



Frontiers

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Flight fantastic

Advances in simulator
technology transform training
for military and commercial
pilots and crews

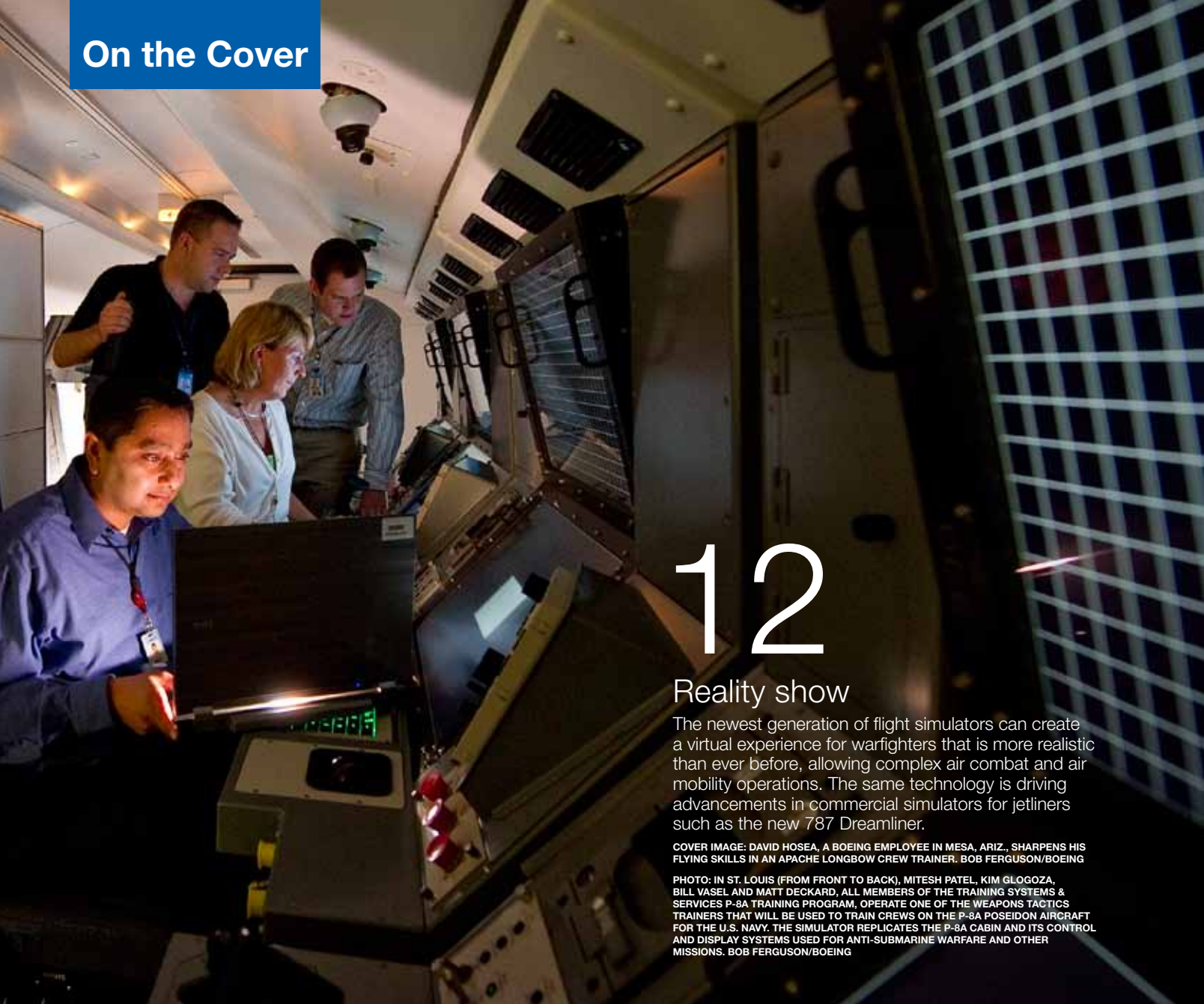
REAL FACTS. REAL CAPABILITY.



	Boeing NewGen Tanker	EADS/Airbus A330 Tanker
Number/Type of Aircraft Capable of Refueling	All Aircraft	Limited
Combat Maneuverability	Superior	Limited
More Booms in Air From Any Base	Yes	No
Deployable Aircraft per Airfield	More	Less

When you look at the real facts, it's easy to see which tanker offers real capability to the U.S. Air Force. The Boeing NewGen Tanker. Right tanker, right choice.





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Reality show

The newest generation of flight simulators can create a virtual experience for warfighters that is more realistic than ever before, allowing complex air combat and air mobility operations. The same technology is driving advancements in commercial simulators for jetliners such as the new 787 Dreamliner.

COVER IMAGE: DAVID HOSEA, A BOEING EMPLOYEE IN MESA, ARIZ., SHARPENS HIS FLYING SKILLS IN AN APACHE LONGBOW CREW TRAINER. BOB FERGUSON/BOEING

PHOTO: IN ST. LOUIS (FROM FRONT TO BACK), MITESH PATEL, KIM GLOGOZA, BILL VASEL AND MATT DECKARD, ALL MEMBERS OF THE TRAINING SYSTEMS & SERVICES P-8A TRAINING PROGRAM, OPERATE ONE OF THE WEAPONS TACTICS TRAINERS THAT WILL BE USED TO TRAIN CREWS ON THE P-8A POSEIDON AIRCRAFT FOR THE U.S. NAVY. THE SIMULATOR REPLICATES THE P-8A CABIN AND ITS CONTROL AND DISPLAY SYSTEMS USED FOR ANTI-SUBMARINE WARFARE AND OTHER MISSIONS. BOB FERGUSON/BOEING

Ad watch

The stories behind the ads in this issue of *Frontiers*.

Inside cover:



"Real Capability" is one in a series of NewGen Tanker ads developed as part of a campaign featuring the concept of a competitive scorecard. The ad highlights the NewGen Tanker's capabilities over the Airbus A330 tanker.

Four additional scorecard ads each address key focus areas of the U.S. Air Force KC-X competition. The campaign is running in *The Washington Post*, congressional publications, and key military and trade publications.

Pages 7-9:



This is one of a series of new 787 Dreamliner ads that captures the superior flying experience this new airplane will provide for passengers. The ads will run worldwide in 11 languages in a combination of trade, business, lifestyle and

business traveler magazines, in several airports and online.

Back cover:



This ad is part of a series that reinforces Boeing's many partnerships with the United Kingdom. Boeing is the largest overseas customer of the U.K. aerospace industry and partners with more than 300

businesses and universities there. The ad will run in *The Sunday Times*, *Economist UK*, *House Magazine* and other U.K. publications.



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Dream campaign

With its large windows and multiple other innovations, the cabin of the new 787 Dreamliner is designed to reconnect passengers to the magical experience of flight. Starting this month, a new Boeing ad campaign will highlight the superlative experience passengers will have on board the 787, reminiscent of ads Boeing ran at the dawn of the jet age when Boeing's then-new 707 jetliner delivered a travel experience like none before.

PHOTO: BOEING



Talent pool

Boeing's year-old Test & Evaluation organization, which brought together resources from across the company, provides many services other than flight testing. And it has been making a name for itself by getting talented employees to where they are needed at the business units—and doing so quickly.

PHOTO: PAUL PINNER/BOEING



Triple success

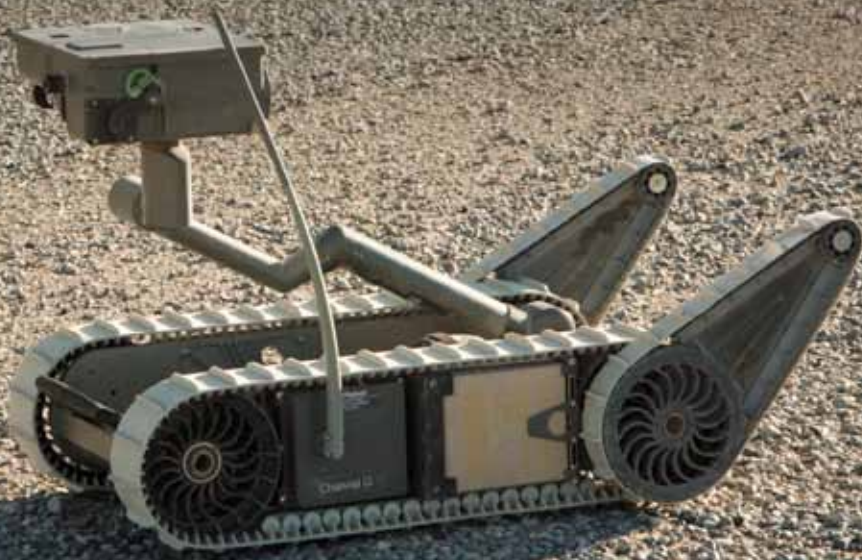
Twenty years ago this month, United Airlines placed the first order for Boeing's 777, leading to the program's formal launch. With six family members, including a new freighter version, the 777 has proved popular with airlines, pilots and especially passengers. Boeing engineers are exploring ways to make this long-haul, twin-engine jetliner even better.

PHOTO: BOEING

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24 Bits and bytes

Without software, the advanced hardware that's essential to the U.S. Army Brigade Combat Team Modernization program—such as the small unmanned ground vehicles that will help give warfighters the battlefield edge—could not work together. A Boeing lab in Huntington Beach, Calif., integrates software from seven different suppliers—no easy task. PHOTO: PEGGY MASON/BOEING



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Situational awareness

As Boeing's business has grown, so has its security needs. Although the company has first-class security teams, systems and support equipment, alert and watchful employees remain one of the best countermeasures to potential security threats.

PHOTO: MARIAN LOCKHART/BOEING



INSIDE

06 Leadership Message

Boeing's core performance has been strong and has allowed continued investment in the company's future, according to James Bell, corporate president and chief financial officer. Although Boeing is well-positioned heading into 2011, employees must continue the focus on innovation and improving competitiveness to succeed in challenging, dynamic markets, Bell explains.

10 Snapshot/Quotables

11 Why We're Here

26 Historical Perspective

47 Milestones

51 In Focus

CLARIFICATION

In the September issue of *Frontiers*, a quote by Robert Kramer of Phantom Works on Page 31 should have read:

"We provided SBInet [Boeing's border security program] a very accurate digital terrain model for developmental use, and that has now become one of the gold standards in how to do terrain mapping."

