BOEING

August 2008 | Volume VII, Issue IV

Frontiers

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SPOTN

The Weapons Program team at Boeing is reinventing itself to better meet emerging warfighter needs.

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Before creating comes imagining, whether it's new technologies or an individual career.
Boeing wants everyone who comes here to imagine the future they want to build, both for themselves and for the world.
Which is exactly what this newest image in Boeing's "Epic" recruitment campaign was created to do.

ON THE COVER: Mike Dour performs final-assembly tasks on a Small Diameter Bomb in St. Charles, Mo. RICHARD RAU PHOTO

RICHARD RAU PHOTO

COVER STORY

BULLSEYE | 12

Otis Stith uses ergonomic handling equipment to move a Joint Direct Attack Munition tailkit from the St. Charles, Mo., assembly line to the packaging area. He's a member of the newly formed Weapons Programs organization, which is reinventing itself to better meet warfighter needs and deliver even greater capabilities to U.S. and allied forces.

FEATURE STORY

Rich history, strong future | 50

Turkey reveres its storied past as it moves confidently into a technologically capable, global future. With 65 percent of its population age 34 and under, the country is working to develop a tech-savvy work force. That's important to Boeing, which is undertaking a cross-enterprise approach to doing business in this market—the home to customers in both the commercial and defense segments.

A clean handoff | 22

In July, the first P-8A Poseidon achieved "factory complete" status as workers at the Boeing Commercial Airplanes factory in Renton, Wash., rolled it off the moving assembly line. Now, Integrated Defense Systems teammates will complete systems integration and functional checks.

A load of assistance | 27

Boeing Commercial Airplanes' structures engineering team was spread thin supporting several development programs. Where did the business unit find the know-how to support the new 747-8 Freighter? From around the enterprise—including Integrated Defense Systems sites.

46 Brussels-based employee Fabienne Jacob, Human Resources staffing specialist for Europe, the Middle East and Africa, uses four languages on the job. Jacob and Boeing's many multilingual employees, based in the United States and internationally, help strengthen the company's global presence. PIERRE WACHHOLDER PHOTO

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After an airplane is ticketed but before it flies away, Boeing Repair Stations ensure its continued airworthiness. The company's repair station certificate allows Commercial Airplanes to fulfill its commitments to customers.

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The T-45 team at Boeing is not merely building this trainer aircraft for the U.S. Navy, it's creating upgraded programs that give future aircrew members a robust training experience.

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Matt Ganz joined Boeing in February as the president of Phantom Works, the organization that's helping support the technology needs of Boeing's business units. He's been primarily in a "listening mode" during his first six months. Here's what's on his mind.

We've got connections | 42

Network-enabled operations aren't just to support battlefield awareness. In Boeing's vision of the factory of the future, tools and sensors will be part of a huge global system of systems that connects facilities, customers, suppliers and external support and services.

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Today, Boeing has employees in 70 countries and customers in 90. The company's multilingual employees, located both in the United States and internationally, play a major role in supporting Boeing's business goals around the world.

INSIDE

Managing benefits makes good business sense

Rick Stephens

Senior Vice President, Human Resources and Administration

BOB FERGUSON PHOTO

Just pick up a newspaper, watch television news or click on your favorite online news source and you can read one story after another about the state of today's global economy. Finding ways to increase productivity and manage costs is increasingly critical for the success of all areas of our business. And since it's people who contribute to Boeing's success, focusing on improving employees' and their families' well-being is equally important.

Offering a competitive benefits package is a key part of our overall strategy to attract and retain the talented people we need to run our businesses effectively. At the same time, we must be sure that the benefits and programs we're offering meet the needs of our current employees, the future work force, and the company.

We recently introduced a couple of benefits changes that are geared toward helping us achieve that balance.

In late June we announced that, after Jan. 1, 2009, all nonunion new hires will be offered a new retirement program that includes a savings plan with both an automatic company contribution and a company matching contribution. One of the key reasons we made this change is to ensure we are positioned to meet the needs of our future work force while remaining competitive in the marketplace. More and more, newer employees want more flexibility, portability and financial control than they can get from traditional defined-benefit pension plans, so companies are moving in that direction.

Another driving force behind the new hire retirement-program changes is the company's need to better manage the costs, financial risks and long-term liabilities of pension plans. Changes in the economy can quickly affect pension funds, and this increases the company's funding obligations. Those obligations could potentially constrain our ability to invest in products and services as well as research and development that persuades customers to choose Boeing over our competitors. The retirement program changes address the long-term liability issue; they also help us continue to support our businesses and provide competitive benefits to all our employees.

On the health-care front, Boeing is committed to offering programs and resources that allow employees to focus on their well-being. Through September, we again will offer on-site wellness screenings. We want to make it convenient for employees to participate in screenings because we know screenings are critical to maintaining people's health and making an early identification of a potentially serious illness. So we encourage employees to use the results of their wellness screenings—such as cholesterol level and blood pressure—to complete the online Health Assessment, which is a great tool for tracking their progress year over year. (Look for news about this year's assessment later this year.)

My own cholesterol level has continued to drop each year and is now at 167. The annual wellness screenings provide me the motivation to eat right and exercise regularly.

Why do we put so much effort into these well-being programs? Put simply: Physical and financial health generally contributes to a better quality of life for people and a tendency for them to be more focused and productive. Productive employees are critical to our business success and our ability to remain competitive.

Boeing will continue to look for ways to improve the health and financial well-being of employees. As employees, we have a role to play too. By taking advantage of the programs and resources Boeing offers and focusing on our personal health and financial well-being, which helps improve productivity, we all will contribute to Boeing's continued success. ■

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"What a great issue you put out in July. It was the best one I've seen."
—Mary Chavrat, Bellevue, Wash.

KUDOS, FRONTIERS

What a great issue you put out in July. It was the best one I've seen. Every article is interesting. You had a great cover and cover story, and terrific photos and illustrations—especially the "chalkboard" explanation of Share-Value Trust. Thanks for clearing up a few points!

—Mary Chavrat, Bellevue, Wash.

DEGREES OF DIVERSITY?

I am writing because I am very disappointed in the cover story of the June 2008 issue of Boeing Frontiers. The article "Degree of success" features seven employees who have continued their education through the Learning Together Program. Of these seven employees, I did not see one African-American, Asian-American or Hispanic employee featured. The featured employees appear to be mostly Caucasian male employees.

Boeing is about diversity. But this article falls short of reinforcing the diverse group of employees at Boeing who have received degrees with the help of the Learning Together Program.

I am African American and I obtained my degrees thanks to Learning Together. I work with and know of many other employees of various ethnic groups that have also earned higher degrees using Learning Together. Also featuring one female employee and six males is not cool either!

—Mitzi Bowman, Long Beach, Calif.

REMEMBERING THE 707

Regarding the July 2008 article on the first delivery of the 707: I was a member of the first Boeing Customer Engineering Group and was responsible for 707 customers Pan American Airways and several other airlines. The first production 707 was my airplane in Engineering. I was responsible for assuring it met all FAA and Pan Am requirements. The rollout of the initial 707 was witnessed by seven people—five with Pan Am and two with Boeing. I was one of the latter. The only special identification was a sign attached to the nose saying the airplane was the first Boeing 707 and was for Pan Am.

I represented Engineering at the delivery process, which covered three very memorable days. I have the only 707 photo signed on Aug. 15, 1958, by Boeing and Pan Am officials, including Charles Lindbergh, a consultant to Pan Am. During my Boeing career, I had the pleasure of working closely with Pan Am from the Stratocruiser through the supersonic programs. Pan Am was one of the world's best.

—Sid Weiner, Mercer Island, Wash.

CORRECTIONS

• The caption on Page 28 of June 2008 issue misidentified the location of the radome being replaced. The correct location is Kwajalein in the Marshall Islands.

Letters guidelines

Boeing Frontiers provides its letters page for readers to state their opinions. The page is intended to encourage an exchange of ideas and information that stimulates dialogue on issues or events in the company or the aerospace industry.

The opinions may not necessarily reflect those of The Boeing Company. Letters must include name, organization and a telephone number for verification purposes. Letters may be edited for grammar, syntax and size.

CALENDAR

Aug. 12–14: 29th National Aerospace FOD (Foreign Object Damage or Foreign Object Debris) Prevention Conference. Las Vegas, Nev. See www.nafpi.com

Aug. 23–26: 2008 Air Carriers Purchasing Conference. Chicago. See www.acpc.com

Sept. 9–11: American Institute of Aeronautics and Astronautics' Space 2008 Conference and Exhibition. San Diego. See www.aiaa.org/content.cfm?pageid=230&lumeetingid=1872

Sept. 9–11: World Airline Entertainment Association 29th Annual Conference & Exhibition. Long Beach, Calif. See www.waea.org/events/conference/2008

Sept. 15–17: Cargo Facts 2008. Miami. See www.cargofacts.com

Sept. 17–21: Africa Aerospace and Defence Exhibition. Cape Town, South Africa. See www.aadexpo.co.za

Sept. 23: Aviation Week Green Aviation forum. Madrid, Spain. See www.aviationweek.com/forums/greenmain.htm

Oct. 1–5: Japan International Aerospace Exhibition 2008. Yokohama, Japan. See www.japanaerospace.jp

Oct. 6–8: National Business Aviation Association 61st Annual Meeting & Convention. Orlando, Fla. See www.nbaa.org

SNAPSHOT

SEE YA LATER, FREIGHTER!

The first 777 Freighter successfully took to the skies over Puget Sound on July 14 on its initial flight. The sixth and newest member of the 777 airplane family took off from Paine Field in Everett, Wash., and flew for more than three hours. During the inaugural flight, 777 Chief Pilot Suzanna Darcy-Hennemann and 777 Deputy Chief Pilot Van Chaney took the airplane to an altitude of 18,000 feet (5,486 meters) and an airspeed of 270 knots, or about 311 miles (500 kilometers) per hour (Mach 0.42), customary on a first flight. Typically, the cruise altitude for the 777 is 35,000 feet (10,668 meters), and the airplane's cruise speed is Mach 0.84. During the next several months, this airplane and a second one will prove the airplane's safety, reliability and service-ready condition during approximately 270 flight hours and more than 450 ground-test hours. The plan is to earn certification from the U.S. Federal Aviation Administration and Europe's Joint Aviation Authority during the fourth quarter and deliver to launch customer Air France shortly thereafter. To date, Boeing has secured 78 firm orders from 11 customers for the 777 Freighter.

TIM STAKE PHOTO

QUOTABLES

"The danger for us is that we get lazy, live off this exchange rate and let costs build up. … I'm trying my best not to let that happen."

— Jim McNerney, Boeing chairman, president and CEO, about how the weak U.S. dollar affects Boeing and international competitors such as Airbus, in the July 14 *Aviation Week & Space Technology*

"A lot of people have tried to say this is all about 'Buy America,' but to us it was all about (how) the Request for Proposal was not followed."

— Jim Albaugh, Integrated Defense Systems president and CEO, about Boeing's reasons for protesting the U.S. Air Force's contract award for tanker refueling aircraft, in the July 14 *Financial Times*

"The size of our order mirrors the rising prominence of the Middle East and its increasing emergence as a new focal point of aviation."

— James Hogan, CEO of Etihad Airways, at last month's Farnborough International Airshow, in the July 15 *Wall Street Journal*. Etihad and Boeing announced an order for 35 787-9 Dreamliners and 10 777-300ERs (Extended Range) airplanes.

IAM PROMOTIONS

No promotions listed for periods ending June 27 and July 4, 11 and 18

ETHICS QUESTIONS?

You can reach the Office of Ethics & Business Conduct at 1-888-970-7171; Mail Code: 14-14; Fax: 1-888-970-5330; TDD/TTY: 1-800-617-3384; e-mail: ethicsline.ethics@boeing.com; Web site: http://ethics.whq.boeing.com

A step to the moon

DC-X experimental lander set up Boeing for future NASA work

By Ed Memi

You probably remember the Apollo lunar lander from the 1960s. But did you know that Boeing has more recent experience with this type of space vehicle? McDonnell Douglas, a Boeing predecessor company, built the Delta Clipper–Experimental DC-X, a prototype experimental lander, and the more-advanced Clipper Graham DC-XA vehicle. Boeing will put that expertise to good use when it competes to build the United States' next lunar lander in 2011 or 2012.

The DC-X program was an unmanned prototype of a reusable single-stage-to-orbit launch vehicle. The one-third-scale DC-X was never designed to achieve orbital altitudes or velocity. Instead, it was meant to demonstrate various flight concepts, such as vertical takeoff and landing and responsive operations.

McDonnell Douglas received its DC-X contract on Aug. 16, 1991, from the U.S. Department of Defense's Strategic Defense Initiative Office; the contract was taken over by NASA's Marshall Space Flight Center when it became the DC-XA program.

The cone-shaped 42-foot (12.8-meter) DC-X and DC-XA vehicles were assembled in Huntington Beach, Calif., with test flights taking place at the White Sands Missile Range, N.M. The DC-XA was a lighter-weight version of the DC-X that relied on the use of more-advanced technologies to provide improved performance.

'VERY COMPLEX SYSTEMS'

The DC-X conducted its first of eight test flights on Aug. 18, 1993, while another four flights were flown under the DC-XA program. The flights lasted from 59 to 142 seconds, and the highest altitude was 10,300 feet (3,140 meters).

"Rocket-powered vertical landers are very complex systems, and we have a really deep understanding of how those systems work," said James Ball, who was on the original DC-X proposal team and eventually went on to lead the DC-XA software team. Ball, now a Boeing manager for the flight function at Huntington Beach, noted that the lunar lander was a simpler vehicle than the DC-X; for example, the DC-X featured four engines, while previous landers had just one.

The DC-X demonstrated that aircraft-like operations are possible using rocket-powered reusable vehicles. "The vehicle flew forward, backward, sideways and could hover. Most vehicles don't do that," said Dan Nowlan, a Boeing technical fellow who was the DC-X guidance, navigation and control lead.

There were also a host of performance requirements for the vehicle, which used innovative fuel-tank technologies such as lightweight composite tanks, lines and valves. The DC-X program featured new propulsion technologies such as gaseous oxygen and hydrogen roll-control thrusters. Other innovations included an autonomous checkout to include leak detection and isolation. These technologies can be directly applied to future lunar lander designs.

One of the objectives of the test program was to demonstrate that the DC-X had a robust, adaptive vehicle design. During the fifth test flight, a portion of the side of the vehicle was damaged, but the design was so robust that the vehicle was able to land safely. Lt. Col. Jess Sponable, Single Stage Rocket Technology program manager for the Ballistic Missile Defense Organization, was quoted in a company press release saying, "This anomaly resulted in successful demonstrations of several important firsts: executing the autoland sequence demonstrating an 'aircraft-like' abort mode; landing on the gypsum (desert ground), demonstrating the ability to land future vehicles virtually anywhere; and demonstrating the system's toughness and robustness, since the DC-X continued to fly despite the aeroshell damage."

During another test flight, a vehicle fire destroyed a control flap, but the vehicle was repaired in time for its next test flight. On test flight three, the vehicle survived a propellant helium bubble during liftoff and autonomously recovered

The McDonnell Douglas DC-X blasts off from the desert at White Sands Missile Range, N.M. The DC-X needed only two years from contract award to first flight.

