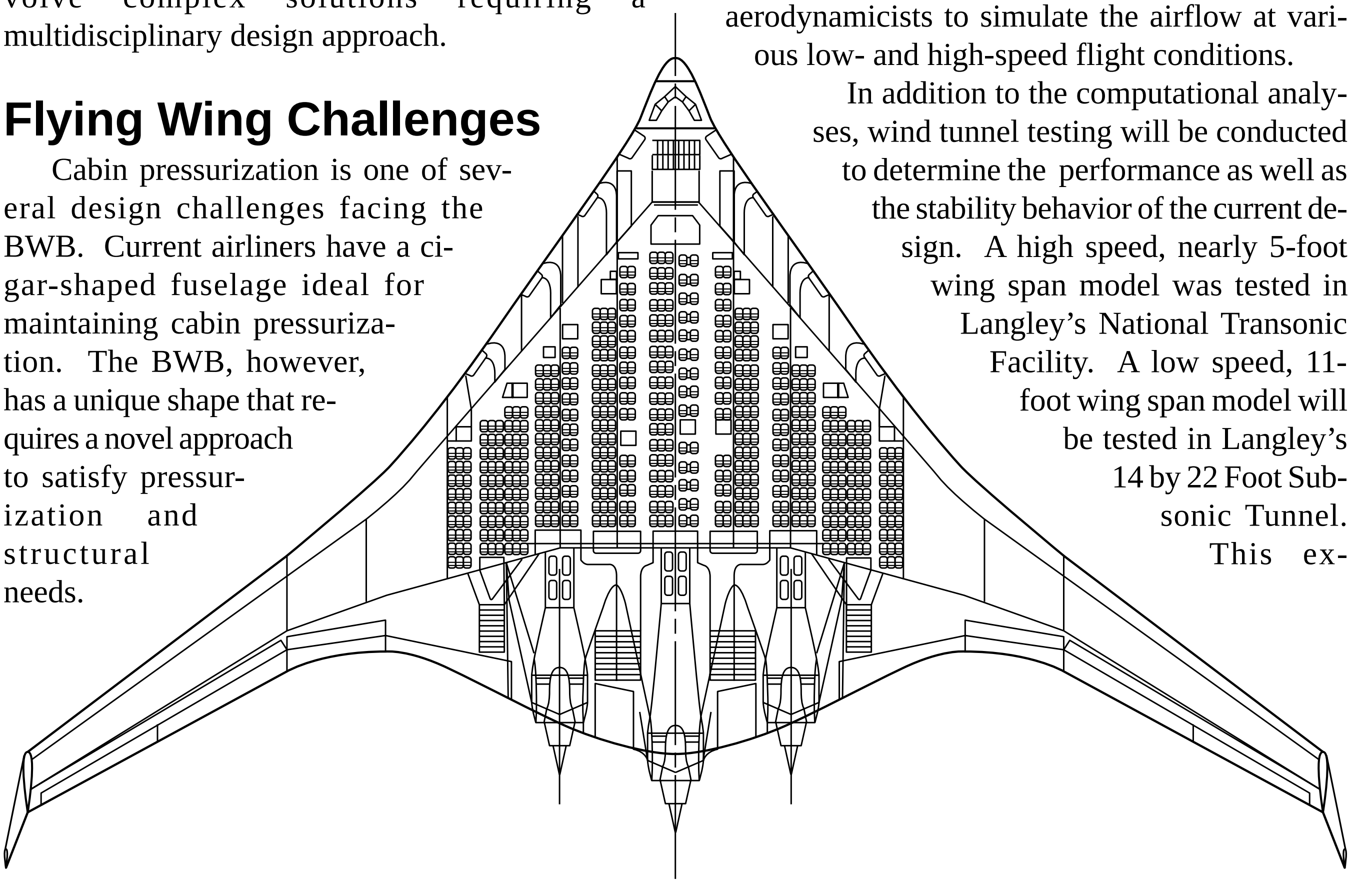
The design uses ten intermediate chord-wise (front-to-back) ribs to connect the upper and lower wing skins. These ribs separate the interior into ten passenger bays. Advanced composite material will be required to minimize the amount of structure needed to withstand the pressurization loads and deflections in the skins.

The design work is being conducted using various structural analysis methods and computer simulations. Structural tests of scaled components will be performed at NASA Langley and used to calibrate some of the analytical predictions.

Overcoming Drag

Today's aircraft fly at speeds approaching 600 mph. At these speeds, the thick wing of the BWB would experience substantial aerodynamic drag without carefully designed control of the airflow over the wing. Current transport aircraft wings are relatively thin compared to the airfoils required for the BWB and do not experience this problem as severely. Computers help in the research process by allowing aerodynamicists to simulate the airflow at various low- and high-speed flight conditions.

In addition to the computational analyses, wind tunnel testing will be conducted to determine the performance as well as the stability behavior of the current design. A high speed, nearly 5-foot wing span model was tested in Langley's National Transonic Facility. A low speed, 11-foot wing span model will be tested in Langley's 14 by 22 Foot Subsonic Tunnel. This ex-



Internal layout features double deck seating with video monitors in the back of each seat. Shown here is the 529-seat upper deck.

A technican works on the 11-foot wide BWB wind tunnel test model.

perimental testing will help researchers verify their computational work.