A strong core

Today's performance strengthens opportunities for tomorrow

James Bell

Corporate president and Boeing chief financial officer

PHOTO: BOB FERGUSON/BOEING



In a dynamic global competitive environment, it's great to be able to say that Boeing can look to the future with confidence. It's a testament to our employees who focus on meeting commitments to customers and embrace a culture of continuous improvement.

As our Commercial Airplanes business moves through the development of the 787 Dreamliner and 747-8, and as Defense, Space & Security repositions to meet the evolving needs and budget pressures facing the U.S. Defense Department, the core performance this year from our production programs and services businesses, supported by our functional teams, has been consistently strong.

That performance has been very important in enabling Boeing to continue investing in our future and ensuring we remain competitive.

The ability to generate strong cash flow has traditionally been a source of financial strength for Boeing. But in 2009, we had to enter the debt markets to raise the liquidity, or cash, required to support the 747 and 787 and to continue the repositioning at BDS.

At the same time, we increased our focus on disciplined cash management to ensure we had adequate resources to support our growth and productivity initiatives. The results have been very encouraging.

Across the company, teams have embraced Lean+ tools and processes to improve cash performance and productivity, finding better ways to create value in their work, either by sharing and replicating good ideas or by pioneering new methods.

We've also seen the functional teams that support Commercial Airplanes and BDS step up the gain on Functional Excellence—ensuring that their goals and objectives are more seamlessly integrated with the businesses and that the people, tools and processes we need to compete are available and effective.

And while we still expect that cash generated from operations will total zero this year, 2010 financial performance otherwise has been strong. We will be well-positioned as we enter 2011 and return to our more normal operating cash flow as deliveries of the 787 and 747-8 begin.

I want to thank you for your commitment to improving cash performance over the past year and a half and for your continued support as we meet future challenges.

Your performance has enabled us to remain competitive and better positioned to bid for programs like the multiyear F/A-18, which would provide our customer tremendous value and capability while bolstering our production base.

Strong performance also provided the foundational resources necessary to help us add new capabilities, such as the Argon ST and Narus acquisitions, and invest in the development of new products like the Phantom Ray, A160T and Integrator unmanned air systems for that fast-growing market.

We were able to fund production improvements and expansion at our facilities in Everett and Renton, Wash., and in Charleston, S.C., as well as the studies on replacements in our single- and twin-aisle commercial offerings.

As a result, Boeing is well-positioned to provide innovative, best-value products and services to better meet emerging customer requirements even as competition grows more intense.

Much of our success is due to operating as "One Boeing" and through the personal leadership demonstrated by employees at all levels within the enterprise.

There will continue to be changes in the business environment—that much is a certainty—but Boeing has always risen to challenges.

We can be confident going forward that we will address them successfully as we continue our focus on competitiveness and innovation to provide best-value solutions that meet our customers' needs. ■



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THE 787 DREAMLINER





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www.newairplane.com/welcome

 **BOEING**



FORWARD STRETCH

The first 747-8 Intercontinental passed an important milestone last month with assembly at the Everett, Wash., factory of the 89-foot-long (27.2-meter) forward fuselage, including the upper-deck passenger cabin. The 747-8 is 18 feet 4 inches (5.6 meters) longer than the 747-400, with much of that added length in the forward fuselage, seen here with a 747-8 Freighter in the background. **TIM STAKE/BOEING**

Quotables

“Four jet-fighter simulators fit today in the space occupied by just one 20 years ago.”

– Rob Lechner, chief engineer for Training Technologies with Boeing Defense, Space & Security. To read more about advancements in simulator technology and what that means for Boeing, see story beginning on Page 16.

“I’ve been in Russia for 18 hours and I have already spoken with three customers who want to buy Boeing airplanes.”

– Jim Albaugh, president and chief executive officer, Boeing Commercial Airplanes, speaking on Sept. 17 at the International Investments Forum in Sochi, Russia. While there, Albaugh and the Russian state corporation Rostekhnologii signed an agreement that brings both parties one step closer to finalizing a deal for 50 Next-Generation 737s and rights to purchase 35 more.

Basic training

A better understanding of the business helps employee teams work smarter, safer and more productively

By Marcy Woodhull and photo by Alan Marts



Spencer McDonald, a facilitator for Employee Involvement teams at Boeing Commercial Airplanes, is helping aircraft mechanics learn the basics of the business. In this *Frontiers* series that profiles employees talking about their jobs and the way their work fits into Boeing's goals, McDonald explains how he helps these teams tap into the best that employees have to offer.

Five years ago I was working as a 737 mechanic and decided to begin taking Lean classes, attending Accelerated Improvement Workshops and learning all I could about the broader Lean+ principles. It was a choice I made to do something different, to do something at Boeing benefiting both the shop-floor mechanics and the company.

Since then, I've seen the advantages and positive results that one Lean+ concept—Employee Involvement teams—can bring to the workplace.

As a facilitator for the International Association of Machinists and Aerospace Workers (IAM)/Boeing Joint Programs on Boeing's 777 program, I'm working with mechanics to help them gain a better understanding of business basics, establishing and posting metrics, and assisting teams with Employee Involvement tools.

At a kickoff meeting in June, Doug Kight, then Boeing Commercial Airplanes vice president of Human Resources, and Tom Wroblewski, president of IAM District 751, together gave a powerful message about management's and labor's commitment to the new Business Basics program. It grew out of contract negotiations in 2008 between Boeing and IAM District 751.

With the program, we aim to tap into the heart and soul of the best mechanics in the world to help them continue to improve productivity. I believe the Boeing IAM members are the rock stars of airplane builders. The 20-week Business Basics program teaches employees about their internal and external

customers, business risks and mitigations, competitors, and how they all fit in the Boeing system, from the sale to delivery of an airplane to the customer. The final modules are related to quality, cost, delivery, morale and safety. Teams also learn how to create metrics that matter for them. The goal is to enable teams to manage their piece of the daily business by using the metrics.

Before joining this program, I was the Employee Involvement lead for the Boeing Fabrication Interiors Responsibility Center in Everett, Wash., for two years. We had a number of successes at the center, and I learned that success with employee involvement, culture change or improvements begins and ends with leadership at all levels. ■

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A healthy unde



Healthy enrollment choices start with understanding medical plan basics

By Jill Godschall

This article is the next in a series to help Boeing employees and their families understand how changes in health care may affect them in 2011 and beyond.

Healthy choices—getting enough sleep, eating fruits and vegetables, and taking a daily walk—are a great way to boost well-being.

Another healthy choice that's often overlooked is selecting the right health plan during annual enrollment, which begins Nov. 4. Based on past years, as many as 50 percent of Boeing employees do not make an active choice during fall enrollment.

Because everyone's needs are different, Boeing offers a variety of health plan options. All the plans offer coverage for preventive care and limit the amount an employee pays out of pocket each year if he or she needs medical care. But each type of plan works differently, so it is important to have a basic understanding of how the plans work to find the one that is the best fit for employees and their families.

To help with these choices, during annual enrollment the Your Benefits Resources website will enable employees to see:

- Comparisons of benefits in available plans, including coverage for specific services, deductibles, copayments, coinsurance, annual out-of-pocket maximums and payroll contributions

Understanding

- 2009 and 2010 costs to date—including a high-level aggregate summary of health care expenses to date (e.g., office visits, prescription drug expenses) and how much the employee paid for them
- Estimated 2011 costs under the various plan options, based on the amount of care employees forecast they'll need
- Which doctors are in each plan's network

Employees should watch their home mail in late October for an enrollment packet that will provide further instructions to help them choose the optimum health plan for 2011.

ABCs OF HEALTH PLANS

Annual deductible: The amount an employee or covered family member pays for care each year before the plan pays benefits. The deductible does not apply to certain types of medical care, such as preventive care.

Coinsurance: The percentage an employee or covered family member pays for most covered services after having satisfied the annual deductible.

Copayment: The fixed dollar amount an employee or covered family member pays for covered services such as a doctor's appointment or prescription purchase at the time of service. Typically a copayment does not apply to the deductible.

Network provider: A doctor, hospital or other provider that agrees to participate in a plan's network and charge reduced fees to plan members. The plan pays higher benefits for care received from network providers.

Annual out-of-pocket maximum: The most an employee or covered family member will have to pay for coinsurance in a benefit year. In some plans, this limit also includes the amount of the annual deductible, but it typically does not include copayments for office visits or prescription drugs.

Payroll contribution: An employee's cost to participate in a medical plan. This amount is deducted from an employee's first two paychecks each month. The contribution covers a portion of the total cost of coverage; Boeing pays the majority of the cost.

Primary care physician, or PCP: A physician who manages medical care for an individual and makes referrals to specialists as needed. This physician is usually an internist, family practitioner, pediatrician or obstetrician/gynecologist. ■

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PHOTO: SHUTTERSTOCK.COM

Who pays for the doctor's office visit?

Most Boeing health benefits are *self-funded* rather than *insured*. That is, Boeing contracts with health plans to manage the administration of its employee plans, and Boeing itself pays for the covered costs employees incur whether they visit a doctor, purchase a prescription or are hospitalized. Hence the health of the work force directly affects the company's bottom line.



Experiencing the dream

New Boeing ad campaign focuses on what it will be like to fly in the 787 *By Lauren Penning*

Search the Internet for “787 Dreamliner” and chances are you will find facts and figures on range, payload and improved airplane performance, as well as the advanced technologies incorporated in Boeing’s new jetliner.

But it is the experience of flying in the 787 that Boeing’s Communications and Marketing team wants frequent fliers to feel. And that’s the goal of a new Boeing advertising campaign.

“We have done a good job communicating the technical advantages,” said Jeff Robinson, Commercial Airplanes senior advertising manager. “And now we’re tapping into the positive emotional experience of flying.”

Experience is at the heart of the new advertising campaign rolling out this month. “What does an airline want? To fly an airplane full of passengers,” Robinson explained. “So we want to showcase what this amazing new airplane has in store for passengers.”

That includes smoother flying, inspiring views throughout an advanced-design cabin and arriving at the destination more refreshed. “All are factors that are unique to a 787,” said Rob Pollack, vice president of Marketing, Commercial Airplanes. With this ad campaign, “we want to show people really enjoying the experience of being on the Dreamliner.”

The new Boeing ads (see examples on pages 7–9) will run in publications around the world starting this month. The campaign will run in business, lifestyle, trade and travel publications that reach the premium passenger. Ads will be featured on trade, business and travel websites.

