Testing the limits

Pilot Gary Meiser takes a 737 on a production test flight to ensure it's ready to be delivered to a customer. The Flight Operations, Test & Validation organization faces a busy 2008. Not only will it handle production test flights, but it's prepared to conduct engineering flight test activities for more than 12 airplanes covering three new or derivative models.

ED TURNER PHOTO

Inside

Boeing's new Test Operations Center is preparing to handle this year's unprecedented work statement

By Sandy Angers

When the 787 Dreamliner takes to the skies this year for the first time, the airplane won't be the only thing being tested.

The revolutionary jetliner's first flight will mark the debut of the new Test Operations Center, which will help Boeing manage flight testing more efficiently. An unprecedented schedule of upcoming new and derivative airplanes has compelled the Flight Operations, Test & Validation organization to dramatically transform the way it manages test airplanes and other assets during this final phase of bringing a new airplane model to market.

For the first time in the company's history, more than 12 new and derivative airplane models will be in engineering flight test this year. The challenge is not just about the number of airplanes in the test fleet, but the number of different test programs. In addition to six 787s, two 777 Freighters, one 767-200 Special Freighter and one 767-300 Boeing Converted Freighter, FOT&V will test carbon brakes and an improved Quiet Climb system on two 737-900ERs.

Additionally, the organization will support Integrated Defense Systems on several military aircraft including the Airborne Laser, TS-3 (a 707 AWACS), the Peace Eagle 737 Airborne Early Warning & Control aircraft for the Turkish Air Force, the P-8A Poseidon and the KC-767 Tanker. And in the case of the 787, Boeing will complete testing in six-and-a-half months, about half the time it took to flight-test the 777.

All this work is in addition to FOT&V conducting production test flights. The team flies jetliners that come off the production line, to ensure the airplanes are ready to be delivered to customers (see story on Page 26).

"These are challenging times for us," said Joe Kranak, director of Test Programs Integration. "We've got the greatest number of airplanes in test inventory, a shorter time period in which to complete the tests and the challenge of working with global partners across multiple time zones to solve flight-test problems."

To meet these challenges, FOT&V will conduct engineering flight test activities on a 24/7 schedule. Seven days a week, test airplanes will fly during daylight. Ground tests will take place during second shift, and maintenance and preparation for the next day's testing will be conducted during third shift.

But around-the-clock operations won't be enough to ensure airplanes fly when they are scheduled.

"The key to having a six-and-a-half-month flight-test program is on-time release of airplanes for testing. Our track record for on-time release is 50 percent. That is going to change with the new Test Operations Center," said Dennis O'Donoghue, vice president of FOT&V.

THE BIG PICTURE

The Test Operations Center is a centralized control center for all test activity. It's a one-stop shop to monitor the test fleet and provide a greater degree of coordination and communication and ensure test airplanes release or take off when they are scheduled.

In the past, teams were assigned to flight-test airplanes, and each team operated independently of others. If a significant issue came up on airplane No. 1, the team's test director would coordinate with the test director of the second airplane to swap schedules or equipment or whatever the issue required.

"The ability to interact between airplanes was a lot easier back then. Informal exchanges of information and agreements were easily made among two or three airplanes," said Janet Mueller, Test Operations Center project manager.

But that business model can't handle a 12-plus airplane fleet. "To achieve the efficiencies we need to achieve, we have to take a different perspective on how we operate. We developed a flight-test operation that scales up and down fairly easily to accommodate any number of airplanes in a test fleet," O'Donoghue said.

The new operations center provides a fleetwide perspective. It looks at all test airplanes, making sure they are ready for test, looking for conflicts that might occur and resolving those issues quickly or even before they materialize.

That perspective also will help preposition requirements including parts, plans, tools, pilots, mechanics and engineers—something that wasn't done previously. Similarly to the way parts and equipment are staged at the point of use in Boeing factories, FOT&V employees will ensure everything needed to do a job is available and ready.

Also key to efficient test operations is having help available whenever it is needed, day or night. Although most flight-test operations are based at Boeing Field in Seattle, flight-testing of new and derivative models can occur literally anywhere in the world. During those times when an airplane is halfway around the world and it's nighttime in Seattle, remote test crews need access to answers.

Under the old system, if there was a problem that required engineering support from Seattle, remote flight crews would have to wait until Seattle engineers arrived to work the next morning. Now they know someone will pick up the phone when the call for help is made.

