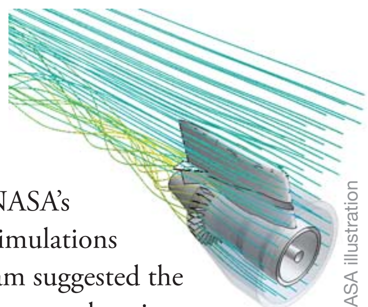
Deployable Engine Air Brake

For quiet drag management

On approach, next-generation aircraft are likely to have airframe noise levels that are comparable to or in excess of engine noise. ATA Engineering, Inc. (ATA) is developing a novel quiet engine air brake (EAB), a device that generates "equivalent drag" within the engine through stream thrust reduction by creating a swirling outflow in the turbofan exhaust nozzle. Two Phase II projects were conducted to mature this technology: (1) a concept development program (CDP) and (2) a system development program (SDP).

Concept Development Program

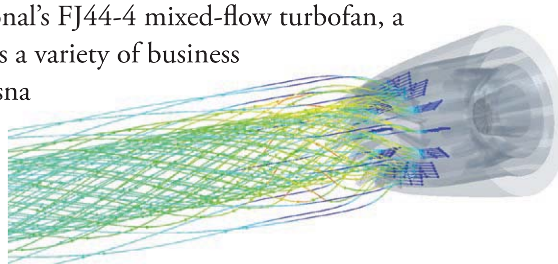


NASA illustration

The CDP used computational fluid dynamics to quantify the relationship between flow, thrust, and equivalent drag for a number of EAB geometries designed by ATA. A model-scale prototype was designed and built for experimental aeroacoustics assessment in NASA's Aeroacoustic Propulsion Laboratory. Flyover simulations using NASA's Aircraft Noise Prediction Program suggested the technology could enable, for example, a steep approach trajectory (from a baseline 3.2° glideslope to 4.4°) for a 737-800-class aircraft, resulting in a peak tone-corrected perceived noise level reduction of up to 3.1 dB.

System Demonstration Program

The system demonstration program (SDP) currently underway includes detailed design and fabrication of a mechanical EAB prototype to be used in demonstrating a system that can seamlessly switch between stowed and deployed modes while the engine outlet nozzle is charged with a high-pressure flow stream. That is, the system will include a mechanism to allow swirl-inducing vanes to be stowed within the engine structure, facilitating normal flow during cruise conditions and deployment on demand to reduce the engine's thrust while maintaining flow capacity. To demonstrate the technology on a relevant platform, the prototype is being designed to integrate with Williams International's FJ44-4 mixed-flow turbofan, a family of engines that supports a variety of business jet customers, such as the Cessna CJ4, Hawker 400XPR, and Pilatus PC-24.



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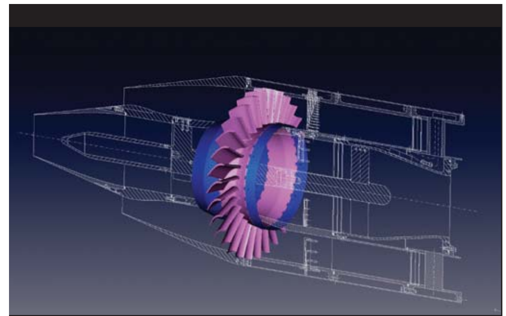