Blake Emery, director of Differentiation Strategy, Commercial Airplanes, said the Dreamliner interior is designed to reconnect passengers with the experience of flight. “There is something very magical psychologically about the flying experience,” Emery said. “The 787 interior is going to trigger that magic.”

To bring this promise to life in print and on the Web, the ad campaign features sweeping views of the premium passenger cabin.

A weeklong photo shoot for the campaign took place this summer at Boeing’s Customer Experience Center in Renton, Wash. The facility has an interior mock-up of the 787, but re-creating the passenger experience for the ads wasn’t as simple as placing models in the display mock-up.

The team pulled the seats out of the 787 mock-up to shoot them on set with the models and then shot the airplane mock-up’s interior, bringing the shots together in composite images. This allowed the shooting team to perfect the lighting and re-create what 787 passengers will experience. “For the person who sees the ad in the magazine, there is no difference between the real airplane and the ad,” said Peter Serchuk, creative director and manager of Boeing’s partner advertising agency Frontline Communications Partners.

Specialists in makeup, wardrobe, lighting and video were on hand throughout the week. “Everything is about the image of the airplane and the image of Boeing,” Pollack said. “And that is why everything has to be perfect.” ■

PHOTO: A film crew transformed the warehouse at Boeing’s Customer Experience Center in Renton, Wash., into a studio to photograph and shoot video of an interior mock-up of the 787 for the advertising campaign. The Dreamliner features many new cabin advancements.

JIM ANDERSON/BOEING

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Back to the future

The 787 represents a huge leap in aviation, just as Boeing's 707 did when it helped usher in the jet age a half-century ago. The new Dreamliner advertising campaign also shares a link to the one produced for the 707—its lifestyle angle. The 707 ads promised a travel experience like none before:

- "Only seven hours to brush up on your French."
- "Not a ripple in your coffee aboard the 707."
- "Would you rather drive for a day or rest for an hour?"
- "Hardly time to start a sweater."
- "Once aboard you won't believe your eyes ... or ears."
- "A lullaby in flight."
- "Only one drawback—the trip was too short!"

PHOTO: Norma Jean Baker (Marilyn Monroe), left, boards a DC-6 in this ad. She appeared in several Douglas Aircraft ads.
BOEING ARCHIVES

**“The Boeing-
produced
Strike Eagle
simulators
are actually
changing how
we instruct.”**

*— Lt. Col. Eric “Chappy” Chapital,
former F-15E weapons systems
instructor, North Carolina*





The *virtual* sky

No longer a tool used just for flight training, simulators create a realistic experience for warfighters

By Jay Spenser

As a pair of F-22 Raptors streak through the skies, their pilots coordinate with other F-22s and an Airborne Warning and Control System (AWACS) aircraft to complete the operation—despite enemy fighters and surface-to-air missiles.

But only the two F-22s are in the air. The crews of the other Raptors and the AWACS aircraft are participating in this exercise from simulators at various U.S. Air Force training centers in the United States. As for the enemy fighters and missiles, they appear real on cockpit displays but are computer-generated.

A decade ago, the role of military flight simulators was to help crews transition to new aircraft types, hone their basic flying skills and practice emergency procedures.

“Today it’s a different world,” said Mark McGraw, vice president for Boeing’s Training Systems and Services in Defense, Space & Security. “Even the most complex air combat or air mobility operations can be simulated with fidelity, letting warfighters train just as they might someday be called on to fight.”

All manned aircraft programs in Defense, Space & Security benefit from these new simulator capabilities. And Boeing is leveraging the growing sophistication and fidelity of flight simulation to further benefit its military customers.

“We’re helping our military customers reduce their costs and risks even as they increase the readiness of the warfighter,” said Randy Deidrick, director of the Capability Center Shared Integrated Product Team within Training Systems and Services.

“With budgets tight, our customers need to offload time spent in the air with simulator time,” he added. “To meet this requirement, we at Boeing have collaborated with our customers and suppliers to develop a truly immersive training environment.”

It’s a training environment that:

- Familiarizes crews with real-world operations and threats
- Acquaints crews with new locations
- Allows crews to deal with emergencies not safely practiced in the actual aircraft
- Spares crews from having to fly all the way to a target and back
- Lets crews fire more missiles than an aircraft actually carries
- Concentrates the learning

After a simulator mission, the crew and instructor review the training session at a debriefing station that is essentially a miniature theater, where the crew’s

PHOTO: A pilot is shown using an F-15E simulator—a major component of Boeing’s three F-15E Mission Training Centers. RON BOOKOUT/BOEING

decisions, control inputs and communications are reviewed with visual aids.

"Instructors can have students fly a complex mission, offer performance feedback during a quick debrief and then have the students re-fly the same mission to assess their improvement," said Kay Grabanski, program manager for Boeing's three F-15E Mission Training Centers at Seymour Johnson Air Force Base, N.C.; Mountain Home AFB, Idaho; and Royal Air Force Lakenheath, United Kingdom.

Lt. Col. Eric "Chappy" Chapital was until recently an F-15E weapons systems instructor at Seymour Johnson Air Force Base in North Carolina. "The Boeing-produced Strike Eagle simulators are actually changing how we instruct because they let us teach at a higher level and perform more of the training in the simulator," Chapital said. "This saves time, fuel and dollars while delivering better results to the Air Force."

Improvements over the years to visual display systems help make this realistic training possible.

"Four jet-fighter simulators fit today in the space occupied by just one 20 years ago, when visual systems required a 40-foot-diameter [12-meter] dome," said Rob Lechner, chief engineer for Training Technologies with Boeing Defense, Space & Systems.

Last December, Boeing unveiled a dramatic leap forward in simulation capability. The Constant Resolution Visual System (CRVS) combines greater simplicity with lower costs and visuals that approach reality.

"CRVS is unique because it offers the same high resolution throughout the entire viewing area, providing an uninterrupted field of view and unvarying target acuity," said Boeing's McGraw. "It makes virtual training missions and other simulations more immersive and effective."

Progress in networking and integration likewise is transforming today's flight training. A decade ago, Boeing experts in St. Louis implemented the U.S. Air Force Distributed Mission Operations Network, a virtual environment in which simulator crews at different mission training centers can fly and train together. What started with the F-15C Eagle is today a collaborative battlespace that can accommodate many different aircraft types, as well as what's known as "constructive threats"—computer-simulated enemy weaponry and actions.

The F-22 Raptor Mission Training Center at Langley, Va., connected to this network last November, and three more Raptor training centers are joining in the next three years.

The Distributed Mission Operations Network is the "premier virtual training environment" for combat aircrew in ground-based simulators, said Boeing's Barry Cossel, an F-22 training manager.

The capability to fly virtual missions alongside actual aircraft in the sky is a key element of what's known as Integrated Live, Virtual and Constructive training, or I-LVC. It eliminates the geographical constraints of having to train over existing ranges. This technology represents the ultimate in military flight training, and Boeing is leading the way with I-LVC.

Boeing also is supporting various U.S. Navy programs with its simulator expertise, including the F/A-18 Super Hornet, the EA-18G Growler and the new P-8A Poseidon maritime patrol aircraft, which is a military derivative of the Next-Generation 737 commercial jet.

Crew training for the P-8A will be in Operational Flight Trainers that are based on the Next-Generation 737 full-flight simulators. Featuring full motion and visual systems, these Operational Flight Trainers replicate the Poseidon's unique flight deck. The first of these trainers is scheduled to become operational at the Naval Air Station in Jacksonville, Fla., in late 2011.

Poseidon crews also will train on another simulator known as the Weapons Tactics Trainer, which replicates the aircraft's cabin with its state-of-the-art control and display systems. In the simulator, Poseidon crews will be trained

PHOTO: Boeing's Mission Training Center at Langley Air Force Base, Va., includes F-22 simulators such as this one. BOB FERGUSON/BOEING





**“We’re helping
our military
customers reduce
their costs and
risks even as
they increase
the readiness
of the warfighter.”**

*– Randy Deidrick, director of the
Capability Center Shared Integrated
Product Team with Boeing Defense,
Space & Security’s Training
Systems and Services*

in the aircraft's anti-submarine warfare, anti-surface warfare, and intelligence, surveillance and reconnaissance systems and capabilities.

"The Poseidon program is very important to the Navy and United States," said Tom Lavender, manager of P-8 Training Systems for Boeing. "We're pleased that our Navy customers chose us to also provide Poseidon training support."

As many as 20 of the P-8A Operational Flight Trainers and 15 of the Weapons Tactics Trainers could eventually be in operation at several locations, he said.

Boeing-developed simulators also are being used to train U.S. Army pilots to fly the company's Apache AH-64D Longbow helicopter. These training devices provide so much value that one Longbow Crew Trainer is assigned to each battalion in Iraq and Afghanistan.

"The Army says its in-theater Longbow Crew Trainers save lives," said Ken Bloms, program manager for Boeing's Apache Training Systems. "They do this by allowing combat crews to practice more than 280 simulated emergencies, including engine and transmission failures and hits from enemy fire."

Apache pilots also can preview missions and even practice brownout landings, a disorienting situation that occurs when the main rotor kicks up a blinding swirl of desert sand while landing.

"Without a doubt, training systems like the Longbow Crew Trainer not only prepare our pilots well for combat but also provide the opportunities to make mistakes and learn," said U.S. Army Lt. Col. John Vannoy, product manager for Apache Sensors at Redstone Arsenal, Ala. "The system is clearly, in my mind, the 'best of the best' training devices in the field today."

Boeing C-17 Globemaster III crews also rely on simulators to develop and sustain their readiness for a variety of missions. Each C-17 Weapon System Trainer combines a C-17 flight deck with the aft loadmaster station so crews can practice typical operations such as airdrops, where C-17s deliver supplies by parachute.

"As many as six crews at a time can practice formation airdrops in our networked simulators," said Tracy Mead, C-17 Aircrew Training Systems program manager and a former U.S. Air Force C-17 pilot. "For maximum realism we also include additional C-17s that are virtual, as well as a host of constructive threats." ■

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PHOTO: Robert Heiman, Training Systems & Support electrical engineer, in the P-8A Poseidon simulator in St. Louis. **BOB FERGUSON/BOEING**





“Even the most complex air combat or air mobility operations can be simulated.”

– Mark McGraw, vice president for Boeing’s Training Systems and Services in Defense, Space & Security

Boeing worked with Thales to “meld its technical capabilities with our training requirements.”