By the same token, when issues arise that require help from suppliers halfway around the world, employees can work across multiple time zones to resolve problems.

NEW ROLES

The Test Operations Center concept sounds simple, but it's required months of redefining processes and job roles—and even the gutting of an entire floor at the Flight Test Center. The transformation began in 2007 as cross-functional teams used two new tools—value network analysis and systems dynamic modeling—to revamp processes and put into place new interorganizational agreements (see sidebar on Page 24).

The result is a 32,000-square-foot operations center, including a 2,000-square-foot

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The making of a transformation

Flight Test employees use Lean+ processes to redesign operations

When Flight Operations, Test & Validation teammates decided to transform the way it manages engineering flight test airplanes, the first question they asked was: How do we go from where we are now to where we want to be?

In the past, FOT&V operated within a structure where airplane test teams functioned independently of others. What they wanted was a new Test Operations System with a Test Operations Center at its core that housed a team of test-savvy professionals working 24/7 to provide fleetwide perspective on planning, operations and support.

The ability to transform an organization to meet changing conditions is a challenge, especially when that organization has a complex structure that includes complicated systems and numerous variables.

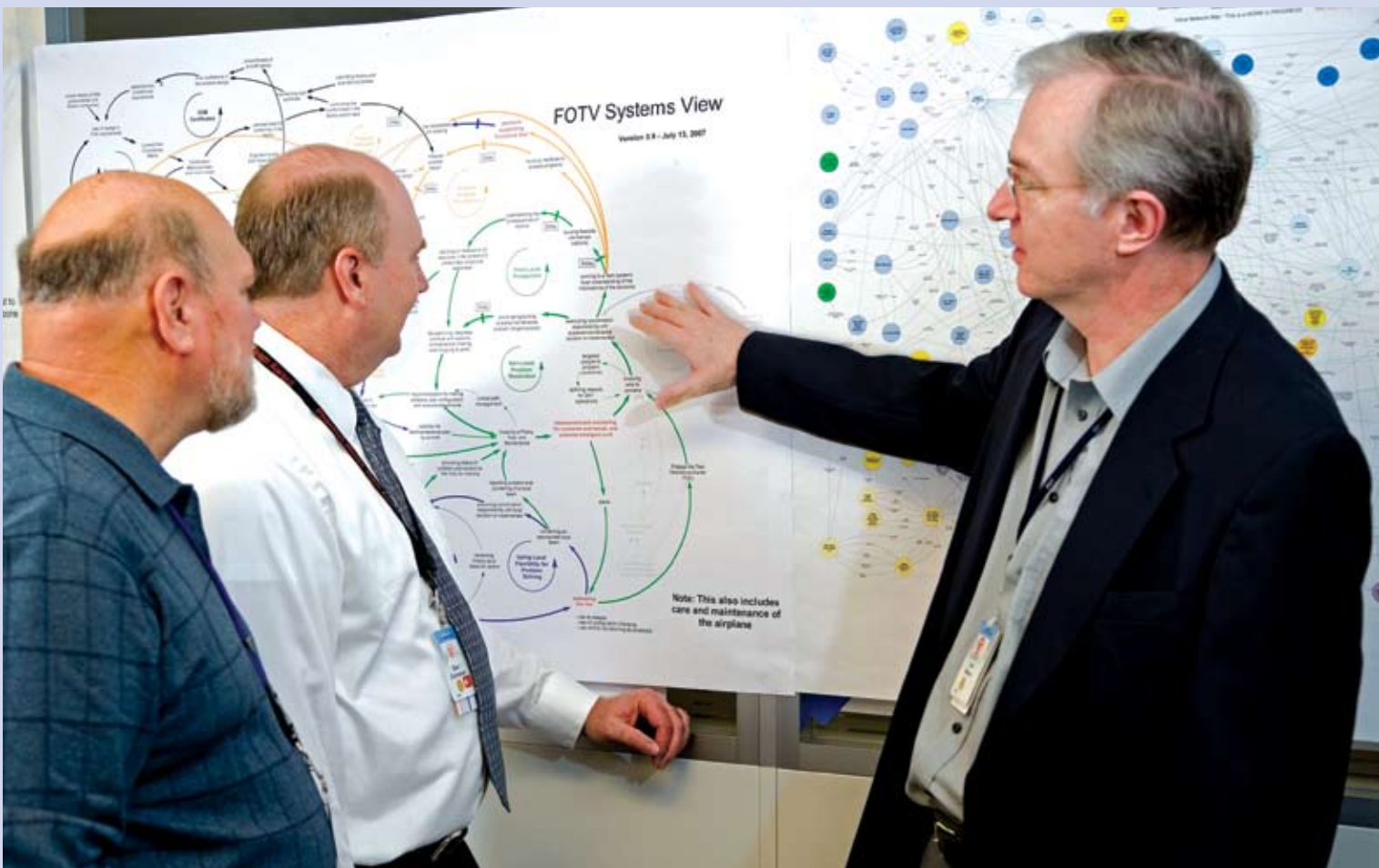
In order to take the steps necessary to create a new Test Operations System, FOT&V created an Integrated Roadmap.