MCDONNELL DOUGLAS PHOTO

control, demonstrating the equivalent of an engine-out capability. "This showed how the DC-X's highly adaptive flight-control system could adjust to an unplanned maneuver and save the vehicle," Ball said.

'FLY A LITTLE, BREAK A LITTLE'

The DC-X was designed for reliability, maintainability, supportability and operability. Given the uncertainties of the design, the plan was to produce a deliberately simple test vehicle and to "fly a little, break a little" to gain experience with a fully reusable quick-turnaround spacecraft. Demonstration objectives included a 7-day turnaround between flights with a 3-day goal and use of 50 or fewer on-vehicle maintenance personnel. The program achieved a 26-hour turnaround with 10 maintenance personnel.

"My heroes during the flights were the operations and maintenance folks. They did amazing things in turning this vehicle around in terms of repairs and doing things quickly," Nowlan said. The DC-X program flew with a total field-support team of only 25 engineers and technicians.

The DC-X used fast-track management rules for the $60 million contract. Nowlan said one of the reasons for success was the reliance on system-level, end-to-end testing to spot problems before each flight. Independent reviewers were impressed with the speed with which problems were addressed and resolved. "The reason DC-X was successful was because of our customer commitment to rapid prototyping principles and our internal program management," Nowlan said.

Even with these achievements in flight, prototyping and program management, one of the program's most significant technical advances was its streamlined software-development process. This helped increase efficiency over previous systems and greatly cut support-infrastructure requirements during test flights. "We literally could turn around software in small fractions of what it takes to launch current systems," Ball said. Echoed Don Barnes, a Boeing Ares I engineer who was a DC-XA stress engineer for the first use of a composite hydrogen tank in the spacecraft: "We did not have much in way of paperwork—which I liked, since it was such a fast-paced development program." ■

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Tale of the tape: *DC-X*

Height: 42 feet (12.8 meters)

Diameter: 13 feet 4 inches at base (4.06 meters), conical shape

Weight empty: 20,000 pounds (9,072 kilograms)

Weight with full load of propellants: 41,600 pounds (18,869 kilograms)

Propellants: Liquid oxygen and liquid hydrogen

Engines: Four RL-lOA5 rocket engines, each generating 13,700 pounds (6200 kilograms) thrust.

Reaction Controls: Four 440-pound-thrust (200-kilogram-thrust) gaseous oxygen, gaseous hydrogen thrusters

Workers pose under the DC-X following its rollout from the factory floor in Huntington Beach, Calif. The DC-X spacecraft demonstrated that aircraft-like operations are possible using rocket-powered reusable vehicles and pioneered the use of lightweight composite fuel tanks, lines and valves with potential for future lunar landers.

MCDONNELL DOUGLAS PHOTO

Let's talk about negotiations

For contract talks, Boeing shares more information, does it earlier

For the 2008 contract negotiations with the International Association of Machinists and Aerospace Workers (IAM) and Society of Professional Engineering Employees in Aerospace (SPEEA), Boeing is sharing more information and is doing it earlier. It's part of an effort to create a more open and collaborative process—lessons learned from past experiences.

Boeing also is calling on its managers, who are often employees' first source for company information, to talk with their teams about the negotiations. Managers already share their knowledge of Boeing's business strategy, motivate teams to meet customer commitments, improve quality and safety and implement process improvements, which all contribute to the company's success.

"It's important for managers and employees to talk about issues that come up during labor negotiations, because labor contracts are a big part of our business plan and have a significant effect on employees," said Doug Kight, vice president of Human Resources for Boeing Commercial Airplanes. "These team and individual discussions are great opportunities to talk about the company's views and make sure employees have the facts."

The IAM contract expires Sept. 3 and the SPEEA contract expires Dec. 1. These contracts cover about 43,000 Boeing employees.

To ensure that managers stay informed, the company launched an external negotiations Web site (http://www.boeing.com/2008negotiations), Kight sends regular negotiations updates to managers, and HR generalists have been briefing managers on the negotiations process and specific pay and benefits issues. Boeing's ultimate goal is to negotiate contracts that share the company's success with employees while ensuring Boeing's competitiveness over the long term.

What are the goals for this year?

• **Listen.** Company and union leaders have been meeting for many months on many issues. These talks include meetings at many levels, including quarterly meetings with Scott Carson, Commercial Airplanes president and CEO, and leadership meetings with union leaders and Boeing President Chairman and CEO Jim McNerney, Senior Vice President of HR and Administration Rick Stephens and Vice President of Employee Relations Gene Woloshyn. The guiding spirit behind all of these meetings is one of openness, honesty and transparency.

• **Communicate proactively.** Negotiations updates, messages and background on the process are available on the external Web site. Managers should encourage employees to review this with their families so they understand the issues and the value of the company's final contract offer. In addition, Kight has entered the blogosphere, creating a virtual dialog with managers. The innerViews blog, at http://innerviews.blog.boeing.com on the Boeing intranet, is a valuable resource for information on the negotiations process and business issues affecting negotiations.

Doug Kight, Human Resources VP for Boeing Commercial Airplanes, addresses an employee meeting in Auburn, Wash., last month. Meetings like this reflect what Boeing is doing to create a more open and collaborative process during union negotiations.

ALAN MARTS PHOTO

• **Begin early.** Boeing chose not to wait for official bargaining to start before engaging union leadership and discussing the challenges the business faces. Boeing outlined its priorities in a "Platform for Discussion" with the IAM on May 9 and will share a Platform for Discussion with SPEEA on Sept. 10. The platforms outline the key compensation, benefits, work-force and employee-relations topics that will be the major focus of ongoing subcommittee work and main-table negotiations. The IAM platform is available on the negotiations Web site and the SPEEA platform will be posted on Sept. 10.

• **Align the team.** Leaders at Corporate, BCA, Integrated Defense Systems, Shared Services Group, and Engineering, Operations & Technology are working to avoid disconnects on any issue so that they speak with one voice on any negotiations topic.

• **Focus on fewer issues.** Pay and benefits issues are complex. The negotiations team wants to avoid having too many issues on the table, which can lead to confusion and misunderstandings. The goal is to present an offer that is clear to all—including spouses and families. A successful outcome will balance how Boeing rewards employees and effectively manages costs so the company can stay in business over the long term. ■

'A terrific investment'

NASA salutes team of Boeing engineers for software innovation

By Ed Memi

NASA recently recognized a Boeing team of engineers for their effort to develop an easy-to-use Web-based database system to operate the International Space Station Software Development and Integration Laboratory more efficiently.

The effort, called the Support Systems Upgrade project, consolidated a number of spreadsheets and localized data sources into a centralized database. The innovative use of Open Source Software earned the Boeing team a NASA Johnson Space Center Exceptional Software Award.

The lab, located at the Johnson Space Center in Houston, is used for integration testing and certification of flight-control software for the 50 computers used throughout the ISS. The lab is also used to test software and hardware together as a system and is used to help resolve ISS on-orbit anomalies.

The flight control software controls virtually everything on the ISS, including electrical power, communications, payloads, life support systems, guidance, navigation, thermal control and other systems that keep the ISS flying safely.

"We are making sure the flight software when uploaded to the ISS works perfectly the first time. That is why this lab is so important," said Manfred Hornung, a Boeing ISS software engineering manager and a leader of the team project. "In a nutshell, we consolidated and integrated the way we operate the software laboratory."

Manfred Hornung (left), manager of the Boeing International Space Station Software Development and Integration Laboratory (SDIL) Support Systems, and Neel Sheth, software engineer, are inspecting bus connections in the SDIL computer room. Boeing recently won a NASA award for improving the way the SDIL is used. PATRICK ARMSTRONG PHOTO

Prior to the Support System Upgrade, setting up a test in the laboratory could be a complex task, especially with computers and subsystems interacting with one another.

"One of the problems was that there was no linkage between the different products, so you could not get an overall picture of what was going on with the lab," said Butch Gaston, a Boeing senior software engineer who designed the new Web-based application. "You often had to go to different people and look at different databases, and there were often data-integrity problems, since everything was separate."

Typical tasks handled by the software include configuration management, scheduling testing tasks, metrics gathering and new automation capabilities that allow quick setup from one test to another. Under the old process, it would take two to four hours to reconfigure the laboratory following each software test. Now that the test configurations are pulled directly from the central database, the process takes only about 30 minutes.

Said Susan Creasy, head of NASA ISS Avionics and Software, about the Support Systems Upgrade: "It turned out to be a very successful project and a terrific investment." ■

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IN BRIEF

• The U.S. Air Force could pay as much as $44 billion more in fuel bills over 40 years to operate a fleet of 179 Airbus A330-200 aerial refueling tankers, compared with a similar number of tankers based on the Boeing 767-200ER, according to a study.

This assessment is based on a Conklin & de Decker Aviation Information study, funded by Boeing, that calculated the Air Force's cost with oil at $130 per barrel, $150 per barrel and $200 per barrel. Oil prices recently hit a record high above $147 a barrel, and many analysts expect prices to continue climbing. As the largest consumer of fuel in the Department of Defense, the Air Force spends an additional $600 million annually for each $10 increase in the price of a barrel of oil.

The Pentagon decided last month to request revised bids for recapitalizing the Air Force's air tanker refueling fleet, after the Government Accountability Office ruling in June to uphold a Boeing protest over the initial award. In February, the Air Force selected the Northrop/EADS team to supply new tankers; Boeing protested this award, arguing that the procurement process was flawed.

Boeing welcomed the decision to request revised tanker bids but expressed caution over the possibility of changes in what the service is seeking.

On target_

Weapons Programs business is well-positioned to address evolving needs of warfighters

By Tim Deaton and Linda James

Equipping warfighters to deliver the right weapon—precisely on target, from distances too far to see, under extreme battle conditions—is business as usual for Boeing's Weapons Programs. However, in the evolving world of warfare, business as usual is not enough. That's why this newly formed Boeing organization is reinventing itself to better meet emerging warfighter needs and deliver even greater capabilities to U.S. and allied forces.

Weapons Programs, part of Boeing Military Aircraft, was formed through the merger of Boeing's legacy Weapons and Integrated Missile Defense (IMD) businesses. That merger combines two strong Boeing entities to provide the synergistic, rapid development of innovative systems that armed forces require today. The long-sustaining production discipline of the legacy Weapons Programs with the advanced technology development activities of both Weapons and IMD businesses is a combination that puts the new organization on target for the future.

"Integrating our extensive knowledge of complex, precision engagement technologies with our world-class experience in producing highly reliable weapons is an outstanding formula for responding to our customers," said Debra Rub, Weapons Programs vice president. "Meeting the needs of the warfighter is not part of our job—it is our job. We are dedicated to understanding and responding to our customers' requirements with innovative solutions that work the first time, every time. It's why we come to work every day."

And it's a commitment that customers have recognized.

"Boeing continues to provide excellent products and support to our Naval warfighters," said U.S. Navy Capt. Mathias Winter, Precision Strike Weapons Program Office (PMA-201). "The strong Boeing/PMA-201 teaming relationship will ensure our Naval, joint and coalition warfighters have these world-class capabilities today and into the future to fight the fight, and win."

DEEP, BROAD CAPABILITIES

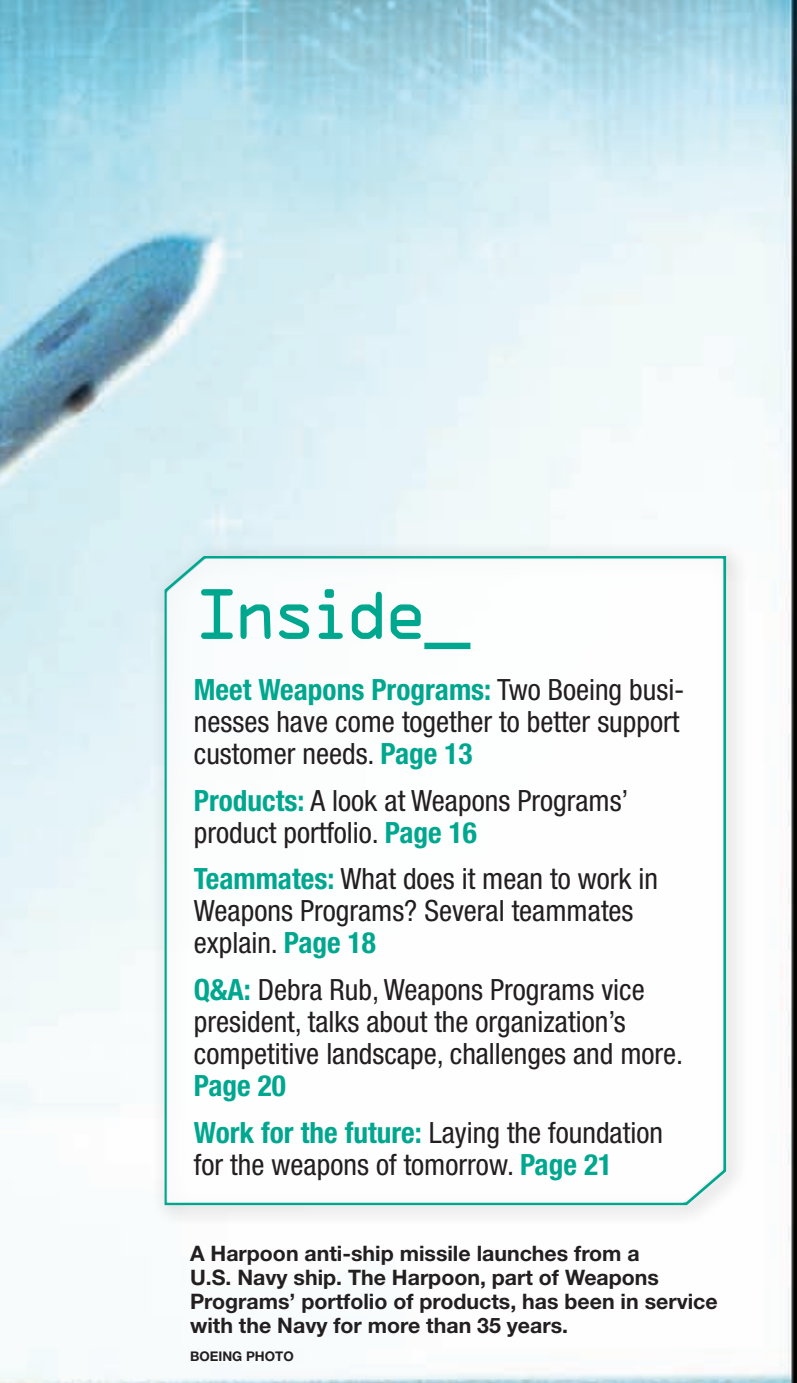
Weapons Programs, which generates about $1.2 billion in annual revenues, delivers all elements of the weapon system throughout its life cycle—from design and development, to delivery of a completed missile and its integration on the launch platform, to post-delivery support of the weapon system.

"The merger of our businesses is a perfect example of bringing together the best of Boeing to take our customer focus to the next level," said Rub, who was leading the IMD programs before moving to lead the integrated organization.

Those capabilities address the evolving needs of warfighters and have created results that are pretty explosive and unquestionably accurate. For example:

- When a malfunctioning satellite threatened to crash to Earth in February, bringing with it toxic hydrazine gas, Boeing's Aegis Ballistic Missile Defense team and several industry partners worked with the Navy and the Missile Defense Agency to shoot it down with the kinetic

Inside_



A Harpoon anti-ship missile launches from a U.S. Navy ship. The Harpoon, part of Weapons Programs' portfolio of products, has been in service with the Navy for more than 35 years.

