

Wings

of innovation

The best of Boeing—and the best ideas—went into engineering the 747-8's advanced wing

By Bret Jensen

PHOTO: The redesigned wing on the 747-8 features fly-by-wire (electronically controlled) technology. GAIL HANUSA/BOEING

While there is no mistaking its evolution from the 747-400, the 747-8 is in many ways a fundamentally new and different airplane from its predecessor.

Improvements in the 747-8 include an advanced flight deck that incorporates some of the technologies developed for the 787, new engines developed for the 787, and one of the most advanced wings ever designed by Boeing engineers.

"People have really been giving their all for this airplane," said Elizabeth Pasztor, Commercial Airplanes chief engineer for Flight Controls. "The level of innovation and dedication ... has been amazing."

The advanced wing on which the Flight Controls Engineering team worked features fly-by-wire (electronically controlled) spoilers and outboard ailerons, which are flight control surfaces that provide aircraft roll and speed-brake control. There also are double-slotted inboard and single-slotted outboard flaps—high-lift devices located on the trailing edge of the wing—that are extended to generate additional lift at low speeds. The 224-foot (68.3-meter) wing also features distinctive raked tips. All this combines to create less noise and improve fuel efficiency.

Since the 747-8 left the drawing board, as many as 225 Flight Controls employees and additional supplier representatives have toiled long hours to make improvements so the newest member of the 747 family flies better and more efficiently.

A demanding, highly compressed schedule was required to incorporate, perfect, test and certify not only the wing but all the new designs on the 747-8.

"The Boeing team has been fantastic," said Scott Pelton, Commercial Airplanes director of Airplane Systems Engineering. "Many employees have made significant personal sacrifices working long and late hours. Through these difficult conditions, they've maintained their personal integrity toward technical excellence and safety."

The wing design meant the 747-8 would need new software programming for the flight control computer to keep the same handling and landing characteristics as the 747-400. This allows pilots who fly the 747-400 to easily make the switch to the 747-8 with minimal training. Programming also was required to add enhancements such as turbulence mitigation for a smoother ride.

"Because the new wing is fly-by-wire, we in Flight Controls have greater flexibility to make changes to the airplane electronically," said Pio Fitzgerald, lead engineer for the 747-8 Flight Control Laws engineering group. "We can command the ailerons and elevators to behave a certain way, thus making the airplane perform and feel the way we want it to."

Enhancing and improving the airplane with software programming speeds development and production. It also allows flight controls engineers to more easily and quickly correct problems.

Once flight testing began on the 747-8, for example, a small vibration was detected in the outboard portion of the wing. Although the vibration was subtle—caused by



approximately an inch of wing-tip deflection—and didn't impact airplane performance or structural life, the flight controls engineers were challenged to find a solution.

Vibration is not unusual. The very first 747 had vibration in its wing. The solution back in the late 1960s was to add structure, which also added weight. Today, these types of problems can be fixed with flight controls software adjustments, avoiding a weight gain that would affect performance of the airplane.

The effort was dubbed OAMS, or Outboard Aileron Modal Suppression. The core team that went to work on a fix consisted of Fitzgerald, John Forster, Brad Xanthopoulos and Chuong Tran.

"We thought we should be able to utilize the fly-by-wire on the ailerons on the ends of the wings to control the vibration," said autopilot engineer Forster. "We've got a more modern actuator out there attached to a new flight computer. There must be a solution using the ailerons to control it."

Added Xanthopoulos, Flight Controls engineer: "It was a unique solution. But the data showed that it was the better solution."

Tran, also a Flight Controls engineer, worked on the control law design team while on loan from the 787 program. "We saw that using the aileron was better. It became the only choice."

All involved were putting in long hours when the first upgrades to address the vibration issue went into flight computer software in the summer of 2010.

"I was amazed how many people came together in a short period of time and worked together selflessly to come up with a solution that worked," said Fitzgerald, who was recently named Commercial Airplanes Engineer of the Year for 2010. He credits his team and sees them sharing in the award.

Meanwhile, the 747-8 Freighter is nearing delivery to the first customer. Delivery of the passenger version, the Intercontinental, will follow once flight testing is completed.

Innovative engineering and programming make the 747-8 the most advanced 747 ever built. Challenges had to be overcome, but after much work it is the high-performance airplane its designers envisioned years ago. ■

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PHOTOS: (Above) The advanced flight deck of the 747-8 contains new technology, but it is similar enough to the 747-400 that pilots rated for that airplane can be rated for the 747-8 with minimal training. **BOEING**

(Below) Flight Controls engineers John Forster (from left), Pio Fitzgerald and Chuong Tran review flight-test data next to a flight control computer similar to that used on the 747-8. **ED TURNER/BOEING**