"We were designing a new way of doing business, and once we understood our guiding concepts and role network, we applied Lean+ tools to define the business," said Les Music, Business Process analyst.

The Integrated Roadmap served as an overarching guide for employees while they designed a new business model and identified design components they would need in that new model.

With the road map in hand, the group turned to Boeing experts in the field of Systems Dynamic Modeling. SDM allows an organization to view influences and interactions between people and groups over time from a systemwide perspective, rather than as isolated parts.

What evolved was the Systems Dynamic Modeling chart—or, as it's more affectionately known, the "swirly chart." The model allowed FOT&V to develop a new business model concept and see how the business would work in an ideal environment.



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Business Process Analyst Les Music (right) discusses the Systems Dynamic Modeling chart—affectionately known as the "swirly chart"—with Dan Compton (center) and Bob Wiebe, senior operations analysts and SDM experts.

"Systems Dynamic Modeling provided a good context for seeing how we wanted work to flow into the organization and how we would plan and accomplish the work," said Music.

The team could also see other elements—for instance, how local problem-solving would work with a test crew. And if the problem could not be solved at the local level and there was no return to plan, SDM captured the plan of escalation for the Test Operations Center and whom they might engage to find a solution.

Next, FOT&V needed to know the network of roles and exchanges the TOC would need to be successful, and that led the group to use Value Network Analysis. VNA is a methodology that helps people visualize business activities and sets of relationships from a dynamic whole-systems perspective. The result of this visualization is a map FOT&V employees refer to as the "bubble chart."

The VNA map captured the network of interactions in the test cycle from minor local adjustments to fleet-level perspective, and showed the many TOC interactions—not just within Flight Test, but with Airplane Programs, the FAA and other regulatory agencies.

In addition, a decision was made to refer to job roles rather than job titles. "Concentrating on job roles allowed us to recognize the complexity of the business in a compact form and look at all important interactions," said Music. "Once people got used to talking about things in terms of roles, then we really started thinking about what might be possible in the future."

By doing so, they found everyone's job includes many different roles. That helped FOT&V focus on critical roles and how they interact with each other. They also discovered there were roles that were not previously acknowledged and that needed to be made more efficient. Lastly, the group identified roles and exchanges that are activated all the time, as well as roles and exchanges that were specialty interactions.

By using SDM and VNA, the Flight Operations, Test & Validation group restructured its entire business model and is now on its way to taking the new organization for a test flight of its own in the new Test Operations Center.

—Kamara Sams

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Test Operations System Development team members develop, document and simulate new business processes in the Test Operations Center control room. Clockwise from the front right are Dennis Rainey, Terrance Boyle, Bob Kalan, Cindy Phillips, Bob Risi, Bill Woche, Dan Hrehov and Janet Mueller.

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control room (2,970 square meters and 186 square meters, respectively), with a 6-foot-by-16-foot screen (1.82 meters by 4.88 meters) showing real-time status of the test fleet.

The TOC is also staffed with engineers, mechanics and other technical experts, each focused on keeping test activities on schedule. These new roles include

- The Controller. As the first point of contact in the TOC, this person handles phone calls, radio calls from the test aircraft, or walk-in requests for help or status information. This information is logged, processed and moved to the appropriate TOC role to be worked on.
- Service Request Owner. This person works to resolve problems that have been submitted to the TOC. Employees from Flight Test Engineering and Maintenance are represented. When called upon, they'll serve as the focals for ensuring solutions are found quickly, allowing the person who called in the problem to continue to perform his or her scheduled work.
- Fleet Optimizer. This teammate provides oversight to ensure that decisions are made with a fleet perspective. When there has to be a change, the Fleet Optimizer looks at the overall plan and makes sure decisions made for one airplane don't hamper the test plan for other airplanes.
- Fleet Readiness Focal. This person looks across the fleet and ensures all test resources are in place at the appropriate time for the next test.
- Fleet Operations Manager. This person provides general oversight, ensuring execution of the daily test operations. The manager also is the final authority in resolving resource allocation conflicts or last-minute timeline changes.
- Data Visualizer. This role gathers data from multiple sources to track performance to plan.