– Mike Saladin, senior manager with Simulation Engineering at Boeing Training & Flight Services





Dreamscape

Learning to fly the 787

While military jet-fighter simulators feature ultra-realistic visuals of aerial combat scenes from the cockpit, commercial pilots being trained to fly the new 787 Dreamliner also are getting breathtaking virtual views, whether it's the Tokyo skyline or snow-covered Mount Rainier near Seattle.

For the 787 suite of training devices, this includes higher-resolution, crisper visuals produced by state-of-the-art content and projection technology.

And the 787 simulation devices have all the new technology that's part of the 787 itself, including dual Electronic Flight Bag displays that replace bulky paperwork and dual head-up displays that let pilots see flight data overlaid on the view ahead.

Flight training begins on desktop trainers that display virtual cockpits on standard computer monitors. Later, students move on to flat-panel trainers, with large LCD pilot displays with the same resolution as in the actual flight deck, and finally to a full-flight simulator, where pilots experience not only the realistic visuals but also the motion resulting from their control inputs.

Ascents and descents, pitches and rolls are created by a new electric and hydraulic mechanical system that provides a faster response time and uses only 20 percent of the electricity of previous full-flight motion systems.

Students can prepare for and review their full-flight sessions at a nearby station that provides a time-based audio and video recording of their training session.

Pilots spend up to 20 days learning to fly a 787. If they already are certified to fly a 777, they need only five days of training due to the commonality between the two models.

Maintenance training uses desktop trainers that feature a virtual airplane and various maintenance scenarios. Students can troubleshoot and fix simulated faults in the virtual airplane.

There are eight training suites at five Boeing Training & Flight Services locations in Tokyo, Singapore, Shanghai, Seattle and outside London. The training suites were built by Thales (pronounced *tal-lis*), a leading provider of onboard and ground systems for the civil aerospace market.

"We worked in close collaboration with Thales to develop training devices and environments that meld its technical capabilities with our training requirements," said Mike Saladin, senior manager with Simulation Engineering at Boeing Training & Flight Services.

— *Kathrine Beck*

PHOTO: Vincent Eckelkamp, instructor pilot, Boeing Training & Flight Services, in a Thales 787 full-flight simulator in Seattle. GAIL HANUSA/BOEING

Code-maker

Software is the brains behind the star players of this U.S. Army program to give soldiers a battlefield edge

By Peggy Mason and photos by Bob Ferguson and Rich Rau



kers

The hardware is pretty cool.

Small unmanned ground vehicles, or SUGVs, resembling *Wall-E* in the 2008 Disney-Pixar film, that surreptitiously enter buildings, caves and tunnels to perform dangerous reconnaissance missions.

Unmanned aerial vehicles that hover for hours over a target to provide critical surveillance to soldiers positioned out of harm's way.

These are just some of the players in the U.S. Army Brigade Combat Team Modernization (BCTM) program, the ones that get most of the attention. But the real star of the show is the underlying software that runs these various platforms and allows them to connect with one another.

Without that software, nothing would work. That's what is essentially the brains of these platforms and what allows the hardware, soldiers and commanders to connect with one another across the all-important secure network that's the centerpiece of the Army program.

The amount of information contained in the software package that makes all the cool technology work in the program—for which Boeing is the prime contractor—is massive. This is no off-the-shelf software that can be downloaded within minutes into a home computer. The quantity of information, in fact, is closer to that found in the Library of Congress, the largest library in the world, with millions of books and other resources.

And the software is written not just by Boeing but by software engineers from seven suppliers: Northrop Grumman, Honeywell, Overwatch, General Dynamics Information Technology, Raytheon, Lockheed Martin and Textron.

The biggest challenge with having software come from multiple sources is getting all the lines of code to work with one another without crashing. And that's the job of Boeing's System of Systems Integration Lab, or SoSIL, located in Huntington Beach, Calif.

"The integrated hardware and software being created at the SoSIL for our Army customer is key to ensuring that the BCTM capabilities are able to provide real-time situational awareness to soldiers in combat," said Roger Krone, president, Network and Space Systems.

During the initial software integration process at the System of Systems lab, engineers eliminate bugs and glitches in the different pieces of software and mesh them into a smooth-running product. Once the bits and pieces of software work seamlessly together, it's on to Phase 2, "where the real hardware meets the real software," said Kirk Reher, director of Boeing's Network Systems Integration.

"When it's all pulled together, we have the Integrated Battle Command software," Reher said.

Next stop after the lab is the White Sands Missile Range in New Mexico, where soldiers rigorously test all the components.

Early summer tests at the range demonstrated that the network works as it is supposed to, according to Mike Laske, a hardware and software integration manager at Boeing.

And that's very gratifying for Boeing employees such as Shaun Goodger, who works largely behind the scenes of the program as a software and hardware integration engineer.

"We get to see in real situations how our work helps soldiers do their job on the front lines," Goodger said. "It's so gratifying to see it all in action and to know we've provided a good, reliable product."

Starting in 2011, a team led by Boeing is scheduled to equip the Army's first Infantry Brigade Combat Team with these network capabilities. ■

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PHOTOS: Software engineers at Boeing's System of Systems Integration Laboratory integrate software from seven companies for the U.S. Army's Brigade Combat Team Modernization (BCTM) program. Clockwise from top middle: Boeing's Leona Wong (left), software integration lead, and Will Lopez, systems engineer; U.S. Army soldiers operate a command post at White Sands Missile Range, N.M., where the capabilities of the Army's BCTM program are tested in realistic scenarios; Ryan Andersen (left), Army test engineer, and Boeing's Tin Vu, software tester; Boeing's Miukei Siu (left) and Raytheon's Girma Kassa, software engineers on the BCTM program; Boeing's Matt Viss (left), design and analysis engineer, and Marco Corrado, software engineer.

After studying the A-3D drawings, the Navy reset the requirements. Douglas won the contract.

By the early 1950s, Heinemann had become concerned about the growth in size, weight and cost of contemporary combat airplanes. On his initiative, Douglas funded a study for a light combat airplane. The Navy was interested, but it already was committed to a fighter and asked him to adapt the design to a carrier attack aircraft. Heinemann was back in front of the Navy within two weeks with a preliminary design for a plane weighing 14,600 pounds (6,620 kilograms), less than half the weight requirement initially set by the Navy. The proposed Douglas design would allow for a fighter 20 percent faster with 30 percent more range than the requirements.

Intrigued but skeptical, the Navy contracted for only two prototypes. The result was production of more than 2,900 A-4D Skyhawks from 1954 through 1979.

In 1978, Heinemann was awarded the Gugenheim Medal—established in 1929 to honor notable achievements in aeronautics. The citation issued with Heinemann's Gugenheim Award was for "outstanding achievement in the innovative design of military airplanes which are noted for longevity of service, versatility of tasks, simplicity of design, high performance and elegance of line."

Others from Boeing and its heritage companies who have won the Gugenheim Award include Bill Boeing, Donald Douglas, James Kindelberger and

Joe Sutter. In 2010, it was Bob Liebeck, a Senior Technical Fellow and program manager with Boeing Research & Technology, who was cited for his work on the company's Blended Wing Body aircraft concept.

Ed Heinemann was inducted into the Aviation Hall of Fame in 1981, and in 1983 he received the National Medal of Science from President Ronald Reagan. ■

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PHOTOS: The A-4 Skyhawk provided the U.S. Navy and Marines, as well as a number of allied nations, with a highly maneuverable and powerful attack bomber. Between 1974 and 1986, the Skyhawk also was flown by the U.S. Navy Blue Angels flight demonstration team. It was replaced with Boeing's F/A-18 Hornet. **BOEING ARCHIVES**

(Inset) Ed Heinemann on the Douglas flight line with his A-4D/A-4 Skyhawk. The attack jet was often referred to as "Heinemann's Hot Rod." **BOEING ARCHIVES**

‘Build them rugged’

Designer Ed Heinemann’s vision led to the development of many combat jets

By Tim Sele

He was a self-taught engineer who joined Douglas Aircraft in 1926 as a draftsman. But Ed Heinemann developed into one of the world’s best known and most respected combat aircraft designers.

“Be practical,” he would say. “Build them rugged. Keep things simple.”

Heinemann’s commitment to that vision left Boeing and its heritage companies a lasting legacy of accomplishments—and groundbreaking airplanes such as the SDB Dauntless, backbone of the U.S. World War II carrier-based bombing fleet; the D-558-2 Skyrocket, the first airplane to reach Mach 2; and the F4D Skyray—an achievement that earned him the 1953 Collier Trophy.

During his early career at Douglas, Heinemann developed mentor-type relations with Donald Douglas, James “Dutch” Kindelberger, Jack Northrop and others that lasted many years and helped shape Heinemann’s vision.

The development of two airplanes in particular, the A-3D Sky Warrior and the A-4D Skyhawk, reflect Heinemann’s commitment to simplicity, ruggedness and practicality.

In 1947, the U.S. Navy issued a request for a carrier-based attack bomber with a gross weight not to exceed 100,000 pounds (45,360 kilograms). Curtiss proposed an airplane close to 100,000 pounds while North American dropped out, believing the requirements could not be met at the requested weight. Heinemann and his Douglas team proposed an airplane at 68,000 pounds (30,840 kilograms), just light enough to operate on the Midway-class carriers of the day.



Conti



The merger of Continental and United Airlines is seen as good for Boeing Commercial Airplanes

By Marcy Woodhull

L leading the world's largest airline sounds like a daunting challenge. But Jeff Smisek is taking it in stride, knowing the enormity of the task ahead of him and confident in the abilities of the combined work forces to make it a success.

Smisek, chairman, president and chief executive officer of Continental Airlines, will lead the combined Continental and United Airlines, whose merger, which was approved by the U.S. Department of Justice on Aug. 27, is expected to be final this month.

From the beginning, the merger was widely seen as potentially good for Boeing Commercial Airplanes.

Boeing and Houston-based Continental have enjoyed a long and fruitful relationship, dating back more than half a century, when Continental was one of the first operators of the 707 in 1959. The airline now operates an all-Boeing fleet, with 350 airplanes, and is the North American launch customer for the 787-8 and 787-9 versions of the Dreamliner.

An all-Boeing fleet has made good business sense for Continental, Smisek said.