BOEING PHOTO

Integration technicians Edrek Jackson (left) and Jeff Anderson assemble the Standard Missile-3 kinetic warhead Guidance Assembly in Huntsville, Ala.

MIKE MCCORMICK PHOTO

warhead of an Aegis Standard Missile-3 (SM-3). Boeing builds the hit-to-kill kinetic warhead for the sea-based SM-3 system.

- When the military recognized the need for a bomb that could be used in congested urban areas, the Small Diameter Bomb (SDB) team responded with the Focused Lethality Munition (FLM), a highly accurate weapon with an extremely low collateral-damage footprint.
- When the Navy and international allies recognized a gap in anti-surface warfare for over-the-horizon engagement, the Harpoon anti-ship missile team developed the Block III upgrade. Harpoon Block III is the first network-enabled weapon, allowing the warfighter to control the missile throughout its flight.
- When warfighters in the Global War on Terror identified a need for precision targeting of fast-moving ground targets, the Laser Joint Direct Attack Munition (Laser JDAM) was created to engage vehicles moving at up to 70 miles (113 kilometers) per hour. "Boeing's early investment in Laser JDAM technology laid the foundation for meeting this urgent operational need to intercept high-speed targets," said Lynda Rutledge, director of the U.S. Air Force's 708th Armament Systems Group. "Because of Boeing's strong belief in Laser JDAM, we were able to deliver a capability to the warfighter in 11 months."

"Boeing has a long history of partnering with our customers to design and build weapons and systems that defend America and its allies. The lives of our warfighters depend on the work that we do, and we never lose sight of that," Rub said.

LEAN MATTERS HERE

As Weapons Programs sharpens its focus on understanding and meeting customer demands, it's maintained its attention to continuously improving the ways it designs and manufactures these products and systems.

"Our strategy is to pull from across programs and the geographically dispersed organization to share ideas and information to speed development and delivery to our customers," said Tony Ham, director of Production Operations.

Weapons Programs uses several complementary manufacturing formats, from high-volume operations to low-volume processes that require more intricate work. The varying formats are a strength and competitive advantage for Boeing.

"These capabilities allow us to provide competitive solutions to our customers' needs, regardless of scope or complexity," Rub said. "Having all of this expertise under one umbrella places us in an enviable position."

Ham said that the Harpoon and SLAM ER programs, for example, draw upon more than 35 years of missile manufacturing experience, yet continually capitalize on opportunities to incorporate Lean+ processes and improvements. Currently, Boeing produces about 60 Harpoons and 50 SLAM ERs each year.

By contrast, JDAM and SDB are produced in a facility designed and built for high-rate manufacturing. The production lines are the only high-rate lines within Boeing. The company produces 60 JDAMs and 10 SDBs every day on these production lines.

"[SDB] enjoys a great reputation within the Department of Defense as a model weapon acquisition program," said Air Force Col. Richard Justice, commander of the 918th Armament Systems Group.

To help achieve those production rates, employees are cross-trained on all assembly operations and rotate jobs daily. "There are some great benefits to job rotation. From an ergonomic standpoint, it cuts down on repetitive motion, and it helps alleviate employee boredom from doing the same job day after day," Ham said.

Another innovation is the use of the Internet to keep the supply lines full on the JDAM line. Webcams have been installed so vendors and suppliers can log on and get a real-time view of how much stock is on hand. When supplies get low, the vendor automatically ships more.

Weapons Programs' Huntsville, Ala., facility demonstrates a third manufacturing style, where employees meticulously assemble PAC-3 missile seekers and SM-3 missile kinetic warheads. The business is a subcontractor to Lockheed Martin on PAC-3 and to Raytheon on SM-3 for these high-technology products that are the key enablers of the missiles' hit-to-kill accuracy.

Weapons Programs fast facts_

Headquarters: St. Charles, Mo.

Other sites: Seattle; Huntington Beach and Anaheim, Calif.; Huntsville, Ala.; Washington, D.C.

Approximate annual revenues: $1.2 billion

Product portfolio:

- Small Diameter Bomb
- Joint Direct Attack Munition
- Harpoon anti-ship missile
- Standoff Land Attack Missile Expanded Response (SLAM ER)
- Conventional Air Launched Cruise Missile (CALCM)
- Aegis Ballistic Missile Defense Standard Missile-3 kinetic warhead
- Patriot Advanced Capabilty-3 (PAC-3) missile seeker
- Numerous proprietary programs

"Assembling, testing and integrating these very complex electronic components is an intricate, time-consuming task that requires extreme skill," Ham said.

Demands for increased production, coupled with decreased costs, have created a manufacturing challenge. To help meet that challenge and ensure that Boeing is positioned to rapidly respond to future production requirements, the PAC-3 and SM-3 teams have successfully incorporated manufacturing improvements. Among them:

- Implementing pulse lines that advance the PAC-3 product down the line at predetermined intervals.
- Identifying a process improvement for curing a sealant material that cut the cycle time by one day for each PAC-3 seeker's critical path. As a result, the team is better able to consistently and predictably meet the customer's delivery requirements.
- Reconfiguring the PAC-3 factory in Huntsville to implement shop-floor improvements that were identified in a Production Preparation Process (3P) event supported by a "one Boeing" team and a Six-Sigma Black Belt from the customer's Lean office. The team has substantially altered the product flow within the factory, enabling the shop floor to produce multiple configurations of seekers on a single production line. The Weapons Programs site in St. Charles conducted a similar 3P event in April to explore the possibility of merging the JDAM and SDB production lines to provide greater efficiency and improve utilization of manufacturing space.

"Employee involvement and engagement creates the positive energy needed to implement Lean improvements on this scale," Ham said.

Employees agree with that philosophy.

"The best thing about employee involvement is that it gives us the ability to have input for how things are set up or designed," said Billy Collins, integration technician and member of the PAC-3 seeker employee involvement team. "Who better to make suggestions and have input than the people doing the work."

In addition, Weapons Programs is constantly exploring technology options to expand its capabilities. The newest addition, a state-of-the-art anechoic chamber in Huntington Beach, Calif., was formally dedicated in May. This Dynamic Advanced Radar Test (DART) site tests seeker engagement and intercept capabilities against tactical ballistic missiles, cruise missiles, air-breathing targets (such as fixed-wing aircraft and helicopters) and emerging threats. The new facility, which includes an anechoic chamber and flight-worthiness test area, doubled the existing chamber's size and expanded the availability of the technology to a range of programs inside and outside Weapons Programs.

"DART provides a one-stop, full-service capability that supports design, development and qualification testing of our most sophisticated radar-based weapons before taking them to the field, where testing can be very costly," Rub said.

LOOKING AHEAD

So how will Weapons Programs define its future? According to Rub, the way forward is to build upon current successes while simultaneously looking for new opportunities to establish the foundation for tomorrow.

"Just as with Laser JDAM, FLM and Harpoon Block III, much of our success has arisen by listening to our customers and adapting existing weapons to meet emerging warfighter needs. That will, of course, continue," she said. "But hand-in-hand with that, we are pulling new and innovative technologies together with the expansive knowledge and expertise from across Boeing to take the business to an even higher level."

One of the first opportunities to implement that strategy is the Navy's Anti-Surface Warfare (ASuW) initiative to develop a new cruise missile. Weapons Programs brings a complete nose-to-tail missile design solution to the competition. Boeing's ASuW design will combine the strengths of the integrated team's seeker and warhead capability with its experience in producing cruise missiles.

"That combination, with its inherent gains in synergy and efficiency is what sets Boeing Weapons Programs apart in the industry," Rub said. "By integrating innovative technologies, proven performance, and an exceptional and committed team, we are positioned to address evolving warfighter needs with cutting-edge weapons and missile-system solutions. This strategy is our foundation for even greater successes." ■

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Terry Griffin torques the bolts on a Joint Direct Attack Munition Tail Actuator Subsystem (TAS) kit. The TAS helps steer the bomb to the target.

RICHARD RAU PHOTO

Hitting the mark_

A look at Weapons Programs' portfolio of products

Aegis Standard Missile–3 (SM-3) Kinetic Warhead

Mission/Role: SM-3 deployed on Aegis cruisers and destroyers defends against short- to medium-range ballistic missile threats in the midcourse phase of flight. Aegis SM-3 has demonstrated the ability to intercept targets with hit-to-kill accuracy during the target's descent phase as well as the more challenging ascent phase. Boeing is responsible for kinetic warhead integration including the guidance unit, the warhead ejector, and the critical-aim-point guidance algorithms and accuracy, which is key to selecting and destroying the target payload.

Location: Engineering – Huntington Beach, Calif.; Production – Huntsville, Ala.

Customers: U.S. Navy, U.S. Missile Defense Agency, 1 International

Factoid: On Feb. 20, the U.S. Missile Defense Agency and the U.S. Navy intercepted and destroyed a nonfunctioning satellite with the Aegis SM-3. The objective was to rupture the satellite's fuel tank to dissipate above the atmosphere about 1,000 pounds of hydrazine, a hazardous material that could pose a danger to people on Earth.

Air-Launched Cruise Missile/Conventional Air-Launched Cruise Missile (ALCM/CALCM)

Mission/Role: Boeing has partnered with the U.S. Air Force to convert surplus ALCMs into non-nuclear CALCMs. The nuclear warheads are replaced with high-explosive, blast fragmentation warheads, and GPS capabilities are added to the missiles.

Location: Seattle

Customer: U.S. Air Force

Factoid: CALCM is dropped from B-52 bombers and has a cruising speed of about 500 miles per hour. The missile is 21 feet long, four feet high and weighs 3,250 pounds.

Joint Direct Attack Munition (JDAM)

Mission/Role: JDAM is a low-cost guidance kit that converts existing free-fall bombs into accurately guided smart weapons. JDAM tailkits incorporate Inertial Navigation System/Global Positioning System guidance to direct the weapon to the target. Laser JDAM adds laser seekers to the weapon to engage and destroy moving targets.

Location: St. Charles, Mo.

Customers: U.S. Air Force, Navy and Marine Corps, 19 International

Factoid: Nearly 200,000 JDAM tailkits have been manufactured since production began in 1998. Laser JDAM was first deployed in-theatre in May.

Harpoon

Mission/Role: Harpoon is the world's most successful anti-ship missile, with more than 35 years of service. The Block II configuration includes GPS guidance for autonomous, all-weather, over-the-horizon and land-strike capabilities. With the advent of Block III, older Harpoons will be retrofitted with a data link package for network-enabled warfare.

Location: St. Charles, Mo.

Customers: U.S. Navy, 29 International

Factoid: Harpoon has a 100 percent hit rate for those fired against enemy ships during conflicts in the Mediterranean and Persian Gulf.

Patriot Advanced Capability–3 (PAC-3) Missile Seeker

Mission/Role: PAC-3 uses hit-to-kill technology to intercept and destroy tactical ballistic missiles, cruise missiles and hostile aircraft through direct body-to-body impact. The PAC-3 Missile seeker provides active guidance data to the missile, which enables the missile to acquire the target shortly before intercept, select the optimal aim point and initiate terminal guidance to ensure target kill.

Location: Engineering – Huntington Beach, Calif.; Production – Huntsville, Ala.

Customers: U.S. Army, Army National Guard, 4 International

Factoid: Currently deployed in Iraq, PAC-3 is the first and only U.S. terminal-phase defense system that can protect against ballistic missiles. The first operational intercept was in the opening hours of Operation Iraqi Freedom, when it scored two intercepts of short-range ballistic missiles that were intended for U.S. military headquarters located in Kuwait.

Small Diameter Bomb (SDB)

Mission/Role: SDB is a low-cost, low collateral damage precision strike weapon. SDB's smaller size, coupled with its four-place carriage, enables more weapons to be carried on each aircraft, thereby improving mission effectiveness against stationary targets. The Focused-Lethality Munition (FLM) variant combines ultra-low collateral damage and pinpoint accuracy for precision strikes on selected targets with limited damage outside the blast zone. The weapon incorporates a carbon fiber composite casing to eliminate fragmentation. The small blast area makes it possible to defeat targets in sensitive areas while minimizing risk to nearby personnel or structures.

Location: St. Charles, Mo.

Customers: U.S. Air Force, 1 International

Factoid: True to its name, the Small Diameter Bomb is only 7.5 inches in diameter, but despite its small size, it can penetrate more than three feet of steel-reinforced concrete.

Standoff Land Attack Missile Expanded Response (SLAM ER)

Mission/Role: SLAM ER is an upgrade to the combat-proven SLAM cruise missile, which is a Harpoon derivative. SLAM ER incorporates GPS guidance and increased range. It is the U.S. Navy's choice for surgical strikes against high-value land targets and ships in port and at sea. SLAM ER has an improved warhead to increase penetration and lethality against hardened targets.

Location: St. Charles, Mo.

Customers: U.S. Navy, 2 International

Factoid: SLAM ER has a range in excess of 150 nautical miles and has a 500-pound titanium penetrator warhead. It is the first missile that can be retargeted after launch. The warfighter can assess the primary target through the missile imaging infrared video display. If the primary target has already been destroyed, the missile can be redirected to another target.

'A great area to learn and grow'_

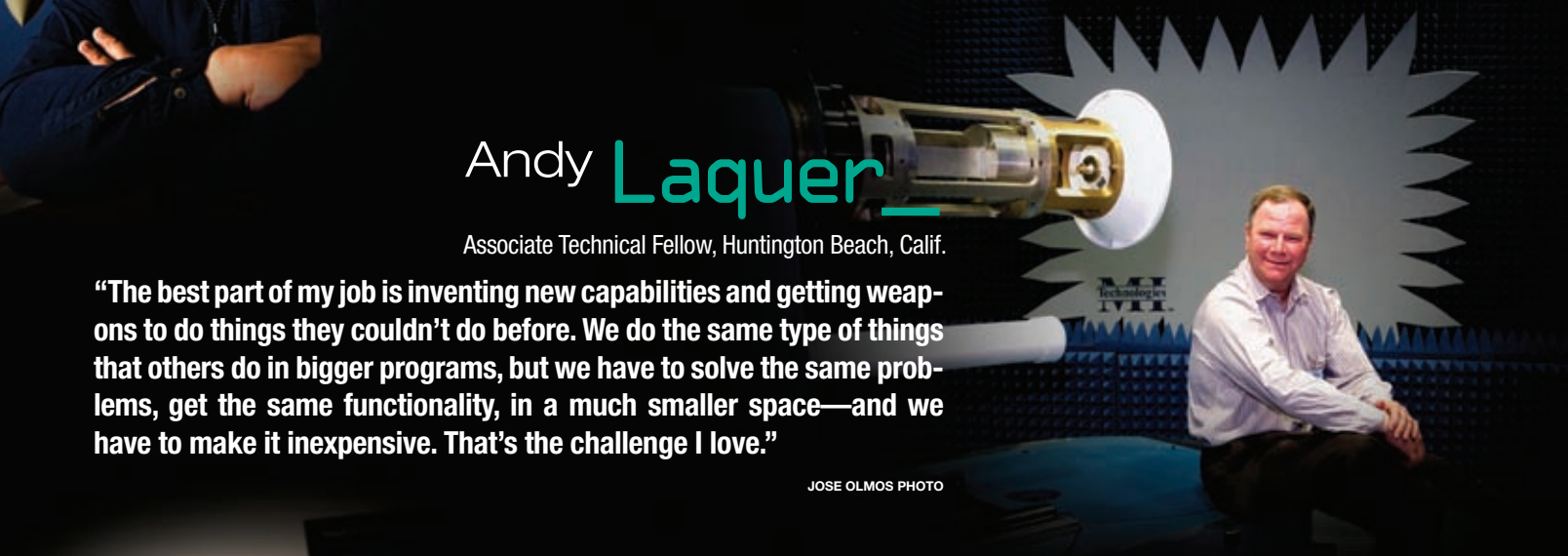
What does it mean to contribute to Boeing's weapons business? Here are opinions from some teammates in Weapons Programs.