SHALL WE DANCE?

"Flight testing is going to be a finely choreographed dance," said Mueller. "It will require discipline to follow the test schedule, and from that standpoint it'll enable some high fly rates."

But the Test Operations Center can't get it done alone. According to O'Donoghue, suppliers and employees in FOT&V and the airplane programs need to help, and it will require some degree of tough love.

That includes walking away from an airplane that does not meet all the necessary requirements to conduct testing. It's a stance that O'Donoghue believes is necessary to meet the challenges of flight-testing multiple airplane models.

"It's all about process discipline. Many times we go around the process because we think we're doing the right thing for Boeing, totally unaware that we have suboptimized the entire flow," said O'Donoghue. "Years from now, people will look back and see the new TOC as a part of the 787's game-changing legacy. Our part is to get the airplane in the air and validated for certification and delivery with efficiency and speed." ■

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Types of flight testing

What's the difference between a production test flight and an engineering test flight?

Production test flights are performed to certify every new airplane that rolls off the assembly line. Pilots note anomalies—called squawks—for Manufacturing to address prior to customer delivery. Once the issues are addressed, pilots test fly the aircraft again.

Engineering flight tests are a rigorous battery of tests conducted when an all-new airplane model rolls off the assembly line. Engineering flight tests also are conducted when upgrades are made to existing models—such as putting carbon brakes on 737s—or in support of modifications, such as passenger-to-freighter conversions. In 2008, Commercial Airplanes will have about 12 different airplane models—an unprecedented number—in engineering flight test.

By the numbers

1,683

Number of test flights Commercial Airplanes Flight Operations, Test & Validation provided pilot support for, between Jan. 1 and Nov. 21, 2007. These flights were for commercial jetliners produced by Commercial Airplanes and certain Integrated Defense Systems products.

3,558

Number of flight hours logged by these flights.

325

Number of days from Jan. 1 to Nov. 21, 2007

Flying in formation

Production test flights ensure safety, reliability of Boeing jetliners

A commercial airplane is a complex piece of machinery featuring millions of parts. Time and again, these parts come together to make an inherently safe product. However, a single undetected problem can have serious consequences.

As a result, prior to each airplane's delivery to a customer, a team of Boeing Production Flight Test pilots puts the aircraft through rigorous ground and flight tests in a process called production flight test.

Flight test is the last step in the airplane production process, performed by a team made up of more than 30 test pilots and a crew of systems operators in the Puget Sound region of Washington state. The team's No. 1 priority: "Safety is first. Do what's safe—everything else comes second," said Dennis O'Donoghue, vice president of Flight Operations, Test & Validation.

The tests conducted are considered medium-risk tests. Yet thanks to the skilled, dedicated people of Boeing throughout the value stream, an airplane taking its initial flight is very safe.

Gary Meiser, assistant chief production test pilot, has performed more than 500 test flights. He noted that Boeing has good processes in place and test flights can become a fairly routine operation.

"It can get pretty mundane, really," said Meiser. "But that's a testament to a solid build process by a great team. By the time we get the airplane, we tend to see the same squawks (a term denoting an anomaly or issue with an airplane component), and there are no surprises." This might include items such as engine vibration and the need to rebalance the engine prior to delivery—a very common occurrence. "Major safety discrepancies come along very rarely," he said.

Indeed, when an airplane does have a problem, it causes a significant disruption to the schedule. However, Meiser and Keith Otsuka, chief production test pilot, said the safety of an airplane will never be compromised simply to meet a schedule date.

The Flight Test team participates in weekly air crew meetings to go over each airplane flown, discuss the latest issues and note any trends they may be seeing. Commercial Airplanes' safety record is a testament to the company's vigilance about safety and risk mitigation. Safety is built into Boeing's robust build processes and continuous-improvement culture.