"We appreciate the value and reliability of Boeing products, and Boeing has highly professional and creative people," he said. "Having an all-Boeing fleet has benefited Continental because of the efficiency it drives in training, operations, maintenance and spares, as well as the consistency and reliability it gives us."

As a new company grows from the combination of Continental and United—a Chicago-based airline whose fleet has included competitors' jets—Boeing hopes that partnership will grow as well.

"Boeing and Continental have teamed for a number of firsts, and we foresee a strong relationship with the expected merged airline," said Marlin Dailey, vice president of Sales for Boeing Commercial Airplanes.

Continental was the North American launch customer

"All the good things that everyone from our airline — co-workers, customers, shareholders and communities — wants come from sustained profitability."

— Jeff Smisek, chairman, president and chief executive officer of Continental Airlines

PHOTO: CONTINENTAL AIRLINES

Continental

shift



for the Next-Generation 737-900ER (Extended Range), receiving the first one in January 2008, and will be for the 737 Boeing Sky Interior, a redesigned passenger cabin based on extensive passenger research. In January 2009, Boeing and Continental teamed, along with GE Aviation, CFM and Honeywell's UOP, for the first sustainable biofuel demonstration flight by a commercial carrier using a two-engine airplane, a 737-800.

Smisek said Continental often is first in line for Boeing innovations because capturing the benefits of technology as quickly as possible gives the airline a competitive advantage.

"When Boeing first presented the 787 to Continental in 2004, we quickly realized that it would be a game-changing aircraft," Smisek said. "The 787's superior range, enhanced passenger comfort and operating efficiency are attributes that will ensure that we continue to provide our award-winning service in a cost-effective manner."

He lauded the 737-900ER as evidence of Boeing's capacity to make a superior product event better.

"The 737-800 has been the backbone of our [single-aisle] fleet and one of our more profitable aircraft to operate. With transcontinental range and 13 more seats than the 737-800, the 737-900ER is an ideal aircraft for high-demand routes that we serve," Smisek said. "In addition, the 737 Boeing Sky Interior will greatly enhance our passenger experience, and we look forward to being the first U.S. airline to introduce this exciting improvement to our customers in December."

Like Boeing, Continental is committed to fuel-efficient technology and environmental responsibility. The airline has joined with Boeing to demonstrate that sustainable biofuels are viable in their aircraft.

"Over the long run, we need to see biofuels become available at economically competitive prices and in large enough quantities," Smisek said. "But in order for those things to happen, we first need to demonstrate that biofuels work. Our demonstration flight, and similar demonstration flights conducted by Boeing in partnership with other carriers, helps make that happen."

But it is the relationship between parts of the new airline that presents an immediate challenge for Smisek

PHOTO: Continental is displaying this 787 cabin mock-up at Houston's Bush Intercontinental Airport in anticipation of becoming the first U.S. operator of Boeing's newest jetliner. CONTINENTAL AIRLINES

“We foresee a strong relationship with the merged airline.”

– Marlin Dailey, vice president of Sales for Boeing Commercial Airplanes

GRAPHIC: An artist’s rendering of a Boeing 777-200ER (Extended Range) in the proposed new United Airlines livery combining the Continental logo with the United name. CONTINENTAL AIRLINES



and his soon-to-be-merged company.

Bringing together two corporate cultures of this magnitude requires detailed planning, foresight and a solid foundation. “When you have the right culture, choose the right leaders and give co-workers the tools they need to do their jobs, then the rest takes care of itself,” Smisek said.

“Above all, we need to focus on our core values—values that both Continental and United have in common—such as working together, treating one another and our customers with dignity and respect, and staying committed to open, honest and direct communication.”

He added that with the right culture, employees enjoy coming to work every day, resulting in better service.

“If we give good service, our customers will keep flying us. If customers keep flying us, with good management we will be able to achieve sustained profitability,” he continued. “All the good things that everyone from our airline—co-workers, customers, shareholders and communities—wants come from sustained profitability.”

Smisek foresees great benefit for all stakeholders from the prospective merger. “For our customers, these include the world’s leading network and frequent-flier program,” he said. “Continental’s and United’s route networks are highly complementary, with minimal overlap. We bring to the merger our New York hub, our Houston gateway to a strong Latin America network and our broad trans-Atlantic presence. United brings its West Coast and Pacific access, as well as its strong mid-continent hub in Chicago.”

The combined airline will provide employees with improved long-term career opportunities and enhanced stability by being part of a larger, financially stronger and more geographically diverse carrier, Smisek said.

“And for our shareholders, the transaction creates a platform for greater opportunities for improved profitability and sustainable long-term value.” ■

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Day of the robots

New robotic technology for making composite parts is speeding V-22 production

By Jeff Barnett

At Boeing's facility in Philadelphia, Celso Silvera, a composite fabricator on the V-22 Osprey program, has two invaluable teammates.

Neither is human.

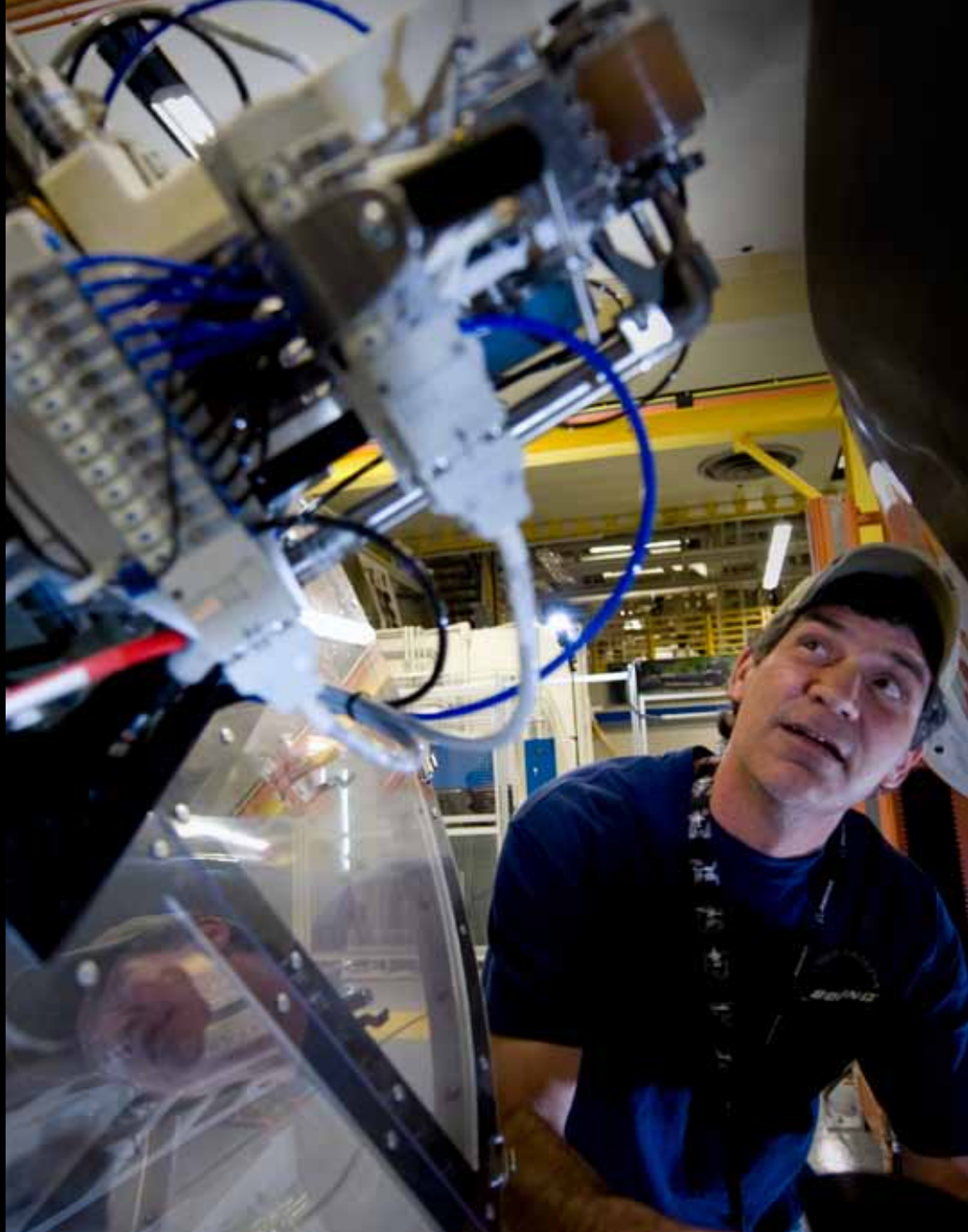
The twin robots work in tandem to create the composite curved sections located aft of the aircraft's wing by laying and overlapping composite fiber to a predesignated shape. The completed parts are then moved to the V-22 assembly line.

"It means we can turn these composite parts out faster," Silvera said of the two machines. "That makes my job easier and frees me up to do other valuable work."

Today's military and commercial aircraft use more composites than ever. But traditional fiber-placement-machine technology typically supports a single-part build at a time and is much more expensive. This older technology also has physical limitations. Once in place, the equipment usually can't be moved to another production area.

But the robotic machines being used on the V-22 program at Boeing's Composite Center of Excellence can be moved to nearly any existing factory with "minimal footprint and effort," according to Robert Vitlip, Philadelphia site project lead. "Best of all, it's much less expensive than traditional technology and offers ongoing savings through its life cycle."

Developed by Boeing Research & Technology in Seattle and the composite center in Philadelphia, the fiber-placement machine combines off-the-shelf technology with Boeing-patented composite capabilities.



"This is the first production robotic fiber-placement technology application of this kind in industry," Vitlip said, "and it offers a significant leap ahead in process efficiency and cost savings, especially over traditional machinery. That means a faster rate of production—vital with the program's planned rate and production schedule increases."

The technology represents the best of the "One Boeing" approach, said John Kivitz, senior manager at the composite center.

"We brought together the most knowledgeable personnel, best technologies and expertise within Boeing," he said. "This is Boeing-owned technology that can be applied for future commercial and defense-related products."

Added Brice Johnson, Boeing Technical Fellow: "This is a very unique, very new capability for Boeing. The ability to customize this kind of low-cost composite system is a major milestone." ■

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PHOTO: Darryl Purrfield, composite fabricator, inspects robotic fiber-placement equipment used on the V-22 at the Composite Center in Philadelphia.

FRED TROILO/BOEING



“We don’t have to reinvent the wheel every time.”