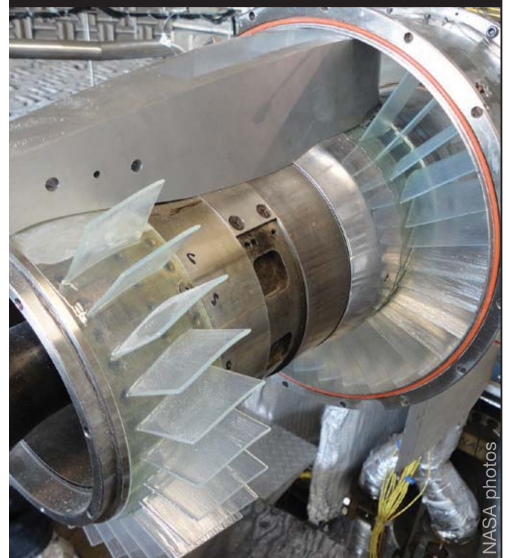

NASA photos

CDP Phase II Objectives

- Design and build a stationary model-scale EAB simulator for performance and noise testing
- Quantify relationship between swirl vane angle, equivalent drag, fan and core stream flow, and noise for a representative high bypass ratio engine
- Evaluate how the performance of an EAB is affected by deflection of the engine pylon trailing edge
- Assess system noise reduction potential via flyover simulation

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Planned On-Engine Testing

The mechanical EAB prototype will be ground tested for functional, thrust reduction, and noise performance when installed on an FJ44-4 turbofan engine. The engine's operational parameters will also be measured over a range of throttle settings with the EAB at stowed, deployed, and intermediate points to ensure adequate surge margin at all operating conditions. Acoustic measurements will quantify the noise difference between the stowed and deployed states. Stresses, temperatures, and pressures within the engine will be monitored to validate normal operation. The operational test program is slated to be performed at Williams International's Outdoor Test Facility in mid-2015.

Applications

NASA

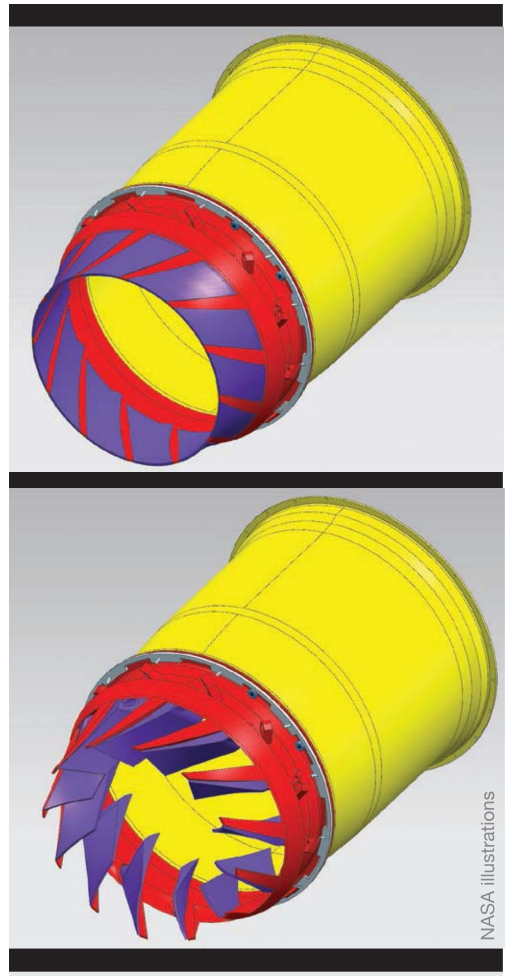
- Promote feasibility of next-generation quiet aircraft concepts:
  - Tube and wing (current generation +1)
  - Integrated airframe propulsion system configurations (current generation +2)

Commercial

- Existing aircraft:
  - Incorporate technology through retrofit (ejector) hush kits on older aircraft engines in order to meet current and future noise requirements
- Future aircraft:
  - Modify traditional engine exit guide vanes or bypass nozzles with a variable mechanism that generates a swirling outflow in drag management mode

Benefits

- Enables slower and/or steep approaches, thereby locating the noise source farther from affected communities below the flight path
- Reduces aircraft approach noise by creating "drag on demand," without the associated unsteady flow structures of devices such as flaps, slats, and undercarriage
- Can be rapidly stowed in a go-around event


NASA illustrations

SDP Phase II Objectives

- Development of a design specification for an FJ44-4 EAB
- Preliminary and detailed aero and mechanical design of a mechanical EAB prototype
- Hardware fabrication, assembly, and bench testing
- Operational testing of hardware on FJ44-4 engine

Firm Contact

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