Winfield Kang_

Quality manager, St. Charles, Mo.

"I've worked on other, bigger programs, but I truly enjoy working in the smaller environment of Weapons. You have a closer relationship with everyone, you really rely on each other, and you get to see everything out here, every aspect of the program, from womb to tomb."

PETER GEORGE PHOTO



Andy Laquer_

Associate Technical Fellow, Huntington Beach, Calif.

"The best part of my job is inventing new capabilities and getting weapons to do things they couldn't do before. We do the same type of things that others do in bigger programs, but we have to solve the same problems, get the same functionality, in a much smaller space—and we have to make it inexpensive. That's the challenge I love."

JOSE OLMOS PHOTO

Megan Richter_

SDB Contracts administrator, St. Charles, Mo.

"I came from the BCFP (Business Career Foundation Program) rotational program and had a say in my final placement. Weapons was my top choice because I like the culture here. This is a great area to learn and grow because it's small enough that you see, do and touch more. In a smaller program, you have many more varied opportunities due to the fewer number of people."

PETER GEORGE PHOTO

Adell Graham_

Aegis Ballistic Missile Defense guidance processor software lead, Huntington Beach, Calif.

"What we do in software development is not as visible as the hardware. Because software is intangible, it's a challenge to understand. Software is the 'brain' of the weapon that is equally vital to the weapon's functionality. I am truly satisfied that what I work on contributes to the defense of freedom."

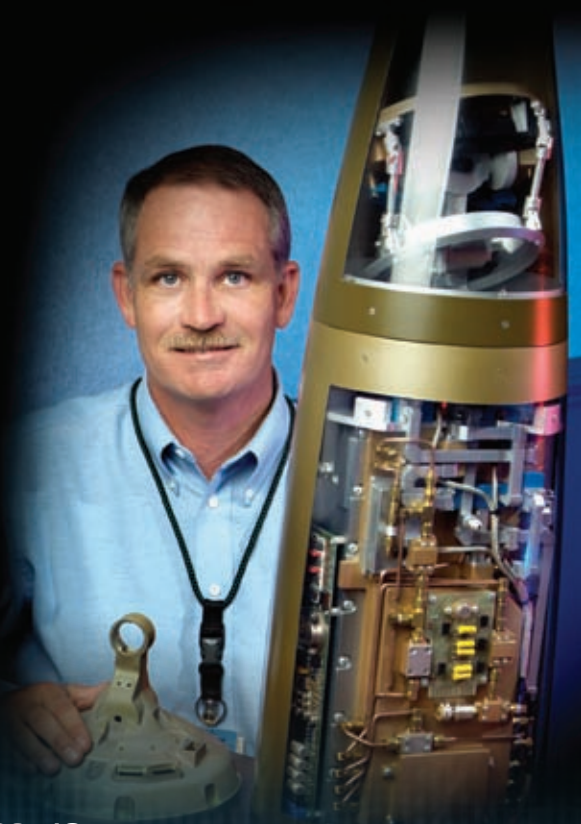
ROSS MISHIMA PHOTO

Phil Winn_

Senior business manager, Bombers and Weapons, Seattle

"I came back to this organization because I enjoyed it so much the first time I was here and because this position offered me a new challenge. Because it's a relatively small program, I get to see everything that's going on, and we have a close relationship with our customer. We're successful because we pay a lot of attention to what the customer's saying, and work to satisfy that need."

MARIAN LOCKHART PHOTO



Marc Hughes_

PAC-3 reliability engineer, Huntsville, Ala. (also a colonel in the U.S. Army Reserve who just spent 15 months in Iraq)

"Reliability is critical when you're in Iraq. Once you leave the walls (of your camp), everything has to work. When you're out there, that's not the place to find out something doesn't work. I was fortunate that I understood the supply chain from both sides. I have an appreciation of what happens if you have to replace or fix equipment in the field. So although there is a rush to get our products to the troops in the field, I know that if something doesn't work, it impacts operations and lives. So I ask myself, 'Is there something we can do here to make sure it works there?' I don't want to compromise quality, it's too important."

ERIC SHINDELBOWER PHOTO

Passion 'second to none'_

Weapons Programs leader: People are key to business's success

Debra Rub was raised in a military family. Perhaps not so coincidentally, she now leads the Weapons Programs business of Boeing. "My personal commitment is to make certain that American warfighters have the best products that we can provide and to ensure that they come home safely to their families," she said. "Every day they put their lives on the line. They sacrifice so much. They deserve nothing less than our very best, every day."

Rub shared her thoughts with *Frontiers* magazine on Weapons Programs, including the competitive landscape and the organization's challenges.

Q: What are your goals for Weapons Programs?

A: This organization is poised for even greater success by becoming an unmatched global leader in weapons and missile-system solutions that will address evolving warfighter missions and needs. That prospect truly excites me, and is where I'm focused. We've brought together the best of technology, innovation, proven performance, and an exceptional and committed team, and integrated those strengths with successful and complex missile-defense programs and weapons businesses. How could we not succeed? And, as we look across the enterprise, it's clear that this organization can offer enabling technologies to help take to the next level some of the larger Boeing platforms and offerings including fighter aircraft, ground mobile platforms, and nontraditional platforms such as Unmanned Aerial Vehicles.

Q: What does Weapons Programs bring to the table that makes it different from competitors?

A: First, awesome technologies integrated into affordable, highly effective systems supported by outstanding, low-cost production in St. Charles, Mo., and Huntsville, Ala. Second, a remarkable level of understanding of weapons that can only come with decades of industry leadership by integrating more missiles and weapons—developed by both Boeing and its competitors—on aircraft and other platforms than any other aerospace contractor. And last, and certainly most important, we listen and respond to our customers', the warfighters', needs with a dedication and passion second to none.

Q: Listening and responding to your customer is harder than it sounds. Is there a secret to our success in this area?

A: No secret at all—just a sincere commitment to building relationships with our customers. That's where it starts. If we aren't attentive to those relationships, we will miss the opportunity to gain essential understanding of what is important to our customers, and in this competitive environment, we may never have another chance. That relationship-building goes beyond understanding the technology requirements. For instance, with our international customers we make it a priority to appreciate our differences, both in mission needs as well as culturally. We seek and find common values and understanding. Once we achieve that level of understanding and trust, then working together to determine the right solution is simple.

Q: Is there a single capability that will be key to the business' future success?

A: Without question, it's people. I am constantly awed by the incredible people that I have the privilege to work with at Boeing. We have the best and the brightest, and I would challenge anyone to find another aerospace company that not only has the depth and breadth of knowledge, but also possesses the unique ability to translate that knowledge into the most amazing array of defense systems across the globe. We need to realize our success depends upon our reliance on each other, our differing perspectives, our varied experiences and our unique expertise.

Q: What's the biggest challenge of leading an organization that spans the United States, with customers in 29 countries?

A: Open communication and teamwork. Our potential for success has never been so great. Across the organization I have seen an enthusiasm and commitment to building a team that is stronger together than apart, a team that understands how we can truly make a difference for our company and for the men and women who protect us and ensure our freedom.

— Tim Deaton and Linda James

Gen. Duncan McNabb, U.S. Air Force Vice Chief of Staff, visits with Debra Rub, vice president of Weapons Programs for Boeing, during a recent tour of the Weapons facility in St. Charles, Mo.

RON BOOKOUT PHOTO

Taking aim at the future_

Advanced Weapons ensures future products hit targets for cost, delivery, effectiveness

By Marc Sklar

From the time huge catapults lobbed boulders, military leaders have sought weapons that deliver more force with greater accuracy from a greater distance in a shorter time frame. That's also the goal of Boeing's Advanced Weapons team, part of Integrated Defense Systems' Advanced Systems organization: to develop weapons that will enable the armed forces to act first and reach farther than is possible with today's weapons.

To develop future weapons, Advanced Weapons first listens closely to Boeing's military customers to understand today what their needs will be tomorrow. They then partner with teams across Boeing to define and develop system-level solutions.

"Advanced Weapons focuses on our business portfolio growth, either by innovatively introducing new technologies, winning new initiatives, or enhancing capabilities within existing programs," said Debra Rub, Weapons Programs vice president. "Advanced Weapons is developing and maturing the concepts and technologies that enable our future business growth."

Carl Avila, director of Advanced Weapons and Missile Systems, said making weapons that are part of a network-centric system is increasingly important in weapons development. "They must be tied into near-real-time mission planning and the command and control system," Avila said. "Networking will reach back to the logistics of the delivery of weapons to the battlefield and perhaps eventually to manufacturing."

The budgets for many of these development and technology-development programs can seem small by Boeing standards but can ultimately lead to huge ongoing revenue streams. Advanced Systems therefore has to strike a vital balance.

"We need to be agile and adaptable enough to be a top-notch developer of things never built before. But then we need to embed processes and production planning in our development, so when we hand over a program, our Weapons teammates can execute it flawlessly," Avila said.

A hypersonic projectile is launched from the Electromagnetic Railgun during a U.S. Navy test. EMRG uses electric power rather than propellant to launch the munition.

U.S. NAVY PHOTO

Here are some of the next-generation weapon systems Advanced Weapons is working on:

- **Joint Dual Role Air Dominance Missile.** The U.S. Air Force is developing this next-generation advanced missile that can conduct both air-to-air and air-to-ground missions. In addition to being more lethal and having longer range than existing weapons, JDRADM would give aircrews more flexibility: Crewmembers would not have to decide before a flight how to divide their weapons loads between air-to-air and air-to-ground weapons. Advanced Weapons has won multiple technology-development contracts related to the system, including sensor and other systems.
- **Electromagnetic Railgun.** This hypersonic projectile is being developed for the U.S. Navy. To understand how it works, picture this: A destroyer receives the coordinates of an enemy target hundreds of miles away. Instead of launching a standard shell, the barrel of the ship's electromagnetic railgun is pointed at the target. By diverting electric power from the ship's engine to the gun turret, a 3-foot-long, 40-pound projectile is launched up a set of superconducting rails that develop a powerful electromagnetic force. The projectile leaves the barrel at hypersonic velocity—Mach 7-plus—exits the Earth's atmosphere, re-enters under satellite guidance, lands on the target less than six minutes later and vaporizes it with kinetic energy alone. Since no propellant is used to launch the projectile, the system makes shipboard operations much safer.
- **Joint High-Speed Strike Weapon.** JHSSW, a program under consideration by the Navy and Air Force, is a high-speed cruise missile for use against targets that must be hit quickly. Advanced Weapons is exploring multiple concepts for high-speed land-attack and anti-ship weapons. Under a Defense Advanced Research Projects Agency and Office of Naval Research contract, the team is developing and testing the HyFly Hypersonic demonstrator vehicle as part of this effort. Hypersonic refers to speeds greater than Mach 5.
- **Massive Ordnance Penetrator.** The goal of this technology demonstration program, funded by the Defense Threat Reduction Agency, is to develop a 30,000-pound conventional penetrating weapon that will defeat a specialized set of hardened and deeply buried targets. The weapon will be carried aboard B-2 and B-52 bombers and deployed at high altitudes. Design features include a GPS navigation system. ■

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It's comin' togeth

First P-8A assembly complete. Next stop: IDS

By Chick Ramey

History's in the making on "Line 3" at the Boeing Commercial Airplanes factory in Renton, Wash. And the Boeing employees, military representatives, industry partners, suppliers and others who work there or have visited there know it.

It's the place where the U.S. Navy's newest military aircraft, the P-8A Poseidon, is coming together. The sense of history in the making partly stems from Poseidon's role as the Navy's first new maritime patrol and reconnaissance aircraft in 30 years. It's also historic because the technically complex military derivative leverages the in-line manufacturing efficiencies of Commercial Airplanes' production system that supplies Next-Generation 737s to commercial airlines.

In July, the first P-8A test aircraft reached the end of the line, so to speak, when it achieved "factory complete" status and workers unhooked it from the moving assembly line.

"We're proud to have completed final assembly on the first P-8A Poseidon," said Mo Yahyavi, Boeing vice president and P-8 program manager for BCA. "Our objective on the P-8 program is to provide the Navy with the world's most advanced maritime patrol and reconnaissance aircraft. Working as one team will enable us to do just that. We're ready to hand off the first airplane so our Integrated Defense Systems teammates can complete systems integration, functional checks and deliver Poseidon to our U.S. Navy customer on time."

Following delivery to IDS, the airworthiness test aircraft will undergo calibration of its flight-test instrumentation prior to flying to nearby Boeing Field in Seattle for systems integration and additional testing early next year.

"Our objective on the P-8 program is to provide the Navy with the world's most advanced maritime patrol and reconnaissance aircraft. Working as one team will enable us to do just that."

– Mo Yahyavi, Boeing vice president, P-8 program manager for BCA

Bob Feldmann, Boeing vice president and P-8 program manager for IDS, said the P-8A team has done a terrific job of meeting all build milestones on schedule.

"Program milestones both big and small are met daily, thanks to our outstanding Poseidon industry team," Feldmann said. "Since the start of final assembly in late March, the team has checked off on-schedule assembly milestones including wing-to-body join and the start of the moving line in May and the completion of full-power testing, or 'power on,' and engine installation in June."

(For more on the start of final assembly, see Page 12 of the May 2008 edition of *Boeing Frontiers*.)

After the first P-8A rolled out of the factory, workers still had plenty to do supporting preflight activities next door at Renton Field. And just days after factory completion of the first airplane, Boeing's team welcomed the arrival of the second P-8A fuselage from Spirit AeroSystems. Boeing now will begin final assembly of the program's static-test aircraft.

Overall, Boeing is building five test aircraft, three flight-test and two for ground-based tests, as part of the System Development and Demonstration contract signed with the Navy. The first aircraft will be delivered to the Navy in 2009. The Navy plans to purchase 108 P-8As to replace its fleet of Lockheed P-3C aircraft. ■

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Photo:

Boeing's first P-8A Poseidon is shown on 737 Final Assembly Line 3 last month prior to rolling out of the Boeing Commercial Airplanes factory in Renton, Wash. Following completion of final assembly, the aircraft began preflight engine runs and other functional tests at Renton Field. JIM ANDERSON PHOTO

Got GPS+?

A Qantas 737-800 lands at Queenstown, New Zealand, using Required Navigation Performance operations, which represent a new, comprehensive instrument-navigation plan. Adding the RNP-complementary Ground-Based Augmentation System landing system would provide precision approach capability and unprecedented improvements to safety and efficiency.