— Shawn Knight, flight support generalist, St. Louis

PHOTO: PETER GEORGE/BOEING

Talent search

New Boeing test organization gets resources to where they are needed—and quickly

By Kathrine Beck

When one of the tower operators at the Boeing site in Mesa, Ariz., had to take a sudden extended medical leave in May, it could have meant trouble for the Flight Operations team in Mesa, home of the Apache helicopter.

It wasn’t a job that just anyone could perform.

Tower operators are highly trained and must be certified by the Federal Aviation Administration. They provide air traffic control, support flight testing and work with local air traffic control authorities to keep the skies safe.

But Dan Edwards, Apache test pilot and Mesa’s Flight Operations manager, was able to get a fill-in right away.

It’s an example of how Boeing Test

& Evaluation is able to place talent and resources throughout the enterprise as needed. This new companywide organization brought together elements of the test and evaluation organizations of Commercial Airplanes; Defense, Space & Security; and Engineering, Operations & Technology last year.

When fully integrated as a part of Engineering Operations & Technology, the test and evaluation group will have more than 7,000 employees at 78 different sites throughout the United States. And it will be able to share those resources as it did when the Mesa site urgently needed a tower operator, said Shawn Knight, a flight support generalist from St. Louis who was the replacement sent



“Flying a variety of programs is exactly the challenge we all hope for.”

*—Dan Wells, experimental test pilot,
Edwards Air Force Base, Calif.*

PHOTO: PAUL PINNER/BOEING

to Arizona. “We don’t have to reinvent the wheel every time,” he said.

As a flight support generalist, Knight has many duties, from taking care of aviation life-support equipment and performing radio checks to briefing pilots. He had experience as a tower operator when he joined Boeing.

“I fit the bill, so they asked if I was interested in going out there to help out,” he said.

The process was quick and smooth because both Edwards and Knight work for Boeing Test & Evaluation.

Edwards said that with Knight on board, the Mesa operations “didn’t even slow down. We kept rolling.”

Getting talent to where it is needed

quickly is happening throughout Boeing Test & Evaluation, which provides many services beyond flight test.

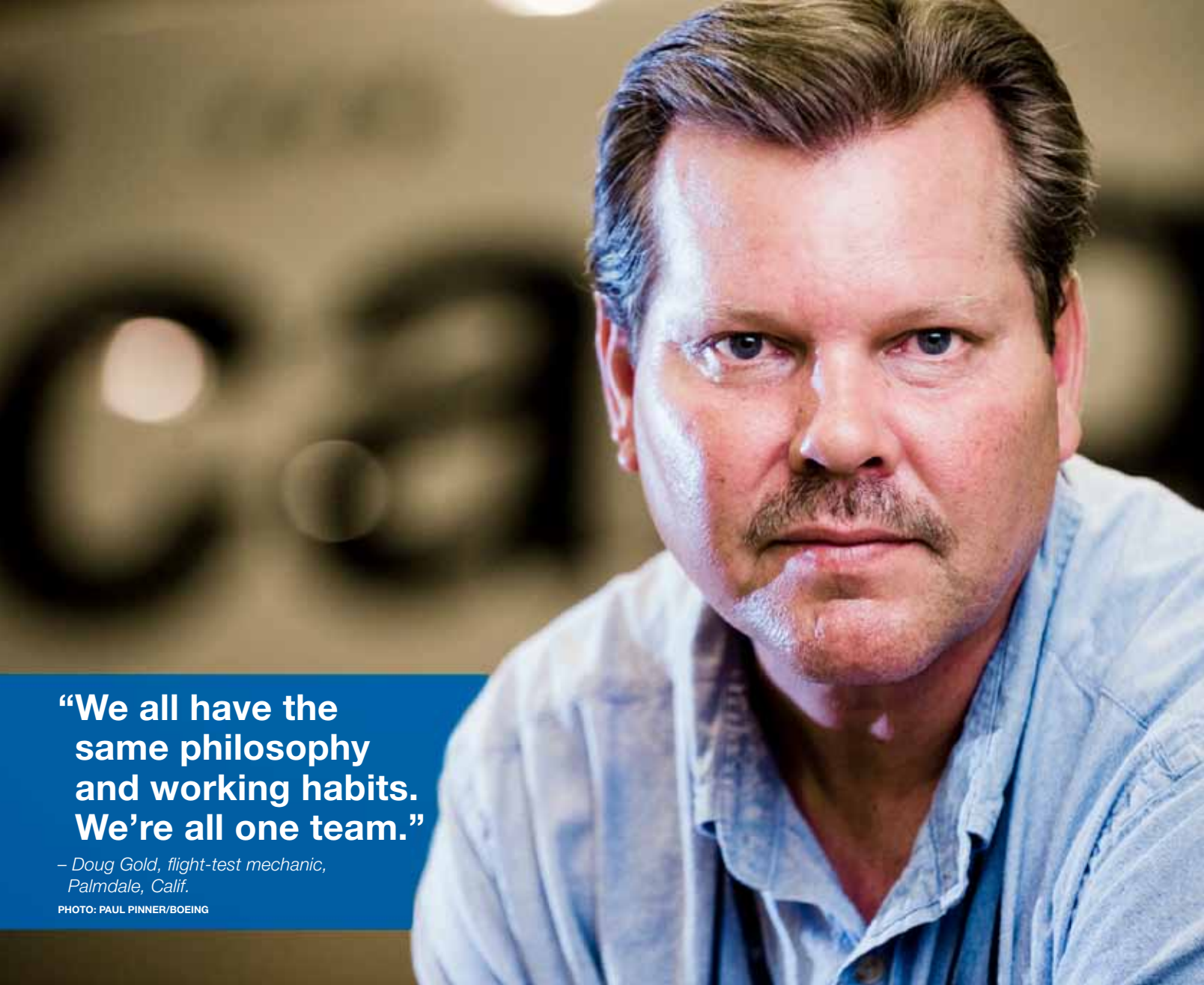
Just as Edwards found Knight quickly through the integrated organization, Dan Wells, an experimental test pilot at Edwards Air Force Base in California, was tapped to meet a sudden need from another part of Boeing.

Pilot testing was scheduled for a new Digital Automatic Flight Control System in the MH-47G Chinook helicopter during a peak production time earlier this year and there weren’t enough test pilots available.

A search for qualified test pilots within Boeing Test & Evaluation revealed that Wells was a helicopter test pilot as

well as an airplane test pilot—he was flying the C-130 at Edwards as part of the Avionics Modernization Program. He’d also flown Chinooks in the Army. Wells went to Philadelphia to learn the differences between the MH-47G and Chinook CH-47, then on to the test site in Middletown, Del., for the flight testing.

Consolidating a number of organizations into Boeing Test & Evaluation has also helped alleviate strains on scarce resources. The 747-8 flight-test program, for example, was shifted to Palmdale, Calif., in August 2009 by Commercial Airplanes and Boeing Test & Evaluation to avoid problems that could have resulted from simultaneously



“We all have the same philosophy and working habits. We’re all one team.”

— Doug Gold, flight-test mechanic, Palmdale, Calif.

PHOTO: PAUL PINNER/BOEING

running two major flight-test programs—the 787 and 747-8—from Boeing Field in Seattle.

“The purpose of BT&E was to bring together test and evaluation resources from across the company, and we’ve been able to demonstrate that right here where we have blended commercial and military teams to execute the 747-8 test program,” said John Stolting, Boeing’s Southwest Region director of Flight Operations in Palmdale.

“We had ground space that could accommodate the airplane, and a lot of people with strong test experience who wanted to add to their skills by working on commercial airplane test operations,” he added. “People were

very excited and still are, and the teams have blended well.”

Doug Gold, a flight-test mechanic in Palmdale, agreed. “It was a good move for Boeing to utilize a facility that they already had,” he said. “And it’s nice to work with other Boeing people who are 1,300 miles (2,100 kilometers) away. We all have the same philosophy and working habits. We’re all one team.”

Chuck Martin, project manager for Ramp Support in Palmdale, put it another way. He called the formation of Boeing Test & Evaluation “one of the best things the company has done in regard to the test world. Why shouldn’t we bring all this talent together?” ■

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“We have a responsibility to work together to design, produce and introduce an airplane that exceeds the expectations of flight crews, cabin crews, and maintenance and support teams, and ultimately our passengers and shippers.” – 1990 agreement between Boeing and United Airlines that is the foundation of the 777 program



PHOTO: Delivery of the first 777 to United Airlines took place at Seattle’s Museum of Flight on May 15, 1995. Flying in the background is the first 777 built. **BOEING**

Family affair

The 777 celebrates two important anniversaries as Boeing aims to make the popular jetliner even better

By **Debbie Heathers**

Passengers flying over Africa on Ethiopian Airlines later this year may not realize that the 777-200LR (Long Range) Worldliner they are on—the airline’s first—is the 900th Boeing-built 777; or that the long-range model, delivered nearly two decades after the program was launched, was in the plan from the very start.

The 777 program celebrates two milestones this month. The first—the 20th anniversary of the program’s first order—took place Oct. 15, 1990, when United Airlines announced an order for 68 777s, which included 34 options. Days later, on Oct. 29, the Boeing board of directors launched the program with a ceremony that was broadcast live to multiple Boeing locations.

“This anniversary gives us the opportunity to realize how far we’ve come and how far we can take this great airplane,” said Larry Loftis, 777 vice president and general manager. “The long-term aspirations our leaders had for the program clearly are being realized.”

The program’s founders envisioned a 777 family of airplanes from day one. It includes five passenger models and a freighter, which is the newest member and entered service in February 2009 with Air France Cargo.

Passenger models range from the initial 777-200, with a range of 5,240 nautical miles (9,700 kilometers), to the 777-200LR, with a range of 9,375 nautical miles (17,395 kilometers), which nearly doubles the range of its predecessor and

connects virtually any two cities in the world.

The top-selling and largest model, the 777-300ER (Extended Range), offers global airlines the opportunity to establish new routes with a full passenger load. Depending on the airline's configuration, the 777-300ER can transport more than 350 passengers in a three-class configuration up to 7,930 nautical miles (14,684 kilometers).

And the innovation hasn't stopped. Boeing engineers, looking for more ways to improve the 777, are exploring ideas that could reduce fuel burn and emissions, lower the airplane's weight, and increase its already extremely high reliability.

"Numerous studies are under way," said Nicole Piasecki, vice president of Business Development and Strategic Integration. "We are always challenging ourselves to make the No. 1 passenger-preferred airplane even better. We intend to remain the market leader and will continue to give airlines even more ways to compete successfully."