In spite of reliable processes and a solid record, there is still room for improvement. One of the goals Flight Test has is to become more integrated into the manufacturing process. Meiser and Otsuka both said that better integration between Manufacturing and Flight Test groups at Boeing facilities at Paine Field in Everett, Wash., Renton Field and Boeing Field in Seattle will help them better understand—and anticipate—any manufacturing problems that might arise that could affect flight-test operations; it also will help reduce flow time.

Awareness of schedule issues and the ability to work contingencies will be crucial in the months and years ahead. BCA has logged three straight record-setting years of orders, and production rates are increasing at a time when more new models will be in Engineering Flight Test than ever before. Improved communication among all groups will become increasingly important.

"We've had a lot of successes, but we never rest on our laurels," Otsuka said. "It's the nature of being a pilot: You can't be complacent or careless in aviation. My mom flies on our airplanes, so they have to be safe."

—Debby Arkell

Making the grade

Want to know what happens on a production test flight? Take a look

Commercial Airplanes Production Flight Test includes more than 30 test pilots and a crew of systems operators. These teammates take each commercial airplane on a series of test flights prior to customer delivery. Flight test is the last step in the airplane production process.

An airplane's first test flight is called its B1 flight. Following the B1 flight, Boeing takes the customer on a demonstration flight, known as the C1 flight, prior to airplane acceptance and delivery. Some customers skip this step, allowing Boeing to accept the airplane for them. Boeing also routinely accepts the airplane on behalf of U.S. Federal Aviation Administration as meeting FAA requirements.

737s are flown on average a little more than three times prior to delivery. Twin-aisles such as the 777 are flown around two times prior to customer delivery.

These pictures show just a few of the many people who support the manufacture and delivery of a Boeing airplane, and a few of the many steps involved on a first test flight.

Step 1

ED TURNER PHOTO

Commercial Airplanes test flight crew members Nick Smargiassi (from left), Gary Meiser and Greg Guest prepare paperwork prior to a production test flight, releasing the aircraft from Manufacturing to Flight Test. Production flight-test authorization is akin to a car-rental authorization. The pilots sign a ticket noting the weight balance and condition of the airplane upon receipt from BCA Manufacturing. The ticket also notes any outstanding items or issues with the aircraft that pilots would need to know.

Step 2

ED TURNER PHOTO

Once the test pilots have completed the necessary paperwork, they head out to the flight line to begin a series of checks outside the aircraft. Here Assistant Chief Production Test Pilot Gary Meiser (left) and Production Test Pilot Greg Guest perform a preflight inspection of a 737's engines.

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Step 3

ED TURNER PHOTO

Preflight ground checks continue inside the aircraft prior to taking to the skies. Pilots Bill Mnich and John Frischkorn test airplane systems with a Ground Crew member on the tarmac at Renton Field. Tests performed during this phase include electrical system function, backup systems operation, and more.

Step 4

JIM COLEY PHOTO

Before every test flight the pilots test the aircraft's brakes and the thrust reversers. To do this, the pilots position the aircraft at one end of the runway then accelerate rapidly in what's known as a high-speed taxi. At the opposite end of the runway they engage the brakes and thrust reversers, bringing the airplane to a quick stop. After the brakes and thrust reversers pass muster, the pilots reposition the aircraft for takeoff, and the airplane quickly is airborne. This begins the flight-test phase.

Step 5

Once in flight, the pilots conduct a series of flight-test maneuvers. The crew on board—two pilots, a flight analyst and a systems operator—check systems at high and medium altitudes. They check backup and critical safety elements, including cabin pressurization and the deployment of oxygen masks, as well as avionics, navigation and communication systems, functionality of in-flight entertainment and more. They also shut down and "relight" the engines during this phase.

ED TURNER PHOTO

Step 6

The pilots land the airplane—in the case of 737s, usually at Moses Lake, Wash., about 200 miles (320 kilometers) from Seattle—on autopilot to test the automatic landing system. The first landing typically is an auto land. "That's how much confidence we have in our airplanes," said Chief Production Test Pilot Keith Otsuka.

ED TURNER PHOTO

Step 7

Aircraft Maintenance Technician Bill Daniels (left) and pilots Meiser and Guest convene after the airplane touches down back at Boeing Field in Seattle, as the pilots prepare to hand the airplane back over to Manufacturing. Manufacturing will then address any issue found during the flight. The production test pilots will then repeat the flight test process prior to delivery to ensure all problems have been addressed.

ED TURNER PHOTO