PHOTO COURTESY OF ALEX PASSERINI/QANTAS

Boeing unveiling a next-generation satellite-based airport landing system

By Walter Polt

Boeing has a bold vision: replace the aging Instrument Landing System (ILS) with one that uses the Global Positioning System.

After a decade-long program with the U.S. Federal Aviation Administration (FAA) and RTCA Inc. to develop internationally harmonized standards and address any system safety issues, Boeing and the aviation industry now have a new capability—known by the acronym GLS. This technology, which is one part of Boeing's overall air traffic management strategy, can enhance safety, reduce airplane noise, fuel consumption and emissions, and increase airport arrival and departure capacity, especially in bad weather. GLS is in use with the Next-Generation 737 and is set to be a basic feature on the upcoming 787 Dreamliner and 747-8; it's also an option on the Airbus A380.

ILS is a WWII-era flashlight-like radio beacon. Its signals can be affected by nearby objects such as terrain, vehicles and airplanes, and keeping ILS protected from these disturbances is cumbersome. ILS also is expensive to purchase and maintain. Most notably, the ILS beam offers little of the flexibility needed for future air traffic management operations. GLS, on the other hand, provides pilots variable approach paths and adjustable glide slopes and runway touchdown points. GLS procedures readily integrate with Required Navigation Performance (RNP) instrument procedures in the process of being adopted. Together, these capabilities are some of the tools available for high-capacity, high-efficiency operations.

Unlike current technology, which relies solely on information from ground stations, GLS integrates data from the GPS satellite system, ground stations and a multimode receiver on the airplane to provide pinpoint accuracy of the airplane's position relative to the runway and surrounding terrain.

Boeing's GLS system is digital. It augments GPS signals, making limited-visibility landings precise to within 6 feet (about 2 meters), exceeding ILS accuracy. To support such accuracy requires two components. One is a Ground-Based Augmentation System (GBAS): a land-based computer-and-antenna system developed by Honeywell, among others, that rebroadcasts satellite-generated GPS navigation data corrected for local signal conditions. The other is an onboard multimode receiver capable of correctly receiving and processing the signals from the satellites as well as from the GBAS ground station. Together these elements support an airplane-level function called a GBAS landing system—which is where the acronym GLS comes from. It has all the functionality of the previous instrument landing system and much more.

"The GBAS essentially tells the incoming airplane, 'Here's where you really are,'" said Steve Duenkel, program manager for Performance Based Navigation in the Navigation Services business unit within Commercial Aviation Services. It also broadcasts precision digital approaches that guide the autopilot to a landing.

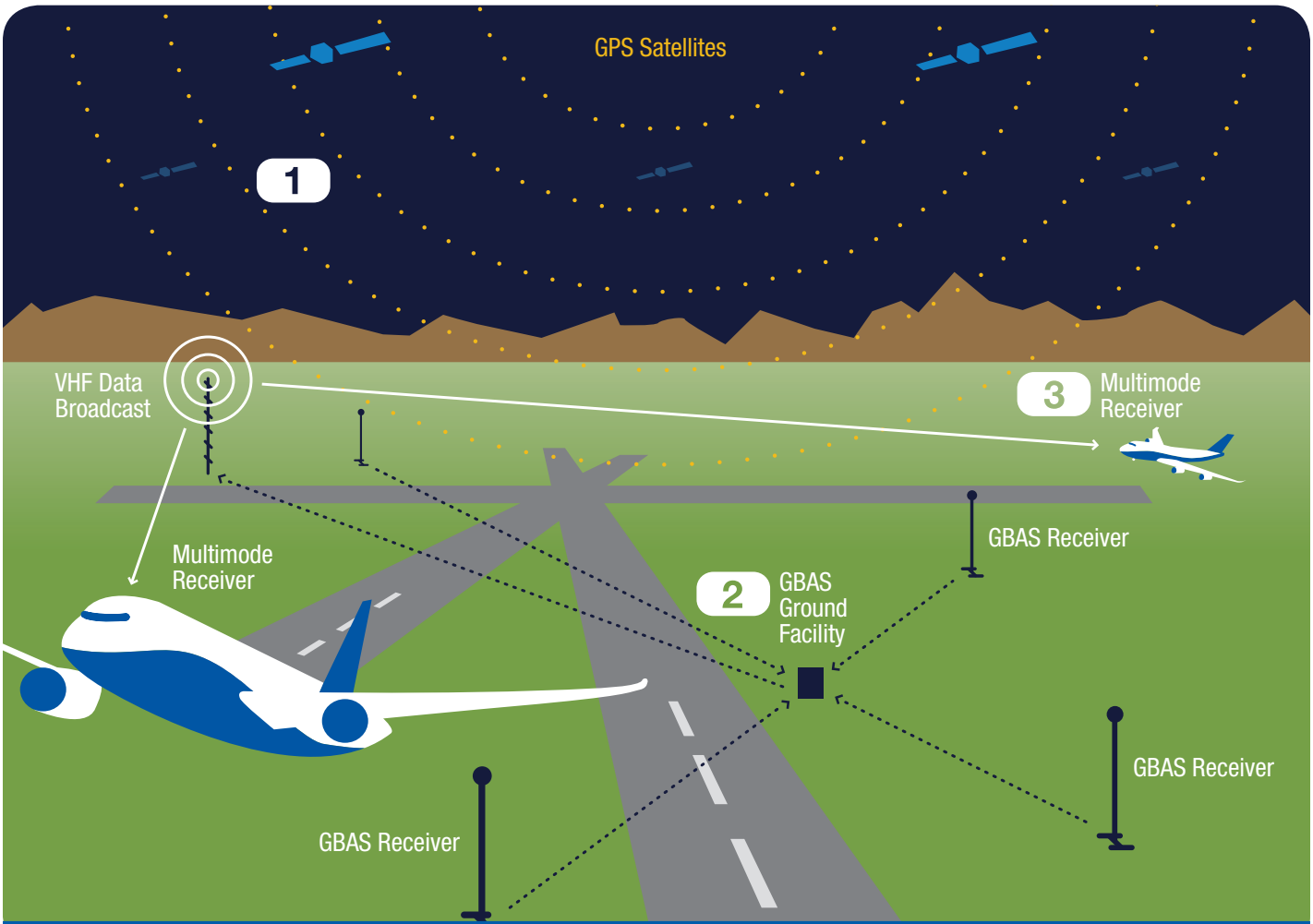
GLS offers many benefits to the whole industry, including Boeing's customers. For example, a single GBAS station can serve multiple runways—perhaps even at multiple nearby airports. That can eliminate the intricate installation, calibration and maintenance of million-dollar ILS devices at both ends of every runway. Simply put, GLS is a much more flexible way to get ILS-type approaches without the expense of the ILS installation.

In addition, any airport anywhere can install GBAS. That gives fast-growing aviation sectors such as those in Australia, the Middle East and the Asia-Pacific region the opportunity for more-affordable precision-guidance access to runways. In turn, this likely will give flights over expansive areas with few airports the availability of additional, closer alternate airports during flights, in case of contingencies such as medical emergencies. That may allow lighter fuel loads, which can help the environment by reducing fuel burn and emissions, while increasing passenger and freight revenues.

Another benefit: Airlines' pilot-training expenses are minimal, because Boeing carefully kept instrument displays and crew procedures essentially the same as those used for ILS operations. As pilots already rated in Boeing airplanes are familiar with ILS procedures, no simulator practice is needed to learn GLS.

OVERCOMING EARLY DISTRUST

Despite these potential benefits, the industry wasn't completely sold on this system.



Boeing's new landing system: (1) Signals from in-view Global Positioning System satellites reach multimode receivers (in airplanes) and Ground Based Augmentation System (GBAS) receivers (on the ground). (2) The GBAS ground facility detects any errors in GPS signals and sends corrections (and digital approach information) to airplanes via VHF broadcast. (3) On board the airplane, the GBAS landing system uses the satellite signals and GBAS corrections to establish and track the airplane's true position—and gives the autopilot precision landing instructions. DAVID DANNER GRAPHIC

"Even with these incentives," said Tim Murphy, Technical Fellow in Electronic Systems and author of several GBAS-related patents, "in the early days the technology was distrusted and unappreciated."

The prevailing opinion internationally was that to achieve adequate performance for low-visibility landings known as Category IIIb

operations, GLS would require new signals in addition to GPS—from systems such as the coming European Galileo satellites.

Boeing has countered that opposition by tackling it from both the technical and operational fronts.

On the technical front, Duenkel said, "Murphy has worked closely with the FAA in recent years to promote GLS as a mature technology. For several years it has been ready for use in Category I operations." That's a category of landing conditions in which visibility is good at least to 200 feet (60 meters) height with a runway visual range of not less than 1,800 feet (550 meters). Boeing also showed that GLS exceeds Category I functioning using today's GPS only—and doesn't need to wait for the input of possible future systems such as Galileo.

The result? Growing international support. Murphy said the International Civil Aviation Organization is working on standards to allow a GPS-only, single-frequency system to support Category IIIb approach and landing operations—for conditions more adverse than Category I. He described that stance as "a major turnaround."

On the operational front, Duenkel said Boeing has teamed worldwide with airline customers, air-navigation service providers, governmental aviation authorities, avionics manufacturers and GBAS manufacturers for opportunities to introduce the technology with early-adopter airlines. "We've been getting airlines equipped to fly GLS operations in the real world" on revenue-generating flights, he said.

These airlines operate with onboard GLS equipment certified in 2005 by the FAA for all versions of the Next-Generation 737; and on the ground are Honeywell GBAS stations provisionally approved by the appropriate authorities. Work is under way through the FAA Local Area Augmentation System Program with Honeywell at Memphis, Tenn., to gain full approval for the ground stations' use in U.S. Category I operations.

Airlines making GLS history so far:

- Qantas Airways began operational trials in Sydney in 2006. Alex Passerini, Qantas technical pilot, Boeing 737, said Qantas has 14 737-800s doing 10 to 12 GLS approaches every day; is nearing its 1,000th approach; and has purchased retrofit kits to equip 24 more airplanes. GLS, he said, is "much more accurate, more stable, cheaper [than ILS]: Pilots like it. Everybody likes it."
- TUIfly introduced GLS "for reasons of cost and capabilities" and has been flying GLS in Bremen, Germany, since last September, said Gabriele Zaki of German air-navigation service provider DFS and the GBAS project manager for DFS.
- Continental Airlines in February received FAA approval for GLS operations on nine 737s at Guam, said Chris Baur, Continental's manager of Flight Technical Programs. This is a first in the U.S. national airspace system. Continental has requested provisions for GLS on all new 737s in anticipation of expanded use at other airports.

NEXT STOP, NEWARK?

A new project team that includes Continental Airlines, the FAA Local Area Augmentation System Program Office, The Port Authority of New York & New Jersey, Honeywell, and Boeing is seeking to implement GLS-GBAS operations at Newark Liberty International Airport later this year, said Duenkel, a team participant.

"This effort is intended to build on Continental's success at Guam" and the anticipated FAA approval of GBAS use in Category I operations, Duenkel said. The technology would help protect or maintain airport capacity at Newark when winds change or weather deteriorates, Duenkel added, plus serve as a potential operational environment to implement Category III capability in all its subcategories once it is available.

And GLS isn't just for commercial use. In a U.S. Department of Defense program called the Joint Precision Approach and Landing System, a variation of GLS is under consideration for both fixed-wing and rotorcraft approaches on ships and land. Boeing, along with Sierra Nevada Corporation and QinetiQ, is a member of the Honeywell team competing for the JPALS System Development and Demonstration Program. ■

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Tim Murphy (left) and Steve Duenkel sit in the flight deck of a Boeing jetliner—in which new landing-system equipment can be installed. JIM ANDERSON PHOTO

Helping carry the load

Regenia Bean (center), an Integrated Defense Systems technical designer from Wichita, Kan., confers on a 747-8 Freighter issue with Jeff Stucki, a Commercial Airplanes stress analyst based in Everett, Wash. BCA engineer Brian Nelson is in the foreground.

GAIL HANUSA PHOTO

Engineering work on 747-8 Freighter elevates BCA, IDS cooperation

By Dan Ivanis

Brian Thorpe, 747 airframe chief engineer, didn't know where to turn. It was late 2006 and there was a mountain of structures design, engineering and stress work to complete for the newest member of the 747 family, the 747-8 Freighter. Major assembly was set to begin in less than two years.

Boeing Commercial Airplanes' core of experienced structures talent was already spread thin supporting other development programs. The manpower to get the 747-8 off computer monitors and into the Everett, Wash., factory simply wasn't available.

Before looking for skills outside the company, Thorpe and his team turned to the structures core skill team and scoured the enterprise for people with the skills they needed. "We knew at that time that Integrated Defense Systems in Wichita (Kan.) was working on the Airborne Laser (ABL) program, which uses a 747 as its platform," Thorpe said. "So we knew they had experience in 747 structures and there was an opportunity to use some available skills there."

Finding the right skills available and waiting to be tapped, Thorpe and his leadership team turned to IDS for help. Today, of about 1,200 employees working on 747-8 Freighter structures, about 110 are in Wichita. In addition to ABL experience, Wichita has a group of engineers who have worked on the 747 platform for the Special Air Mission organization, which provides engineering, maintenance and modification support for the United States' fleet of executive aircraft. During the past couple of years, the 747-8 structures engineering effort has expanded further to include IDS teams in Huntington Beach, Calif., and Renton, Wash.

The arrangement continues a line of programs where BCA and IDS are working together. "It wasn't unprecedented, because BCA and IDS are teaming on a number of different programs" such as the Airborne Warning And Control System aircraft and the P-8A Poseidon, said Curt Haney, 747-8 fuselage engineering leader, who's spent most of his career in IDS and Phantom Works. "This was kind of the next phase."

The collaboration, however, didn't get off to the smoothest start. Ben Miller, senior manager for the 747-8 aft fuselage, said the biggest initial hurdles were communication and understanding. "There were differences in processes and how we used tools," he said. "Once we came to that understanding, our communication and our work improved."

"Things really got better when management stepped in and helped set priorities for all of us," said Brian Nelson, a BCA design engineer in Everett. "Some of us were being pulled in different directions and weren't sure where our focus should be."

Regenia Bean, an IDS technical designer who's spent the past 18 months in Everett working on the 747-8 program, acknowledged there's been a learning curve. "It was bumpy at first because we seemed to be spending all of our time trying to figure out logistics—what worked and what didn't," said Bean, who serves as her Wichita team's on-site representative. "Now, I couldn't ask for better working-together groups."

Jeff Stucki, a BCA stress analyst from Everett who spent a month in Wichita, said a major factor was having key people spend quality time with their counterparts in other locations: "I was able to put myself in their shoes for a while and understand where they were coming from."

"The colocation of key individuals for significant amounts of time was very important," said Terry Moser, IDS-Wichita 747-8 chief engineer. "We can't lose that going forward."

With major assembly beginning on schedule this month, this step in the evolution of BCA and IDS cooperation is considered a success. In fact, Thorpe and his leadership team hope to keep the same teams for work on the passenger version of the 747-8, the Intercontinental.