Teams of engineers are looking at advanced aerodynamics and new materials for the wings and leveraging 787 architecture and technology into the 777's flight deck and systems.

"Our customers tell us they need to customize the interior of the 777, so we are looking at additional ways to do that," Piasecki said. "We are investing in studies to improve passenger comfort and the cabin architecture using new materials."

Other studies focus on lowering operating costs, as well as improving the airplane's environmental profile. "Efficient design means low fuel consumption, less noise and cleaner emissions," she said.

Improvements over the years don't just include updates to the airplane. The production process was transformed into a moving production line over a six-year period from 2003 to 2009. Because of Lean+ initiatives and improvements, the original plan that allocated two factory bays to 777 manufacturing became unnecessary. Today, the program uses only one factory bay; 787 Dreamliner manufacturing occupies the remaining space.

All six 777 models are built on the same production line.

"It's not unusual to see a freighter, followed by a 777-300ER, then a 777-200LR in production," Loftis said. "Our production line allows us the flexibility we need in order to maintain competitiveness."

Today, it takes only 51 days from start to finish to build a 777.

"That's a reduction of 24 percent, and it is a tribute to employees embracing Lean," Loftis said. "The new culture that [former Boeing CEO] Frank Shrontz talked about at the program's launch event came true."

Shrontz, one of several speakers at the program's 1990 launch event, said at the time: "I've called the 777 the right product at the right time before, but I'd like to add one more thought to that description: The 777 provides us the unique opportunity not only to develop the right product at the right time but also to do it the right way. That's a significant opportunity for all of us."

Other airline revenue-producing ideas such as overhead crew and flight attendant rests, 330-minute ETOPS (extended operations), mood lighting, and premium interiors help the 777 to succeed in the marketplace. With 1,149 orders from 61 customers and 890 deliveries as of Sept. 20, the 777 remains highly regarded with airlines, passengers and pilots.

"Boeing started with a blank sheet of paper and said, 'Tell us what you want,'" Gordon McKenzie, then-manager of United's new technology engineering, told the *Seattle Post-Intelligencer* newspaper in 1990.

Boeing wanted input on the 777 from all of its customers, and a precedent-setting "working together" agreement was signed in United's Chicago headquarters boardroom by Jim Guyette, the airline's executive vice president for Operations, and two former Boeing executives, Richard Albrecht and Phil Condit.

The 64-word agreement (see top of Page 35) set out expectations for the two companies. "This agreement set the foundation for the program as we know it today," Loftis said. "The 777 is a proven performer, delivers exceptional value and repeatedly is at the top of operator and investor polls for its revenue-generating abilities." Other airlines later established similar working-together agreements.

And Boeing continues to incorporate new technology and innovations into the 777, he added, improving operating costs, airplane performance and—most important—the passenger experience. ■

777 by the numbers

- 24 million flight-hours
- 5 million takeoffs and landings
- 879 airplanes in service (851 passenger and 28 freighter)
- 99.3 percent reliability (passenger) and 99.4 (freighter)
- Range up to 9,395 nautical miles (17,395 kilometers)
- \$865 billion (3,200 airplane) market opportunity over next 20 years

Source: Boeing Commercial Aviation Services, as of July



Honors and awards

- Voted best airplane by readers of *American Express Executive Traveler* magazine for 2008, 2009 and 2010
- Awarded Robert J. Collier Trophy in 1995 by the National Aeronautic Association
- Won top honors in the 2002 *Airfinance Journal* operators and investors poll
- Received industrial design awards for both the passenger cabin and flight deck from the Industrial Designers Society of America

Distance and speed records

- World record for distance traveled nonstop by a commercial jetliner of 11,664 nautical miles (21,601 kilometers) on a 777-200LR (Long Range) on Nov. 10, 2005
- Great Circle Distance without Landing record—the 777-200ER (Extended Range) flew from Boeing Field, Seattle, to Kuala Lumpur, Malaysia, covering 10,823 nautical miles (20,044 kilometers)
- Speed around the World, Eastbound record traveling the Seattle–Kuala Lumpur–Seattle route at an average speed of 553 mph (889 kph)
- National Aeronautic Association–certified speed records between Kiruna, Sweden, and Seattle; Bangkok and Seattle; Paris and Seattle; Frankfurt and Seattle; and Geneva and Seattle



PHOTO: After a record-setting nonstop flight of 11,664 nautical miles (21,601 kilometers) eastbound from Hong Kong to London that took nearly 24 hours, Boeing's new 777-200LR (Long Range) touches down at Heathrow Airport on Nov. 10, 2005. **BOEING**

Target acquired

Boeing is preparing retired F-16 fighters for a new mission—airial targets for warfighters

By Wendy Locklear

A bright orange ball of fire burst from the middle of an F-16 Fighting Falcon on the range at Eglin Air Force Base in Florida, sending debris and shrapnel into the air, followed by thick black smoke.

No one was hurt during the Aug. 19 static ground test, and nothing was destroyed other than the F-16.

It was blown up on purpose by the 780th Test Squadron at Eglin to test a flight termination system that will be used when Boeing converts retired Lockheed Martin F-16 jet fighters into remote-controlled aerial targets that can be tracked and targeted—and ultimately shot down—by warfighters as part of their training in weapons and tactics.

The first production QF-16 aerial target is scheduled to be delivered in 2014. During the first phase of the contract, Boeing will modify and test six F-16s at Cecil Field in Jacksonville, Fla., leading to the start of low-rate production in 2013.

In all, up to 126 retired F-16s could be converted. They will be equipped to fly and land multiple times in manned and unmanned configurations before their final missions against live weapons on a controlled range.

“The QF-16 contract is significant,” said Boeing’s Steve Waltman, Aircraft, Sustainment and Maintenance director. “We are here to help the [U.S.] Air Force achieve its goals and provide quality and innovative solutions while remaining low risk and low cost.”

The Boeing team faces a complex task to design and modify the QF-16s, he said.

Engineers in St. Louis are creating images and designing parts using scanning technology and processes developed by Boeing Research & Technology for military applications. As part of risk reduction plan, the team utilized a retired F-16 and technology called the X-ray Backscatter Non Line of Sight Reverse Engineering System. Simply put, the aircraft will enable the QF-16 program to apply reverse engineering practices to accurately design the modifications that are required for conversion of the aerial targets.

“Prior to contract award, we used the X-ray scanning and laser scan data to develop 3-D models of the design,” said Bob Insinna, QF-16 program manager. “We reduced program risk by performing rapid prototyping of the flight termination system and a smoke generation system.”

The reverse engineering bridges the gap between aircraft designed in a non-digital environment and those currently being designed, explained Paul Cejas, QF-16 chief engineer.

“This isn’t the type of engineering we typically do, which is what makes this program both fun and challenging,” Cejas said.

In the meantime, Boeing’s team at Cecil Field has been busy over the past few months preparing for and receiving the first six F-16s for conversion.

“We have completed all critical milestones on schedule,” Insinna said. “Our goal is to listen to our customer, keep them well informed, and continue using our proven processes for systems engineering and program management best practices. We are committed to executing this contract and exceeding customer expectations.” ■

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PHOTOS: This F-16 shell in St. Louis was acquired by Boeing for engineering and tests in preparation for QF-16 conversions. **PETER GEORGE/BOEING AND RICH RAU/BOEING**

“This isn’t the type of engineering we typically do, which is what makes this program both fun and challenging.”

– Paul Cejas, QF-16 chief engineer

PHOTO: RICH RAU/BOEING



Arrival at Gate 7

The 787-9 Dreamliner achieves an important program milestone **By Kathrine Beck and Scott Lefeb**

The newest version of Boeing's 787 Dreamliner, the 787-9, recently passed through an important Boeing checkpoint—Gate 7.

But you won't find this "gate," or the next one the plane must go through, at any Boeing site or airport.

Rather, the gates refer to a process that helps Boeing make the right decisions during every step in the development cycle of a new product. What's known as "firm configuration" is the official name for the seventh gate.

Firm configuration is a significant program milestone in the development of a new Boeing airplane. It means the architecture and capabilities of the airplane are locked in. And on June 30, the 787-9 program reached that milestone.

The 787-9 is the second member of the 787 family, a stretched version with a range of more than 8,000 nautical miles (14,800 kilometers). At 206 feet (63 meters), the 787-9 is 20 feet (6 meters) longer than the 787-8. With this added space, the 787-9 can accommodate 40 additional passengers.

But stretching the airplane involved more than adding two fuselage sections. It required making design changes throughout the airplane—changes that were personally approved by about 500 people in engineering, manufacturing and management.

Starting nearly a year before the airplane's scheduled arrival at Gate 7, the 787-9 team conducted monthly readiness reviews. These reviews involved key technical leaders from across Boeing, as well as independent reviewers.

In the past, according to Brad Zaback, 787-9 Airplane Level Integration Team leader, the first review would begin as a development team approached a gate, and often there were unresolved issues. On the 787-9 program, monthly reviews of the gated process meant risks and issues were addressed earlier. By the time a gate was reached—on schedule to the day for every gate—the major issues already had been resolved.

"There is a lot more rigor, discipline and accountability put into the process," said Phontel Shami, 787 Business Operations senior manager. "This discipline has helped us achieve advanced levels of development maturity in many areas on this airplane."

Boeing set out in late 2008 to establish a companywide gated process to make it easier for decision-makers to manage product development across business units. It also allowed for the development of a rigorous process based on best practices.

"Process discipline has been and will continue to be the overarching theme for 787-9 development," said Mark Jenks, vice president of 787-9 development. "Use of the enterprise gated process is the cornerstone of this focus on process discipline."

The gated process is part of the Development Program Excellence initiative, one of the four companywide growth and productivity initiatives. The initiative focuses on ensuring the success of Boeing's development programs. Representatives of the initiative, led by its vice president, Patrick Goggin, attended the 787-9 reviews.

With firm configuration complete, the 787-9 team now begins the detailed design work on the new airplane as it approaches Gate 8—Critical Design Review. ■

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GRAPHIC: The 787-9 will be 20 feet (6 meters) longer than the 787-8 and will carry about 40 more passengers, depending on an airline's configuration.

JEREMIAH SCOTT/BOEING



“Process discipline has been and will continue to be the overarching theme for 787-9 development.”

