Mike Bryan (second from right), 787 project pilot, conducts a flight test in the ZA000's flight deck simulator while test engineers and analysts monitor performance. From left: Cameron Ghahreman, Tyler Finn, Matt Lassen, Christopher Caps, Bryan and Tim Cassady. When the first 787 takes flight, ZA000 will takeoff in the lab and shadow the initial flight. JIM ANDERSON/BOEING

Simulating flight

Test & Evaluation 'flies' virtual 787 Dreamliner to ensure safety, efficiency

By Sandy Angers

Consider it a dress rehearsal: ZA000, the 787 Dreamliner's virtual understudy, has already made its first flight. In fact, this virtual airplane will have "flown" about 1,000 flight test hours by the time the real 787, designated ZA001, takes to the skies for the first time.

ZA000 doesn't look like an airplane, but for all intents and purposes it behaves like one. It's essentially an airplane spread out among networked labs at the Integrated Aircraft System Laboratory in south Seattle. This setup allows the Test & Evaluation team to more quickly and efficiently validate its work integrating the 787's systems and components—and also lets them reduce risk for the airplane's forthcoming flight test program.

"We treat ZA000 like a real airplane," said Mike Bryan, 787 project pilot and the lead test pilot for ZA000. "We release it for flight like an airplane. We fly it, and flight test analysts collect data and write 'squawks' if there's an issue. We even hold a debriefing after each flight."

MANY INTERCONNECTED SYSTEMS

The virtual airplane consists of several independent 787 airplane systems labs that are interconnected to test interaction among airplane systems. Interconnected systems include electrical power, flight control electronics, avionics, electric brakes, propulsion engine controls, hydraulics, flight deck and environmental control systems, and flight control surfaces including flaps, ailerons, spoilers, elevators, stabilizers and rudder.

In addition, 787 program pilots use flight deck simulators to fly virtual missions that assess airplane performance, flying qualities and system effects. As the pilots perform simulated flight maneuvers, systems in the labs respond accordingly, depending on the test conditions.

All the systems were thoroughly bench-tested in the labs before "joining" ZA000, meaning that each was tested as a standalone system to ensure it functioned as designed. Integrating the systems and components so that they communicate and function seamlessly has been the work of Boeing Test & Evaluation and the 787 program teams for the past two years.

"We've spent years testing the 787's individual parts, but ZA000 was the first time for many of those components to 'talk' to each other. In the process, we've made some discoveries that, ordinarily, we would have had to wait and learn on the actual airplane," said Bryan.

Rachel Soderberg (left), an Airplane Systems Lab Integrated Product Team leader, discusses the flight test simulation with Ryan Younkin, ZA000 test director, in the Satellite Test Analysis Room. In the background, engineers monitor test conditions and data during a simulated flight test in ZA000. JIM ANDERSON/BOEING

FLIGHT TEST SUPPORT

Running the integrated systems through the rigors of flight test conditions allows employees to test the robustness of the 787's systems in ways that were unavailable to them before ZA000.

During actual flight tests, employees insert failures into in-flight scenarios to confirm how the airplane will perform. For example, a flight test may call for hydraulic and electrical failures or single-engine landing approaches.

ZA000 will go beyond these conditions. For example, test simulations with ZA000 will call for both engines to shut down and restart during flight. Another test will require the airplane to take off without flaps deployed and with one engine off. Although extreme test conditions such as these will not be flown on a real airplane, the systems knowledge gained from these tests is critical to support other in-flight test scenarios that will be conducted during the 787 test program.

The testing of ZA000 also has helped the team look at the entire airplane for cross-disciplinary issues before flight test. That ability enables the flight test team to ensure more predictable outcomes in actual flight test conditions.

"We're reducing risk for flight testing with ZA000," said Rachel Soderberg, an Airplane Systems Laboratory Integrated Product Team leader. "The ZA000 testing is the only time we look at some of those test conditions before we try them on the airplane. We run the test conditions here and find the problems now so we can fix them before we ever get to flight test."

ZA000 has allowed for the smooth integration of processes and teams, as well. The virtual flight tests have brought together all the people who would be involved in actual flight tests—the test pilots, test directors, flight test analysts—and allowed them to run through flight test processes.

"Working across the fence between Flight Test and the engineers who design the tests and analyze the data, we've determined that we don't always do the best job of communicating when describing flight test issues or providing data to help solve them. So we're fixing that now," said Ryan Younkin, ZA000 test director.

Executing flight test processes in a simulation mode allows Test & Evaluation employees to improve the efficiency of processes ahead of time, something that will be difficult to do once the actual flight test program begins.

"Sometimes our flight plan looks good on paper, but then we fly it in ZA000 and uncover some places where we could be more efficient," Younkin explained. "We also discovered that we needed [to involve] some other people whom we originally didn't think needed to be involved."

Process improvement isn't the only benefit derived from ZA000. Younkin said the virtual airplane also allows Test & Evaluation employees to get hands-on experience before the real 787s transfer into their hands.

"By the time the actual airplanes arrive at Flight Test, we'll be able to do the real testing safely, efficiently and with more experience under our belts," he added.

Bryan agreed: "We test in the lab to be safe. We also test here to be efficient, which means we'll be smarter. It's a lot of work, but it's an investment in accuracy, efficiency and safety." ■

sandra.l.angers@boeing.com