"We've learned a lot and we'll do some things differently going forward," Thorpe said. "There will always be room for improvement, but we've progressed a long way." ■

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Promises fulfilled

Without its repair station certificate, BCA couldn't make good on its obligations to customers

By Kathrine Beck

A special group of skilled Boeing aviation maintenance technicians keeps its bags packed at all times. If a Boeing-built airplane is grounded, for example, because a catering truck at an airport collided with it during servicing, a Boeing Commercial Airplanes Airplane On Ground (AOG) team can head out at short notice to assess the damage, work with the customer to determine the best course of action, and perhaps provide mechanical support and parts.

But the AOG team couldn't operate without a U.S. Federal Aviation Administration repair station certificate. That's because all the work Boeing performs on an airplane that's already been delivered must be performed in compliance with regulations set forth by the FAA and other regulatory bodies around the globe.

When Boeing builds commercial airplanes, it does so under the authority of an FAA production certificate—which ensures that everything is done according to specifications and standards, and the process includes certification of the people who perform the work and quality inspections of the airplane. Once the airplane is built, it receives an FAA airworthiness certificate. It becomes, in Commercial Airplanes parlance, a "ticketed" airplane (see Page 18 of the October 2007 *Boeing Frontiers*).

Any work after an airplane is ticketed must be performed under another license known as a repair station certificate, which carries the official title "Air Agency Certificate." It's required for every job Boeing performs on a post-ticketed airplane, including AOG repairs, aircraft modification, product overhaul and warranty work.

"The Repair Station is what allows us to support our customers," said Jim Testin, AOG director of operations. "Without the Repair Station, there'd be no interface, and AOG would cease to exist."

Boeing personnel operating under the Boeing repair station certificate also provide post-airworthiness certificate support during the delivery phase, after an airplane is ticketed. That's important because Boeing is responsible for an airplane's continued airworthiness after ticketing and before ownership officially changes. During that time, maintenance and other postproduction support is needed as issues arise before the airplane can be turned over to its new owners. However, Boeing mechanics can't touch the airplane and Quality personnel can't inspect it without Repair Station authority.

There's Repair Station activity on just about every commercial airplane that Boeing delivers, as airline customers may require some final touches. One example might be an airplane that goes through predelivery flight tests has some resulting wear on its tires. If the customer's contract calls for brand-new tires on the delivered airplane, they need to be changed. That can't happen without Repair Station authorization to make sure the work is done properly—which provides quality and reliability to the airline and safety for passengers.

'Heart and soul'

of Repair Stations has a wealth of knowledge

If sorting out government regulations with the U.S. Federal Aviation Administration seems like a challenge, then try doing the same thing with an aviation regulatory agency on the other side of the world.

It's just one of Rose Scoones' responsibilities at Boeing Repair Stations, and nobody does it better. Scoones is administrative manager of the Seattle Repair Station.

"She has the ability to sit back and look at all the aspects," said Bob Archibald, FAA's principle maintenance inspector for Repair Stations.

On the Boeing Field flight line in Seattle, Rose Scoones, administrative manager for Boeing's Seattle Repair Station, reviews paperwork as aviation maintenance technician Russ Opthof performs work under Repair Station authority, reinstalling plugs that were removed to inspect the engine on a ticketed 777.

JIM ANDERSON PHOTO

"The Repair Station organization makes sure everything is done properly and all the paperwork is in order," said Rose Scoones, administrative manager for the Seattle Repair Station. "It can get pretty complicated, especially when requirements change or multiple regulatory agencies are involved."

There are Boeing Repair Stations in the Puget Sound region; Long Beach and Palmdale, Calif.; San Antonio; Heath, Ohio; Salt Lake City; and Wichita, Kan. They're also at Boeing subsidiaries Spectrolab in Van Nuys, Calif.; Boeing Australia, at Amberley and Eagle Farm in Queensland; and Aviall in many locations.

Repair Station management is responsible for coordinating with FAA, determining signing authority, making sure work is done properly and paperwork is complete, and maintaining the repair station certificate.

"It's vital that Repair Station operations are performed quickly and accurately," Scoones said. Otherwise, promised delivery dates of new or modified airplanes would be compromised and grounded airplanes would sit idle, resulting in revenue loss for customers—serious business in today's highly competitive commercial aviation environment. ■

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"She creates this trusting relationship, which is the foundation for all of the relationships she's built at Boeing, FAA and foreign regulatory agencies."

– Carl Lester, 737 field operations superintendent of Boeing Commercial Airplanes, on Rose Scoones, administrative manager for the Seattle Repair Station

Whether it's one of Scoones' colleagues outside of Boeing or those who work within the company, all say that her deep knowledge of regulatory issues and her personality help Scoones excel at her job.

"Based on the way she interacts with people, she creates this trusting relationship, which is the foundation for all of the relationships she's built at Boeing, FAA and foreign regulatory agencies," said Carl Lester, 737 field operations superintendent of Boeing Commercial Airplanes.

Scoones coordinates audits, keeps up with the latest regulatory issues and maintains Boeing's air agency certificate, which allows the company to perform aftermarket work on airplanes.

"It's a never-ending endeavor," said Scoones. "Everything is just a little different and you just have to sort through the various issues and work to come up with a solution. That's interesting to me."

In her 38-year career at Boeing, Scoones worked on some of the company's most storied airplane programs. She started with the 727 and 737 programs, installing insulation blankets and floor tubing, then transferred to Everett, Wash., to work on the 747-100SP (special performance) and eventually returned to Renton, Wash., to work in final assembly inspection.

Repair Stations is perhaps where Scoones has made her biggest mark, earning the respect of the worldwide aviation industry.

"Rose is the heart and soul behind BCA Puget Sound Repair Station activity," said Scott Peterson, Scoones' direct manager and director of regulatory and quality systems oversight for Commercial Airplanes.

—Wilson Chow

People helping people

Employees' ergonomic ideas boost efficiency and safety—and win awards

Ken Redfield, a 767 final assembly interiors mechanic, installs an overhead monitor while using an award-winning, ergonomically friendly cart developed by Boeing employees.

WILL WANTZ PHOTO

By Dan Ivanis

Sure, it's nice to receive recognition in a national competition. But two employee teams in Everett, Wash., are even more excited to be able to be making a difference in safety and efficiency for their team members and co-workers.

Earlier this year at the internationally recognized Ergo Cup competition, sponsored by the Ergonomics Center for North Carolina and presented by the Institute of Industrial Engineers, a team from the Interiors Responsibility Center (IRC) won the innovation excellence award for its improvements to the stow-bin-assembly moving line. In addition, a team from 767 final assembly won the cost-savings-excellence award for its monitor lift stand.

HEIGHT OF INNOVATION

The award to the IRC team recognized a "continuous improvement" modification to the moving line, which had already increased efficiency significantly and reduced safety concerns and floor-space requirements.

"The moving line had taken care of a lot of equipment-lifting issues we had with the old process," said Sherrill Tooley, a Technical Fellow in Ergonomics assigned to the IRC. "But, there is a 13-inch (33-centimeter) gap between our shortest and tallest mechanics, so some had to bend way over to do their work, and others had to reach over their heads to do theirs."

K.C. White, a machinist who has since moved into management, and Geno DeBortole, an IRC tool fabricator, took on the problem. Pooling their experience and knowledge, they designed a bin carriage that easily adjusts to the height of the mechanic, eliminating a majority of reaching and bending.

"Because it was a moving production line, we couldn't use pneumatics, and we couldn't use electricity" for power, White said. "We had to make it completely manual and simple."

After fabricating a couple of prototypes, they conferred with other machinists to finalize details and gain their input and approval. The final product not only adjusts vertically but also shifts slightly horizontally at the same time for easier access.

"We built the bin carriages in the shop here at the IRC and had the whole thing integrated in about a week," DeBortole said. "We made these for the 787 line, but we were careful to design them so other lines can be retrofitted" without making major changes.

More importantly, the modifications allow IRC teammates to work more safely and efficiently. The height adjustment reduced the risk rating from high to low for bending (for tall employees) and reaching overhead and above shoulder (for shorter employees) in the Boeing Enterprise Ergonomics System, which identifies and mitigates ergonomics risk factors.

"When you are not pushing your body to the limit, you can work to a level that is comfortable and maintain that level through the day," White said. "This will allow mechanics to do that. This project is the result of the ergonomic passion that we have here at the IRC."

SPARING THAT SORE FEELING

The monitor lift idea was born of a similar situation. The old process forced mechanics to work in pairs while on ladders—one holding a 20-pound (9-kilogram) monitor in place against the ceiling of an airplane while the other mechanic completed wiring and bolting. The 30-pound (14-kilogram) ladders restricted access in the airplane and had to be carried from station to station, which increased the risk of damage to seats and walls.

Despite their height difference, Interiors Responsibility Center machinists Michelle Hawkins (left) and Bob Sampson both can work comfortably, thanks to an ergonomic innovation by Boeing employees.

WILL WANTZ PHOTO

"When you are not pushing your body to the limit, you can work to a level that is comfortable and maintain that level through the day. This will allow mechanics to do that. This project is the result of the ergonomic passion we have here at the IRC."

– K.C. White, Boeing employee

"I knew I'd be sore for a few days after installing monitors," said Ken Redfield, a 767 mechanic and one of the team members, about the old process.

The team's solution is both practical and elegant. A metal stand includes a padded stair-step area for mechanics to kneel on while working, a platform to hold tools, and an articulating top shaft that holds the monitor in place so it can be adjusted with one hand. The stand was designed to move laterally across rows of airplane seats, which increases accessibility and allows mechanics to maneuver easily from one aisle to the other. The team added "hospital wheels" (encased in hard rubber) to minimize the potential for scrape damage to airplane interiors.

In addition, the stand also accomplished the team's primary goal: relieving mechanics' pain from overhead reaching, neck and shoulder extension and extended lifting of heavy monitors. The new process reduced the risk from high to none, according to the Boeing Enterprise Ergonomics System.

The monitor lift stand, which can be used on all models, has been an instant success. The Everett flight line has put in an order for 20.

"This is all about the power of teaming," said DeeDee Kouthong, a team member and 767 program safety leader. "Getting the right people together to come up with a solution that will stick—that's why this is so powerful. They are using it."

In addition to their replication across Commercial Airplanes, effective solutions like these are being shared across the company to drive continued ergonomics improvements. ■

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The 787 Dreamliner static-test airplane entered its test fixture in April in the Everett, Wash., factory. Work continues on preparing the non-flying vehicle for a series of tests designed to stress the airframe by replicating and exceeding by 50 percent the most extreme conditions any 787 is expected to see in the life of the fleet.

ED TURNER PHOTO

Ready for the stress

787 Dreamliner put through its paces, as its first flight nears

By Lori Gunter

Before it can fly, the all-new 787 Dreamliner must be proven to be flightworthy. Although much of this testing can be done at a component level in laboratories, the ultimate tests—static tests and "gauntlet" tests—are run on full-size 787 airframes.

The nonflying static-test vehicle entered its test fixture in April at the Boeing factory in Everett, Wash. Work continues on preparing it for a series of tests designed to stress the airframe by replicating, and exceeding by 50 percent, the most extreme conditions any 787 is expected to see in the life of the fleet.

In addition to finishing some structural work on the static-test airplane, a Boeing crew has been placing the hundreds of actuators and sensors needed to create and measure the stresses on the airframe.

"We need to get through three of the static-test conditions before we can fly," said Mark Jenks, vice president of 787 development. The first one is what's known as "high blow," which applies 14.9 pounds per square inch (1 kg per square centimeter) internal pressure to test the fuselage structure as a pressure vessel, or its ability to maintain cabin pressurization when flying at altitude. On subsequent test conditions, the internal pressure will be combined with fuselage bending and torsion to simulate worst-case flight maneuvering loads critical for wing/fuselage bending, Jenks said. Additional test conditions will be run after first flight but before aircraft certification is granted by government aviation authorities.

Jenks reported the program is confident in the performance of the airplane because of testing that has already taken place. "The composite structure has performed exceptionally in our laboratory testing and in the static testing we have performed on different sections," he said. "I am confident we will find the structure is robust and ready for flight."

Gauntlet testing, which happens on board the first airplane that will fly, includes three stages: the factory gauntlet, the intermediate gauntlet and the final gauntlet. During gauntlet testing, airplane electrical power distribution and utilization are tested and pushed, and systems are put through their paces for one last time before flight.

During factory gauntlet testing, the flight-test organization examines the onboard systems and runs tests that verify the systems perform as expected. With intermediate gauntlet testing, the airplane is moved out to the flight line. There the engines are powered up and in turn provide the airplane with electrical power. During final gauntlet testing, the systems are left running for eight straight days for extensive testing.

"Most people have no idea how much testing we do before we ever fly the airplane," said Jenks. "They just know that when they step on board a Boeing airplane it is going to be safe and reliable. They're right—it is. But that doesn't just happen; it takes the hard work and expertise of an incredible team.

"The Federal Aviation Administration and other regulatory authorities require us to do much of this testing, but we have our own even more demanding standards in many cases," he said. "We take our testing very seriously, because it gives us confidence for the life of the program." ■

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At Naval Air Station Whidbey Island, Wash., crowds get a close-up look at the new EA-18G Growler, the first to be delivered to the U.S. Navy fleet.

MARIAN LOCKHART PHOTO

Set to soar and roar

U.S. Navy fleet gets its 1st EA-18G

By Kathy Cook

The EA-18G Growler program has accomplished something that, in acquisition circles, is rare. It's not the aircraft's airborne electronic attack capabilities, its speed, distance and maneuverability, or even its ease of maintenance.

It's that the Growler team made a promise to the U.S. Navy in 2003 to deliver all the above capabilities on time and within budget—no exceptions. With the early delivery in June of the first EA-18G to the Navy fleet, the Growler team has done just that and more.

"At a time when most acquisition news focuses on problems and setbacks, I am pleased to note that this has been a success story and an excellent example of Navy-contractor teamwork and collaboration," said Donald C. Winter, secretary of the Navy. "By leveraging and evolving legacy programs, this program stands as a model of what can be achieved."

"Being late or more expensive than original projections is something we never bought into," said Mike Gibbons, EA-18G program manager. "From day one, it simply was not acceptable."

It is a philosophy the team intends to maintain as it transitions from its current system development and demonstration phase to delivering the aircraft to the fleet. The SDD phase is scheduled to end in 2009, after the Navy's operational evaluation of the jet to determine its effectiveness and suitability for fleet operations. That evaluation begins next month.

The first squadron to get the Growler is Electronic Attack Squadron (VAQ) 129, which serves as the Fleet Readiness Squadron at Naval Air Station Whidbey Island, Wash.—home port for the Navy's airborne electronic attack aircraft. The squadron currently flies the EA-6B Prowler but is transitioning to the Growler. The Navy plans to transition completely from Prowlers to Growlers by 2013. VAQ 129 will receive the first five fleet EA-18Gs, and eventually will have as many as 12 Growlers, which they will use to teach pilots and weapon systems officers to fly the aircraft.

For current Prowler crew members, the Growler represents a significant change in the way they operate. The Prowler has four crew members, the Growler has two. In the aircraft's development phase, the Growler team asked more than 500 aircrew members to help in designing cockpit displays and other tools. Their input ensured that the two-person crew could perform all the tasks needed to complete the mission without overwhelming them.

The Growler also has more places to attach weapons, fuel tanks or jamming pods; more thrust; and integrated systems that provide greater situational awareness and survivability to the crew.

