



It's a 75-ton 'airplane' that never leaves the ground, but the new systems Integrated Test Vehicle will help the 787 to become airborne.

# Terra firma testing

By CHAS. DOWD

The fledgling 787 Integration Test Vehicle, or ITV, just beginning to spread its wings in Seattle, is the latest member of a flock of "Iron Birds" – land-based test fixtures – first hatched by Boeing in the 1960s. A 75-ton hybrid test rig made up of actual components of the flight control and hydraulic systems linked to three test benches of system software, the ITV makes sure all parts of these crucial systems work together seamlessly.

Len Inderhees, program lead for the 787 Integrated Test Vehicle, at the flight deck in Seattle. In the background is the high bay where actuation and hydraulic components are located.

Many of the new ITV features support the shortest development time in Boeing history, explains Jim Draxler, ITV Integrated Product Team leader. "The 777 Flight Control Test Rig could only run one test at a time," Draxler says. "There are three test benches in the 787 ITV, so we can run three tests simultaneously. It's the only way we could meet the 787's compressed schedule."

The schedule also made it necessary to design the tests and the ITV concurrently with the aircraft design. The goal is to keep the ITV about eight months ahead of the airplane. "Sometimes we had to guess where development was going to have the testing ready when the test article arrived," says Len Inderhees, technical lead for ITV Design and Operation. "Sometimes we guessed right. When we didn't, it meant we had to work to catch up." Inderhees also says that the kind of test being run has changed a lot. Today the majority of the testing involves software, a change from earlier iron birds that concentrated on hardware.

## New control techniques change the ITV

In the control-by-cable era, when there was a direct connection between the controls and the assemblies they controlled, the test vehicles were laid out like the aircraft. In today's fly-by-wire environment, they don't have to be. "I remember going through the 767 electro-mechanical test vehicle," Draxler says. "It was in the corner of the factory up in Everett. You had to crawl over and under structures and a lot of things were hard to access. Here everything's out where it's convenient. It has a much smaller footprint than even the 777 Flight Controls Test Rig."

The 787 ITV components were designed together by both the suppliers and Boeing and then built by the suppliers. At the same time, suppliers built a duplicate rig for their facility so problems uncovered in Everett tests could be replicated in the supplier's factory.

"The rigs were a challenge," says Inderhees. "Every company and country has its own engineering customs – their own ways of mounting test articles, making connections and safety precautions.



**Dave Roberts, lead for the ITV simulation test systems, at an ITV test conductor workstation.**

The first thing we had to do was establish a set of common interfaces so the rigs from different suppliers worked together."

ITV testing is aimed at finding any integration problems before they're built into the aircraft, giving suppliers a chance to correct them. "We're engineering correct operation into the plane from the very beginning," Inderhees says. "It's a lot cheaper than going back and fixing things during or after construction." He also points out that once it's been tested in the ITV, there's less need to test on the airplane and verify it in flight to satisfy the FAA.

## Testing the untestable

Like the wind tunnels, the ITV lets engineers test things they wouldn't dare test on an aircraft in flight. "All of our vital systems feature triple redundancy," explains Inderhees. "You don't want to go up in an airplane and disable every combination of the two layers of redundancy to make sure the third one works. We can also make sure that the second level of one system can work with the third level of another."

Inderhees pointed out that the ITV is one of the concepts that underlie the Boeing core competency in large-scale integration.



**Brian Cohen, engineer for the hydraulic, landing gear and actuation rigs, in the ITV high bay.**

"The 787 ITV represents a very different kind of integration test facility from even the one we built for the 777," he says. "The lessons we learn on this one will be applied to the next testing rig for the next generation of aircraft. It's a constant evolution." ■

## Experience meets the next generation

The Integrated Test Vehicle team is as unusual as the ITV itself. Because of the boom-and-bust cycle of the aircraft business, the 10- and 12-year engineers were gone, so the ITV was created by a team of 20- to 25-year veterans and new engineers just out of college or grad school. With the compressed schedule, the younger engineers weren't eased into the job: they were handed major responsibilities the minute they walked in the door.

"In college they taught us engineering fundamentals. We learned how to learn about engineering. But we had to learn practical applications here," explains Rowena Beaudry, an engineer of only a year who works with newcomer Brian Cohen on hydraulic systems.

"We knew we'd have to do some training," says Jim Ouderkirk, a Boeing electrical engineer for 25 years. "No college curriculum teaches how to build this kind of simulator. Plus we're really trying to reverse engineer an aircraft that hasn't been completely designed yet."

"They needed very little hand-holding and learned our processes and airplane systems very quickly," says Ron Sanders, a 20-year veteran. "They brought tremendous energy and enthusiasm, and cranked out a tremendous amount of work."

"Sometimes they made us rethink the way we did things," says John O'Brien, who has 26 years of Boeing experience. "We've written specs for drive stands before, for instance. We gave Brian some previous specs, and he expanded them, writing in things we'd missed before. And they're the computer generation. They taught us a lot about e-mail and instant messaging," he says with a grin.

Both newcomers and veterans agreed that the mix was a bonus. "We need these young people – and lots more of them," jokes Ouderkirk. "Otherwise we'll never be able to retire."