–Mark Jenks, vice president of 787-9 development



The simple genius of checklists

Boeing's experience using checklists is helping many other professions

By Tom Brabant

A heart surgery gets under way in a busy Boston hospital. A midwife in a remote African village delivers a baby at a primitive medical clinic. A Boeing 747 takes off from Chicago's O'Hare airport.

All these tasks—each requiring sound judgment and precise execution—reflect the expertise of a Boeing Commercial Airplanes team and its innovative work with checklists.

The Flight Technical & Safety group, part of Boeing Training & Flight Services, has long worked with checklists, a concise list of

tasks pilots use to ensure critical functions are performed, even in emergency situations. But now, the recognition that checklists can increase success whenever critical tasks are being performed has some of the world's most vital professions looking to Boeing as a leader in their checklist compilation, structure and use.

"People in other industries find that in one meeting with Boeing they can benefit from our decades of experience," said Dan Boorman, electronic checklist procedure manager and a Technical Fellow. "There is a trend that recognizes checklists as a tool. A light bulb definitely has come on."

Along with his primary responsibilities, Boorman is the contact for organizations outside of aviation that want to benefit from checklists. He has worked with the FBI, the American Society of Radiation Oncologists, Northwestern Memorial Hospital in Chicago and the Washington State Hospital Association.

One of the most important beneficiaries of Boeing's checklist knowledge is the World Health Organization. Using ideas learned in part from Boorman and the Flight Technical & Safety team, a study of eight hospitals around the world showed that major complications for surgical patients decreased 36 percent after the introduction of checklists. Deaths fell by 47 percent. The World Health Organization now is creating and distributing checklists worldwide.

"What impresses me most is that these people are really questioning how things are done in their profession," Boorman said. "They are not defensive. They are willing to say that they are not getting it right."

The rationale for checklists is not an issue of aptitude, but the realization that complex activities can overwhelm. Professionals who



have skill, knowledge and experience are making mistakes, despite their expertise. A different strategy for overcoming failure is required.

But why are checklists so effective, and what differentiates a common “to do” list from a document that can save lives?

“A good checklist is precise and lists only critical steps in a concise way,” said Erich Mahr, assistant chief pilot, Flight Technical and Safety. “They must be easy to use even in difficult and stressful situations.”

Many programs at Boeing use checklists. Commercial Airplanes’ 737 Engineering, for example, uses checklists to prevent errors within Lean manufacturing systems. Space and Intelligence Systems uses checklists throughout satellite development and production to help with compliance to established processes. Checklists used by these groups have proved they can be a substantial safeguard against errors.

As technologies continue to advance, whether within Boeing or in other industries, checklists can be a simple solution to help navigate complexity.

“I don’t think the future will hold significant change to the concept of checklists,” Mahr said. “Technology may change the methodology, but the principal remains the same. It is by far the best tool to contain errors.” ■

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PHOTO: Boeing instructor pilot Gregg Pointon consults the electronic checklist in the 787 Dreamliner flight deck. **ED TURNER/BOEING**

Checklist factory

An unexpected call to Boeing’s Dan Boorman two years ago from surgeon and author Atul Gawande started a working relationship that is helping medical patients around the world.

Gawande had been trying unsuccessfully to implement checklists in the operating room. Frustrated, he asked his research staff to find an expert in aviation. His team

found Boorman’s published papers on checklist technologies and passed the information along.

By coincidence, Boorman, looking for reading material at an airport prior to a flight, purchased Gawande’s book on medical ethics.

“One day my cell phone rang and it was Atul Gawande,” Boorman recalled. “He introduced himself and I said, ‘I know who you are, I just read your book.’”

Boorman later hosted Gawande at Boeing where he taught him about effective pilot checklists from aboard a 777 flight simulator.

The information that Gawande gleaned from his Boeing visit helped him create a valuable checklist for the operating room and was later published in his best-selling book *The Checklist Manifesto: How to Get Things Right*. The author pays tribute to Boeing’s Flight Technical and Safety group by titling a chapter of his book “The Checklist Factory.”

“It is a privilege to work with highly talented people from other fields critical to humanity,” Boorman said. “It takes little time and energy, but it pays tremendous returns for all of us.”

– Tom Brabant

Maximum security

Alert employees can be the best deterrent in protecting against security threats

By Elizabeth S. Davis

The unusual-looking package caught the eye of a Boeing mailroom employee at the company's rotorcraft site in Philadelphia.

A foreign postmark, the wrapping and the label—"Transformers \$40"—raised suspicions. Instead of delivering the package, the mailroom employee immediately checked with the recipient, who did not know what it was. Boeing Security was notified and an X-ray of the box revealed a suspicious-looking object surrounded by wiring.

Police and the county bomb squad were called, who eventually determined the box's contents were harmless. Even so, the package was destroyed.

Employees such as this mailroom worker are often at the front line of helping keep Boeing secure. And security at Boeing is vital: As the company's business expands, security risks increase.

"Evolving technologies and instantaneous communication have made us more vulnerable to security threats," said Dave Komendat, vice president and chief security officer for Boeing.

And the threats are not just external. In fact, the FBI considers insider threats the greatest risk to the aerospace industry. "We



PHOTO: Pinkerton security officers Keith Niswonger (left) and Melvin Shannon process an on-site emergency call from the Regional Communication Center in St. Louis. RONALD BOOKOUT/BOEING

trust our co-workers—as we should,” Komendat said. “Yet those bent on undermining our security can get a tremendous amount of proprietary information.”

Boeing’s Domestic Security Activity, a part of Security & Fire Protection, works behind the scenes to mitigate threats to Boeing, its business and its employees.

“See something, say something. It’s as basic as that—because an alert work force is the best deterrent to espionage and terrorism,” said Ed Kunigonis, senior manager of Domestic Security Activity.

He explained that the recent Greg Chung espionage case offers a warning of the need to stay vigilant.

Chung, a former Boeing employee, was the first person prosecuted under the U.S. Economic Espionage Act. He was convicted in 2009 on six counts of economic espionage and other federal charges for keeping 300,000 pages of sensitive documents in his home. Prosecutors said he intended to share these documents with the Chinese government.

But any successful prosecution and conviction is still

indicative of a security failure, according to Kunigonis. “We’re pleased that we can catch someone inside our fence line but we have to ask ourselves: Why didn’t someone see something sooner, when the damage would have been minimal?”

Kunigonis emphasized that Boeing must always be on the lookout for internal threats of espionage, as well as external threats. The company collaborates with agencies such as the U.S. Department of Homeland Security and participates in activities that enhance security throughout the industry.

Boeing is a member of the Transglobal Collaboration Program, which consists of leading aerospace and defense manufacturers and major government departments. The organization tackles various security issues, including export control compliance, intellectual property protection, and “leaks” of critical commercial and defense information from the company.

“People want our information,” said Tim McQuiggan, director of Government Security for Boeing Defense, Space & Security. “While we have one of the most comprehensive intrusion detection systems out there, there is no fool-proof



PHOTO: Donald Bonner (left), Philadelphia security manager, and Anthony Diplacido, mailroom services employee, conduct X-ray inspections of incoming packages to the central Philadelphia mailroom. **FRED TROILO/BOEING**

technology. We need human interaction—and we need to be aware of others and of our surroundings.”

Both McQuiggan and Kunigonis stressed that if employees see something that doesn't seem right, they should not ignore it.

“It all comes back to the employees,” McQuiggan said. “When our employees are mindful and alert, they know what is out of place and what isn't.”

A good example is the action of that Boeing mailroom employee, who called security rather than delivering the suspicious package at the company's Philadelphia site.

“Situational awareness protects more than just Boeing. It's a good practice, anytime,” said Tom Dickerson, a senior manager with Boeing's Philadelphia Security & Fire Protection.

As Boeing's global business has grown, so, too, has its international security needs. Boeing's International Security Activity group functions behind the scenes, much as the company's Domestic Security Activity team does, to protect Boeing employees and assets outside the United States

by working closely with numerous domestic and international agencies and organizations.

International Security Activity also provides Boeing's security at air shows, such as the major Paris and Farnborough, U.K., events, which occur on alternate years.

“At an air show, we want to highlight our products for the global aviation industry. On the other hand, an air show offers a tremendous hunting ground for illicit data collection and security breaches,” said Verdonn Simmons, a senior manager with International Security Activity.

Overall, Boeing's “security and surveillance efforts rely on today's technologies and the expertise of our security teams to be successful,” said Komendat, Boeing security chief. “But at the end of the day, employees who are aware and alert to strange or unusual activity in the workplace can be our best countermeasure.” ■

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By the numbers

155: Gates and lobby entrances that manage access control throughout the enterprise

5,155,102: Badge transactions enterprisewide during a 30-day period at sites that use SecureBadges

485: Static and mobile guard posts across the enterprise

1,000-plus: Officers who provide around-the-clock uniformed services to secure 17,000 acres (6,880 hectares) of Boeing-owned and leased land

73,600-plus: SecureBadges created for Boeing employees, through mid-September of this year

292,748: Temporary badges issued to visitors, vendors, suppliers, delivery drivers, tour groups and employees so far in 2010, as of Aug. 30

28,000: Average number of dispatch calls processed by 100 Boeing dispatch operators across the enterprise each month (223,000 total calls as of Sept. 15)

Source: Boeing Security & Fire Protection

PHOTO: Boeing K-9 officer Chad Olson and Stryker perform a security sweep on a new Boeing 737 prior to customer delivery. MARIAN LOCKHART/BOEING

FIT FOR LIFE

Fatigue testing of a 787 Dreamliner test airframe began last month at Boeing's Everett, Wash., site. Over the next three years, for seven days a week, engineers will apply loads to the Dreamliner airframe to simulate more than 100,000 flights, with every flight, or cycle, to include a takeoff and landing. "Unlike static tests, where loads are applied to the airplane structure to simulate both normal operation and extreme flight conditions, fatigue testing is a much longer process that simulates up to three times the number of flight cycles an airplane is likely to experience during a lifetime of service," said Jim Ogonowski, structures vice president, Commercial Airplanes.

PHOTO: JEREMIAH SCOTT/BOEING



TOGETHER WE FLY HIGHER.

Where do you go to find smart design? Boeing went back to university. Together with Cranfield University, we're developing Integrated Vehicle Health Management: innovative systems that constantly monitor an aircraft's health to improve maintenance and extend lifespan. Thanks to our UK partnerships, we're not only flying higher together but for longer, too.

Discover more at boeing.co.uk/together