Capt. Bradley Russell, commander of the Electronic Attack Wing, U.S. Pacific Fleet, said that with the Growler "we get the capability to do things at the same rate and capability as Super Hornets. Growlers will be able to perform self-escort, because they will have an air-to-air capability with their radar and Advanced Medium Range Air-to-Air Missiles as well as that big Link 16 (radio) situational awareness picture. You add those things together and it's more than just two plus two equals four. It's two plus two equals 50." ■

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How the Growler works

The Growler's mission is to provide communications jamming and electronic attack support for fighter aircraft as they operate in battle. Simply put, the EA-18G's mission is to help the aircraft it flies with, or the ground troops it protects, to perform their missions and to increase the group's survivability.

The Growler does this by first locating possible radar or communications threats, using its onboard sensors and satellite communications devices. Next, the aircraft neutralizes any threats it detects, clearing the way for the aircraft or ground troops to do their jobs. The Growler does this by interfering with, or "jamming," opposing radars and other communication devices, effectively blinding the radars so they can't be used to direct defensive systems such as surface-to-air missiles. It can also confuse the enemy by denying communications and severing command networks. The Growler also carries high-speed missiles that can track an opponent's radar signal and destroy the threat.

This advertisement is the first in a series of three new ads that support key sales campaigns for the 777 in 2008. The ads, which will appear in trade publications worldwide, emphasize how the 777 is the premier airplane in its class because it delivers more comfort, more performance and more value.


BOEING
More passengers, more revenue, more value. Find out more. www.boeing.com
777-300ER

Next wave for naval air training

T-45s land at NAS Pensacola as Boeing develops curriculum upgrades

By Doug Cantwell

When four U.S. Navy T-45C jet trainers recently touched down in the Florida Panhandle sporting a freshly painted "F" on their orange tails, they opened a new chapter of naval air training.

The "F" signifies their new assignment to Training Air Wing 6 at Naval Air Station Pensacola, which has responsibility for training naval flight officers, weapon systems officers and others who occupy the "back seat" of tactical strike and electronic attack aircraft. Meanwhile, two St. Louis–based Boeing teams had already started work on projects that will dramatically raise the bar of realism for TRAWING 6's Undergraduate Military Flight Officer (UMFO) training program.

These efforts reflect the teams' commitment to continuously improving their product as a fully integrated training system—not just as a sum of the parts. The concurrent upgrades to the airborne and ground-based facets of the T-45 system will enrich the UMFO curriculum dramatically, and the work has been greeted with applause by the customer.

"Having the T-45s on board, together with the upgrades Boeing is developing, marks the biggest modernizing effort we've seen here in 40 years," said Commander Pete Silva, who oversees the UMFO curriculum for CNATRA, or the Chief of Naval Air Training.

LEG UP ON RADAR TRAINING

The training upgrades that the T-45 team is developing consist of two systems.

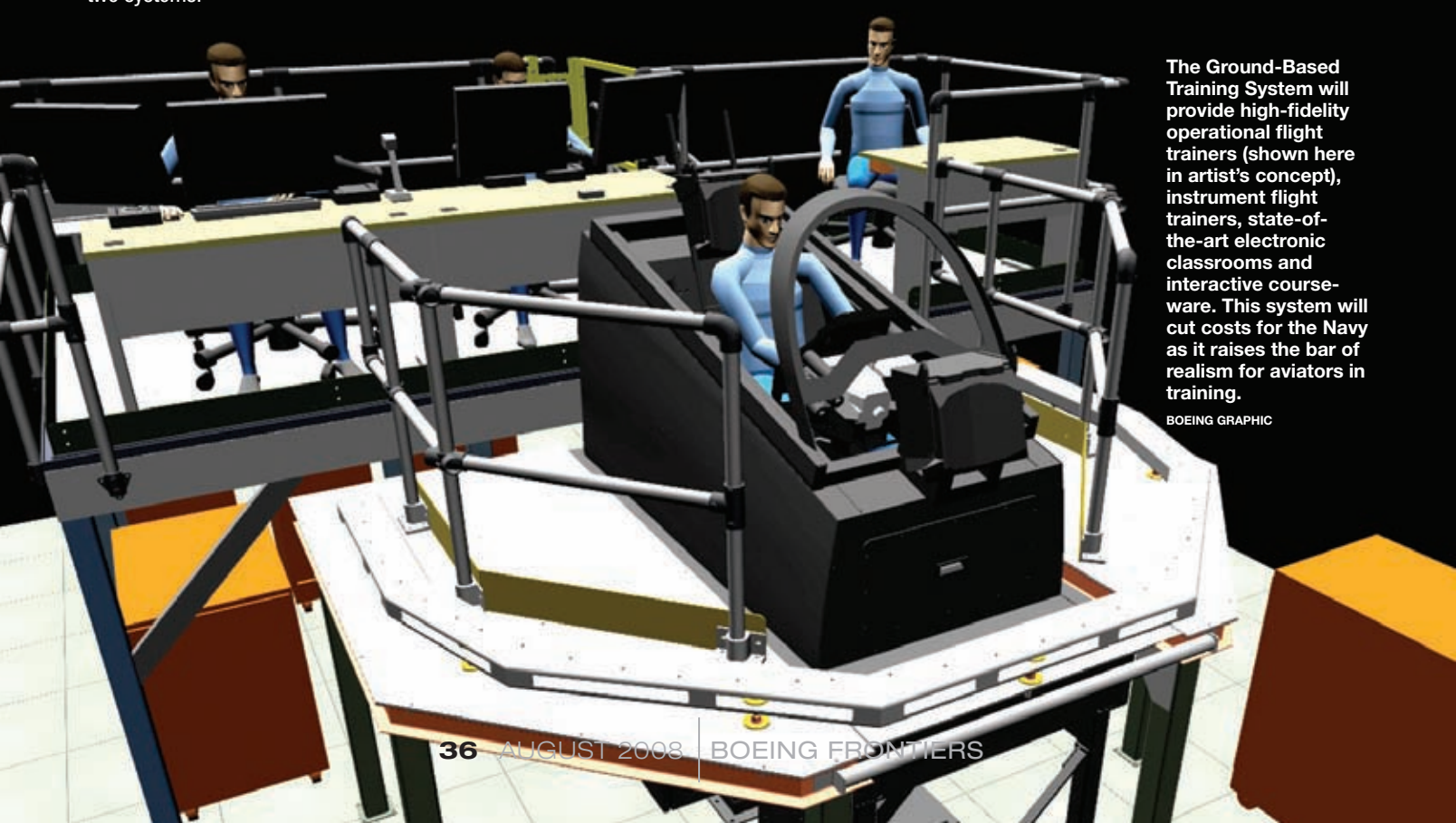
One system, the Virtual Mission Training System (VMTS), simulates tactical radar that provides air-to-air and air-to-ground modes as well as simulated weapons and simulated electronic warfare.

These functions can be networked between the participating aircraft and the instructor ground station that controls the mission presentation. The current phase of work on VMTS, which will be retrofitted to fielded aircraft, will provide student aviators with airborne training in the use of radar and weapons against virtual enemy aircraft, including cooperative strategizing with friendly real and virtual aircraft.

"Adding this degree of sophistication to the tactical training earlier in the game will make a huge difference," said Barbara Wilson, director and program manager for the T-45 Training System. "It will produce flight officers who are better prepared to transition to carrier duty with the fleet, which will cut costs substantially both in the near term and down the road."

Silva put it in more direct terms: "If you're a green aviator entering the fleet with some tactical training already under your belt, you'll be better able to think while you're upside down, sucking on the [oxygen], trying to perform an air-to-air radar intercept. That's a big deal."

As CNATRA lead for UMFO training, Silva has to worry about cost issues as well. "With VMTS on board, we can give students an intensive introduction to tactical radar during their core training at Pensacola at a significantly lower cost in the T-45 than in an F/A-18 once they've transitioned to their FRS [Fleet Readiness



The Ground-Based Training System will provide high-fidelity operational flight trainers (shown here in artist's concept), instrument flight trainers, state-of-the-art electronic classrooms and interactive courseware. This system will cut costs for the Navy as it raises the bar of realism for aviators in training.

BOEING GRAPHIC

Squadron]," he said. "If we have to wait until they've transitioned to an F/A-18 in their FRS, the cost jumps to about $7,000 an hour."

As a system being retrofitted to fielded aircraft, VMTS presents remarkably few headaches to the engineers or accountants. While live, functioning radar would cost a lot and require major refitting of the T-45, VMTS adds only two processing boxes and some wiring modifications. It also allows for future upgrades, or "spirals," such as the ability to train in a network-centric environment using more sophisticated connectivity.

Some 19 T-45s are currently slated for reassignment to the UMFO program at Pensacola, the last of them arriving near the end of 2012. As they come on board, the Wing's legacy T-2 Buckeye and T-39 Sabreliner trainers will be retired. The first VMTS-equipped T-45 is scheduled to enter service in January 2012, and TRAWING 6 will begin training full classes using the Virtual Mission Training System in July of that year.

LEAP IN TRAINING FIDELITY

Demand for higher-fidelity UMFO training has been driven partly by the greater complexity of the backseater's job in today's missions. The Ground-Based Training System (GBTS) will greatly enhance TRAWING 6's ability to train to CNATRA's 2010 requirements, which include multitasking, battlespace management, mission-commander responsibilities and tactical communication—duties that either didn't exist a few years ago or have ramped up in sophistication.

GBTS deliveries will begin next February with instrument flight trainers, followed by the first electronic classrooms and interactive courseware in August. Once they've delivered the full complement of three instrument flight trainers and three operational flight trainers, the Boeing team will upgrade the instrument flight trainers to operational flight training capability.

"Our objective was to 'push down' training that currently takes place at the FRS level to the core training level at Pensacola," said Mark Von Hatten, program manager for GBTS at Training and Support Systems in St. Louis. "With GBTS, the Undergraduate Military Flight Officer will get up to speed sooner and thus be ready for the fight sooner."

Von Hatten noted the huge leap in fidelity that GBTS will bring with its electronic classrooms. The new facilities will include three different configurations: lecture classrooms designed for instructor-led sessions, interactive classrooms that provide each student with a computer workstation for use of interactive courseware and task simulations, and a Learning Resource Center that allows self-paced use of interactive courseware and task simulations without an instructor.

"The task simulations we've brought to the classroom are another example of 'pushing down' the training to a lower, more cost-effective level," Von Hatten said. "With the fidelity we've achieved in the courseware, students can practice tasks in the classroom that used to require a flight simulator."

The simulations focus on operation of the subsystems such as communications, radio, weapons and cockpit functionality. Interactive courseware also introduces students to VMTS exercises they will encounter in the operational flight trainer and then in actual flight, including use of the air-to-air and air-to-ground tactical radar modes and electronic warfare.

NEW DEBRIEF ABILITY IS KEY

Along with the Virtual Mission Training System and Ground-Based Training System will come a major upgrade in debriefing capability, which Silva considers invaluable. It's not so much what you experience during the actual sortie as how well you're able to review and learn from it afterwards. The addition of state-of-the-art debriefing stations with sophisticated graphic displays will also enable other students and instructor-pilots to learn from sorties they didn't actually fly.

"Everything we'll be getting from here on will be higher-fidelity, more adaptable and more flexible in terms of how we'll be able to review the training mission," Silva said. "We'll be able to plug in a thumb drive from each aircraft that participated in a sortie and synch up their flight and mission data for a comprehensive debrief." ■

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The first of 19 T-45 Goshawk jet trainers recently arrived at Naval Air Station Pensacola, Fla., sporting the "F" that signifies Training Air Wing 6. TRAWING 6 has responsibility for the U.S. Navy's Undergraduate Military Flight Officer program. The program also will receive major curriculum upgrades developed by St. Louis–based Boeing teams from the T-45 program and Training and Support Systems.

DOUG CANTWELL PHOTO

Phantom Works engineer and scientist John DeAntoni, pictured in a St. Louis paint booth with an F/A-18 Super Hornet, worked closely with the Missouri University of Science and Technology on developing a chrome-free aircraft coating.

RON BOOKOUT PHOTO

Greener paint for planes

Researchers develop a way of removing chrome from paints that are applied to military aircraft and vehicles—and saving time and costs

By Daryl Stephenson

Military aircraft and vehicles need to be protected from corrosion. Current coating systems—primers and topcoats—do a pretty good job. But there's one problem. A lot of these coatings contain chromate compounds, or chrome, that require stringent protective measures for safe use by workers who apply and remove them.

Researchers at Boeing and Missouri University of Science and Technology have been working together to come up with a better system—one that provides the corrosion protection the U.S. Department of Defense wants but is also safer and more environmentally friendly and saves time and money.

They believe they've found a big part of the answer under a three-year program called the Environmentally Benign Coating System for Department of Defense Substrates that's funded by the DoD's Strategic Environmental Research and Development Program.

Their solution combines rare-earth cerium oxide conversion coating processes developed by Missouri S&T with ultraviolet-light-curable multifunctional topcoats developed by Boeing Phantom Works, Cleveland-based Light Curable Coatings and Wayne Pigment Corp., based in Milwaukee.

The new coating system "has a lot of benefits," said John DeAntoni, a Boeing Phantom Works engineer/scientist in Environmental Assurance in St. Louis who's worked closely with Missouri S&T on the project. "We've taken the chromates out of the pretreatment process and replaced them with a cerium-based conversion coating. And we're replacing the current process of applying a primer and topcoat and wait-

A new coating developed by Boeing and the Missouri University of Science and Technology aims to provide corrosion protection, be environmentally friendly, and save time and money. It would be used on aircraft such as the F-15 (above).

BOEING PHOTO

"We're always thinking about what's next in terms of environmental regulations and the needs of our customer. And that's why we've looked at a comprehensive solution that'll work over time."

– John DeAntoni, engineer/scientist in Environmental Assurance, Boeing Phantom Works

ing hours for them to dry with application of a single, chrome-free coating that dries in seconds because it's being cured with ultraviolet light."

The Missouri S&T–Boeing program, which began in 2006, has progressed to the point that it's being seriously considered for an additional three-year demonstration/validation (dem/val) program that would start in 2009, DeAntoni said.

"Usually, you don't get this kind of interest until after you finish your initial program and you know you've been successful," he said. "But we were about halfway through when we were asked to submit a proposal for dem/val. And that was because we had showed so much promise."

REQUIREMENTS SPARK NEEDS

Boeing and Missouri S&T, formerly known as the University of Missouri at Rolla, have been working together on development of new coating systems for military aircraft for several years. The university, through support from Boeing and the U.S. Air Force, previously developed chromate-free corrosion inhibitor technology that was later licensed by Deft Industrial Finishes. Deft currently supplies a chromate-free primer to the U.S. Air Force for application on F-15s.

Commercial Airplanes also is taking steps to deal with chromium in paint by replacing chromates in its conversion coat, which lies under an airplane's decorative paint schemes, for all commercial models. "We are close to testing a nonchromated primer on airframes," said Randy Jahren, Associate Technical Fellow with the Paints and Coatings Group, Materials & Process Technology. After the primer is accepted, BCA will offer a fully nonchromated coating system.

What sparked the effort between Missouri S&T and Boeing, DeAntoni said, were requirements from the U.S. Occupational Safety and Health Administration that decreased the acceptable exposure limit of humans to hexavalent chromium. The final standard requires employers to institute effective engineering and work-practice controls as the primary means to reduce and maintain employee exposures to hexavalent chromium. (Hexavalent chromium compounds contain the element chromium in its +6 oxidation state.)

