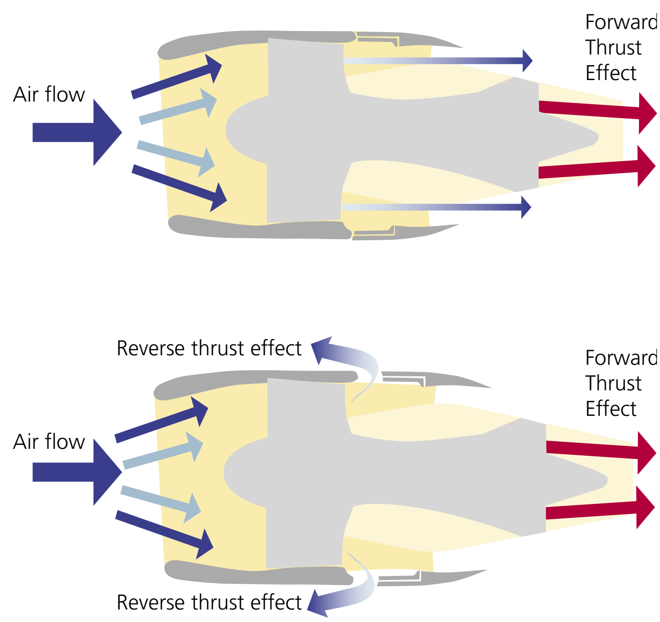
Braking at Full Speed

- Developing the ETRAS® system for the Airbus A380
- Controller developed using a dSPACE prototyping system according to safety standard DO-178B Level A
- First fully electric thrust reverser in commercial aviation

As a passenger on an airplane, if you watch the engines closely, you can observe the effect of thrust reversal as it occurs: As soon as the plane touches down, a vent opens in the engine cowl, and some of the air drawn in by the engine is ejected forward to decelerate the plane. To develop the ETRAS® system on the Airbus A380, Hispano-Suiza, a SAFRAN Group company, used a dSPACE prototyping system. ETRAS® is a fully electrical system with no hydraulic or pneumatic components – the first ever in passenger planes.

Why Reverse Thrust to Brake?

Thrust reversal in aircraft is an additional braking system that takes some of the load off the mechanical wheel brakes to shorten the braking distance. It is also helpful in rain, ice, and snow, when the wheel brakes lose some of their effectiveness. In the Airbus A380, thrust reversal is achieved by a system of flaps that open on the side of the engine when the plane lands, to deflect some of the air flow forward. The engine blades continue rotating in the same direction as during flight. At first sight, it might seem to make sense to simply change the direction of blade rotation – braking in the same way as a ship does at sea, so to speak – but this is actually no use in aircraft. It takes too long, and by the time the direction of rotation has changed, the aircraft has reached the end of the runway.