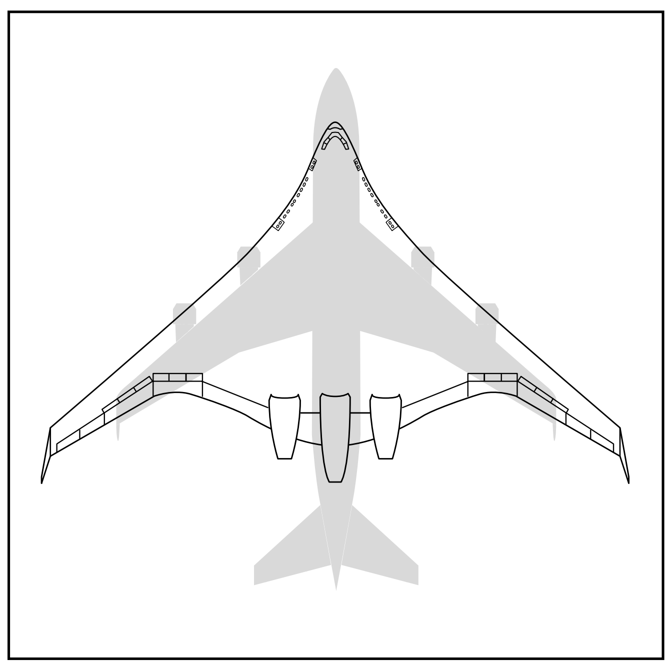
Making It Fly

Stability and control and ride quality are significant challenges to development of the BWB. Normally, all-wing configurations are difficult to stabilize without resorting to techniques that increase overall drag. The stability and control behavior of the Blended-Wing-Body resembles that of a jet fighter rather than a commercial transport. Advanced flight control systems will be required to control the aircraft at various flight conditions. This approach allows the center-of-gravity to be located further aft, which helps reduces drag for this type of design. The low-speed stability and control characteristics will be validated when a subscale demonstrator vehicle -- now under construction at Stanford University -- is flown. The demonstrator will have a 17-foot wing span and will be remotely piloted.

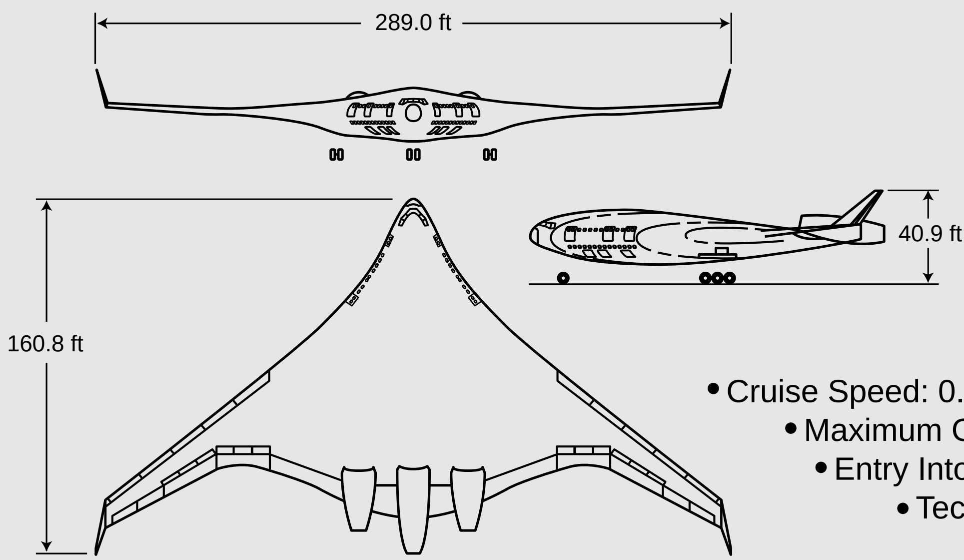
Placing the Engine

The BWB program is examining a new method for engine installation that promises to increase safety and fuel efficiency. Three advanced "high-bypass ratio" engines will be buried in the trailing edge of the center section of the BWB wing. While conventional aircraft engines only take in "free-stream air," both the air on and near the surface of the wing will flow through the BWB's curved inlets and into its engines.

Taking in the layer of air on the wing surface reduces drag. While this technology will require validation before becoming a reality, researchers are initiating tests to determine acceptable levels of turbulence in the engine inlet.



As envisioned, the BWB wingspan would be 67 feet wider than a Boeing 747-400, which would still allow use of existing runways and taxiways.



BWB

- Cruise Speed: 0.85 Mach(~560 mph)
- Maximum Gross Wt: 823,000 lb
- Entry Into Service Date: 2020
- Technology Level: 2015

Technology for the Future

This unique government, industry and university collaboration will allow innovative research to be accomplished in a timely and cost effective manner. The partners bring their respective research, design, manufacturing and analytical expertise to the challenge.

With many applications for BWB technology envisioned -- from commercial transports, to cargo aircraft, to very-long-range military airlifters -- the technology required for the BWB may be the key to realizing continued increases in aircraft size and efficiency.

Advances made in the pursuit of the Blended-Wing-Body will provide new technologies for future aircraft, helping the U.S. aircraft industry to successfully compete in the 21st century.

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