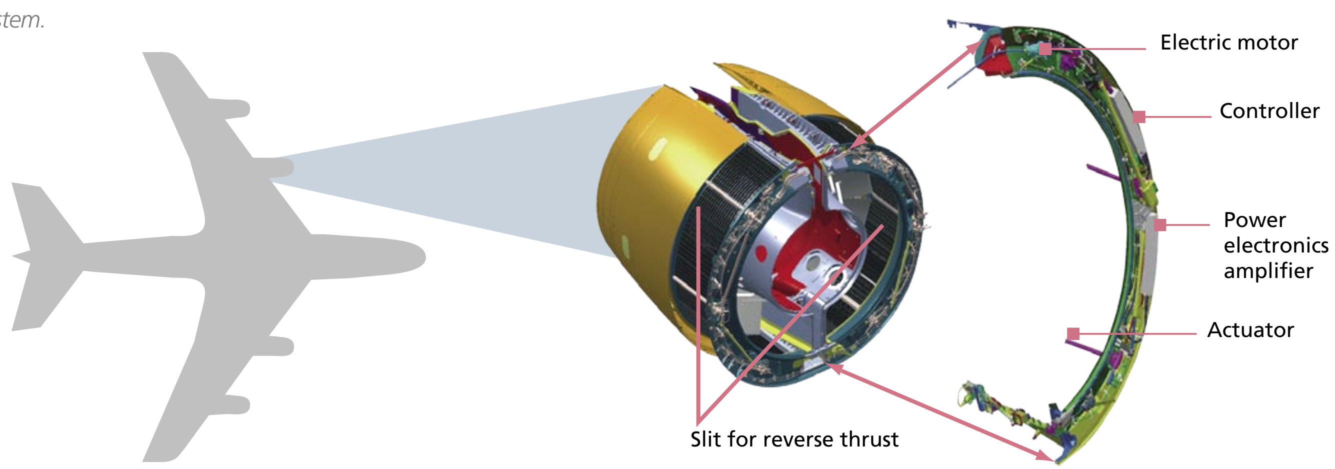


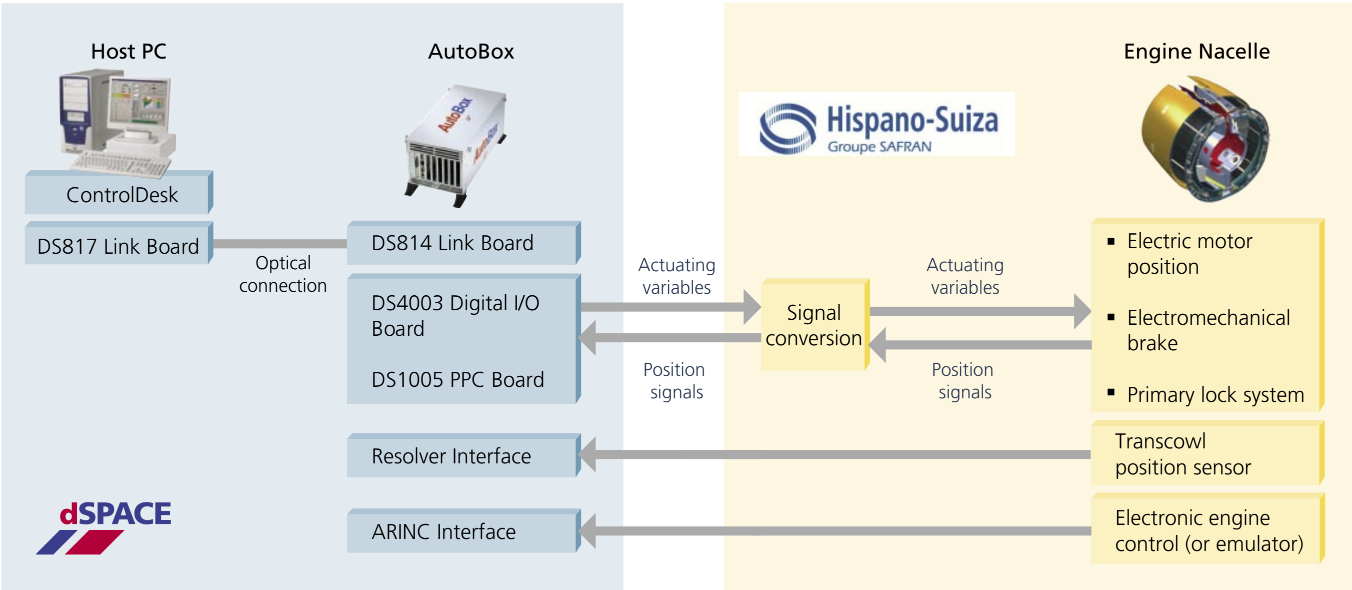
▲ *In thrust reversal (lower picture), braking is performed by a system of flaps that deflects some of the air drawn in by the engine and gives it forward thrust.*

The ETRAS® System – Fully Electric

The dSPACE prototyping system helped us to reduce the risks involved in the complete plane nacelle system for ETRAS® (Electrical Thrust Reverser Actuation System) by validating and optimizing the control algorithms (functional and safety levels). This way, we saved

▼ *The thrust reverser is one of the engine nacelle modules (outer diameter around 4 m). The control algorithms for the thrust reverser were developed via a dSPACE prototyping system.*





▲ *Schematic of the development environment with dSPACE equipment.*

a lot of time and were able to begin the final embedded software development at an early phase, and validate it according to the aviation standard DO-178B Level A.

The ETRAS® system, developed in partnership with Honeywell, is fitted on the nacelles, which were designed and produced by fellow SAFRAN Group company Aircelle for both the engines offered on Airbus A380: the Rolls Royce Trent 902 and the Engine Alliance GP7200. The thrust reverser is a safety-critical system and has to meet some important requirements:

- Thrust reversal must deploy only on the ground.
- Thrust reversal must deploy immediately when the plane touches down, at pilot request.
- The strength and direction of thrust reversal must be appropriate for the engine and the aircraft type.
- The effect of thrust reversal on the aircraft must be symmetrical, to prevent undesired cornering.

Flexible Development Environment

The dSPACE prototyping system, consisting essentially of the DS1005, I/O, interface boards, and the ControlDesk experiment software, gave us an-easy-to-use environment for developing the algorithms for thrust reversal control in the Airbus A380. The control algorithms were designed using MATLAB®/Simulink® and executed on the prototyping hardware using dSPACE's experiment interface, ControlDesk. One of the tasks of the dSPACE prototyping system was to capture sensor signals (incl. the speed and positions of various positioning motors and threaded spindles, and air flow) via I/O interfaces and a resolver interface dedicated to electric motors. This data was then used to calculate the actuating variables for the strength of thrust reversal, which controlled the actuators.

On the Way to a "More Electric Aircraft"

The ETRAS® system is the first ever mounted in a commercial plane to manage entirely without hydraulic or pneumatic components. More electrics and less hydraulics means less weight and therefore less fuel consumption. Aircraft manufacturers throughout the world will therefore continue this trend towards a "more electric aircraft" in other aircraft or engine systems in the future. With our tool landscape, based on a dSPACE prototyping system, we are optimally equipped to meet this challenge. Thanks to its modularity and flexible configurability, the system will allow us to adjust to future tasks with a minimum of effort.

> *"Because of its good flexibility and reactivity, the dSPACE prototyping system performed very well in the development of the first fully electric thrust reverser for commercial aircraft (ETRAS®)."*
> ***Nicolas Huttin***

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