The new regulations accelerated the need to find replacements for chromate compounds. "What we heard from the Defense Department was that their biggest environmental driver was the chromium in the primer they were using," DeAntoni said. "So we've been working hard to get the chromates out of the primer."

CURE FOR LONG DRYING TIME

The current coating system for aluminum aircraft has three main components. There's a chromated metal pretreatment conversion coating that provides some corrosion protection and improves paint adhesion. Then a primer containing hexavalent chromate compounds is applied to provide the majority of the corrosion protection. That's followed by application of a polyurethane topcoat.

Application of chromate-based coatings requires strict safety procedures, as well as the right equipment and facilities, to prevent potentially severe respiratory problems for workers. Those requirements mean that in depot maintenance, the dry-to-fly time of the current coatings can be as long as 72 hours for aircraft like the F-15. "That has a huge impact on the warfighter," DeAntoni said.

The new cerium-based conversion coating developed by Missouri S&T can be applied or removed without presenting a health hazard to workers, he said. And Boeing Phantom Works has replaced the process of applying a chromated primer and a polyurethane topcoat with application of one chrome-free coating that cures rapidly with ultraviolet light.

The result is a coating system that meets Defense Department goals for pollution reduction and prevention and enables the services to maintain a high level of readiness.

"Through internal strategic planning, we're always thinking about what's next in terms of environmental regulations and the needs of our customer," DeAntoni said. "And that's why we've looked at a comprehensive solution that'll work over time." ■

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Matt Ganz leads the Phantom Works advanced R&D unit at Boeing. This group is focused on achieving technical excellence and providing Boeing with innovative solutions that best fit customer needs.

BOB FERGUSON PHOTO

Listening ... ***and deciding***

Phantom Works President Matt Ganz believes strongly in the potential of Boeing products and technologies, but even more in the company's people

By Tom Koehler

Matt Ganz has seen technology development from many different perspectives. He's been a technology leader at large companies, small startups; venture capital groups; and government, private and university research-and-development laboratories.

As the leader of Phantom Works—an organization that's helping support the technology needs of Boeing's business units, as well as helping to protect the company's future by ensuring that advanced, innovative technology is ready when needed—he's been eager to share those experiences.

Since joining the company in February from HRL Laboratories in Malibu, Calif., where he was president, CEO and general manager, Ganz has made a concerted effort to meet as many of Phantom Works' 2,000 employees as possible. He also has been making the rounds with the key people within Boeing's Commercial Airplanes and Integrated Defense Systems business units who are relying upon him and his team to provide the technologies that enable the development of future aerospace solutions.

"The company is extremely well-placed for future growth and for being relevant in a rapidly changing world. I couldn't resist the opportunity to be part of that," Ganz said.

Ganz said he's been primarily in a "listening mode" during his first six months at Boeing. He recently sat down with *Boeing Frontiers* to share his thoughts.

Q: What's on your priority list?

A: My priorities begin with people—making sure we have the right people in the right jobs and that we challenge them and motivate them and then find the right rewards for a job well done.

If you look at our company's work-force demographics, it's clear that we are heading for a period of rapid change. Many of our employees will be eligible to retire during the next 10 years. Becoming the employer of choice for the best and brightest young technologists in the years ahead means that we need to understand their values and characteristics. Many young people are very comfortable with modern connectivity and gaming tools, for example. Many of our longer-serving employees are as well. But we will need to adjust our values and how we do our work today to become better aligned with the younger generation.

Also at the top of my list is making sure that our technology efforts are aligned with the business success of the company. Our Phantom Works team will be focused on the day-to-day technology deliverables that the business units need to be successful. In addition, we will be thinking about and making plans in support of the longer-term future of Boeing: What do we want the company to look like in 15 years, and how can Phantom Works help lay the foundation?

Q: How can the company become more innovative?

A: I'm committed to helping us maintain and accelerate our reputation as being the most innovative aerospace company.

It's important to realize that innovation is about business, not just technology. It's about listening to our customers and solving their problems. There's a difference between invention and innovation. It's really the difference between a technology being interesting and a technology being important. Truly innovative ideas are not only inventive, but they also solve a real problem out there in the marketplace by providing our customers with products and services that greatly reduce their costs and improve their performance.

Q: How does Phantom Works support the company's Enterprise Technology Strategy?

A: As the centrally managed advanced research-and-development organization, Phantom Works has an integral role in the company's new Enterprise Technology Strategy, and we have aligned ourselves with the new technology domain structure (see Page 40 of the May 2008 *Boeing Frontiers*).

Our work—particularly in support of the mid- to long-term technology readiness of Commercial Airplanes and Integrated Defense Systems, in helping to provide technologies and risk-reduction activities for new-business opportunities for the company, and in leveraging the technology being developed by others throughout the world—is well-recognized by our company leaders. We are aligned with the company's current and future success and contribute to it every day.

Along with the rest of the Engineering, Operations and Technology organization, we are committed to helping establish a one-company culture at Boeing by collaborating with our business-unit and functional partners; sharing and replicating best practices and technologies across the enterprise; and identifying and using standard systems, processes and training.

Q: What advanced technology efforts offer the most promise for Boeing in the years ahead?

A: Rather than starting with the question of which technologies are important, we are trying to understand the really important driving themes for the future of our global markets. And we're aligning our technology efforts to quickly address those themes as efficiently as possible.

Clearly, energy and environmental issues are market drivers at or near the top of the list. Global energy demand is increasing faster than oil, coal or gas supply, and our ability to deal with subsequent greenhouse gas emissions is limited. How do we flow that down into technology? There are a variety of ways, some simple—for example, driving weight out of our products directly affects their energy consumption and their environmental performance.

Another big global market driver is the potential of our businesses, governments or the public's safety to be disrupted by what we refer to as "asymmetric threats"—things like terrorism, hacking and pandemics. Again, we are looking at those problems and then working to develop technology solutions to address them effectively.

There are other themes, such as trying to understand how to deal better with massively complex systems and massive quantities of data. How do we enable people to make good decisions when interacting with these systems and data?

Finally, there's also the globalization of our markets and the technology world and trying to understand how we make good technology sourcing decisions and partnership decisions across the worldwide economy. ■

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Phantom Works electrical engineer Aisha Neal (left) looks on as lab technician Phil Steinacher works on a module that will be used to check the health of wire bundles on F/A-18s. RON BOOKOUT PHOTO

Finding NEMO

'Situational awareness' and the power of the network aren't just battlefield concepts. Here's how these ideas will transform factories at Boeing

By William Cole

The year is 2018. A mechanic working on the upper wing of the 787 Dreamliner starts the day by pulling up work instructions that are projected right onto the wing.

The images not only show step-by-step the job that has to be done but the specific tools required to do it. Through electronic sensors installed around the factory, the mechanic knows that the right tools and materials are available and exactly where to find them.

Moreover, a sophisticated electronic sensor embedded into the hand tool the mechanic is using can actually train the mechanic to do this specific job on the spot, using a tiny cell-phone-sized flat screen.

Laser images projected onto the airplane tell the mechanic exactly where to position the part. When the operator centers the fastening tool over a preformed hole, the tool draws information from a 3-D solid model and installs the fastener at the exact torque value.

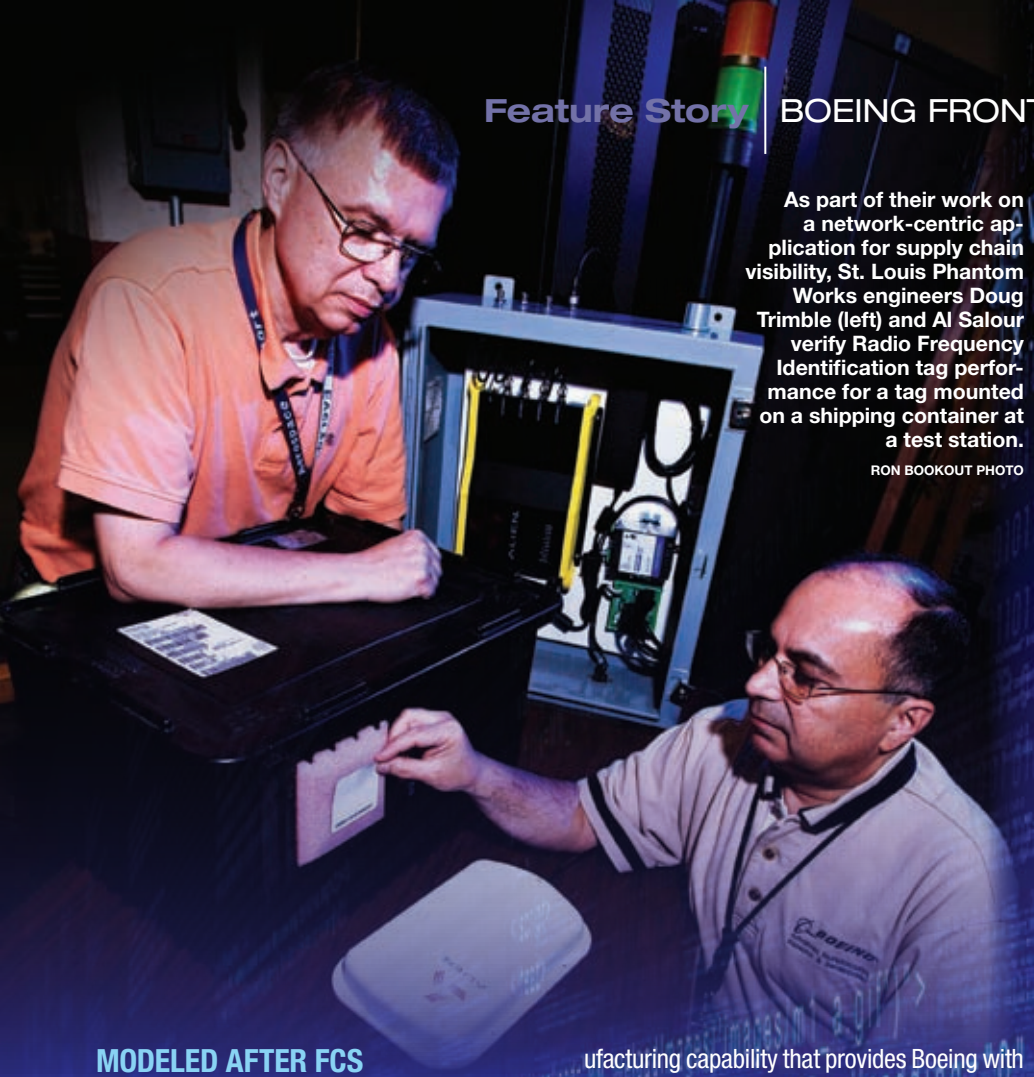
The tool then relays the installation information back to the system that provided the mechanic's work instructions, known as the manufacturing execution system. The system will verify the fastener was installed with the correct torque. Given the green light by the 3-D solid model, the operator continues through a work sequence of more fastener types of different sizes.

There's no guesswork, no manual calculation, no room for error and most important, no additional cost of rework as a result of operator error. The same approach applies to all tools that are connected to the control system: drill motors, sealant tools, dispensing equipment, paint guns, assembly jigs, and numerically controlled machines.

Other sensors and devices in the factory will constantly check the "health" of machinery, monitor safety materials and control even the use of energy. On the assembly line, electronic measurement and inspection systems will monitor and relay in-process information about every aspect of the assembly process.

That's just a glimpse into the factory of the future. Here, "situational awareness," a term often used in the military that refers to knowing exactly where everything is and what's going on, will be just as important in the assembly plant as it is on the battlefield.

But tools and sensors are the first layers of what will ultimately become a huge global system of systems—connecting facilities, customers, suppliers and external support and services—known as Network-Enabled Manufacturing & Operations, or NEMO.



As part of their work on a network-centric application for supply chain visibility, St. Louis Phantom Works engineers Doug Trimble (left) and Al Salour verify Radio Frequency Identification tag performance for a tag mounted on a shipping container at a test station.

RON BOOKOUT PHOTO

MODELED AFTER FCS

The NEMO concept is modeled on Future Combat Systems, the U.S. Army's modernization effort that will link soldiers to a wide range of weapons, sensors, and information systems. A Boeing-SAIC team is the FCS program's Lead Systems Integrator.

When FCS was first conceived, the concept struck a chord with manufacturing experts at Boeing. If FCS is designed to utilize network-centric capability on the battlefield and is demonstrating that the technology works today, why couldn't a similar capability be applied to the factory? Could a person on the shop floor or the engineer in a cubicle act as the "soldier" receiving all the right information for the most effective mission?

"We want to apply the same network-enabled concepts we are developing for our external customers to our own complex manufacturing operations," said Frank Doerner, vice president of AeroStructures, Manufacturing and Support Technologies at Phantom Works. He's been the sponsor of NEMO from its conception.

"The work that is going on will help create a seamlessly integrated operation, leveraging 21st-century information technology and network-centric architecture to create a manufacturing capability that provides Boeing with an enduring competitive advantage," Doerner added. "We have people all over the Boeing enterprise pooling their talents, creativity and resources to bring this vision to life and change the face of aerospace manufacturing."

NEMO advocates said this is a concept that will change the way products are created by reducing cycle time and overhead. It will standardize tools and minimize equipment costs. It will streamline factory-supplier-customer communications. Most of all, it will reduce paperwork and time spent looking for things and performing a variety of tasks manually.

SEEKING 'COGNITIVE' FACTORY

Bryan Dods recalls the time when the NEMO concept was hatched.

"We first started thinking about this in 2001 when network-centric operations was a new hot topic," said Dods, senior manager of Assembly, Integration and Test at Phantom Works in St. Louis, who is leading the NEMO effort. As he remembered, team members began to discuss this concept in meetings, and the team tried some simple equipment integrations on the factory floor.

"We realized we could replicate the Future Combat Systems approach and network our equipment and our shop floor operations into this bigger factory-controlled system-of-systems that would not only give us the information we needed but filter out the information we didn't need," he said. "Our vision now is to have this global manufacturing capability by connecting our suppliers and our internal operations into this massive controls system."

Part of NEMO's mission is to create what's known as the "cognitive" factory—an electronic factory that through a variety of sophisticated network-centric systems is able to think, reason, "be aware" and assist with making decisions based on real-time information. Those factories would be linked in Lean supplier networks to re-establish manufacturing as a competitive advantage for Boeing.

The cognitive factory will significantly reduce the effort of managing the factory floor. "Our employees do a lot of walking to get to the tools and parts they need or check inventory," Dods said. "The factory of the future will eliminate most of the time spent doing that. Shop floor workers and engineers will have fingertip visibility of all aspects of operations relayed to them by sensors and devices that are currently being tested in a majority of our pilot projects." (See story on Page 45.)

Sensors also will be used to take the work out of monitoring equipment and eliminate the clutter of batteries and power cords. They also will regularly check the health of machinery and systems, and recommend repair or replacement before they fail, said Doug Trimble, an engineer/scientist with Phantom Works and a member of the NEMO team. "We call that 'predictive maintenance,'" Trimble said.

Added Al Salour, an Associate Technical Fellow with Phantom Works, who is the principal investigator for an Network-Enabled Manufacturing task that is focused on factories inside Boeing: "With these pilots, we are going to build the model that can be replicated at all Boeing sites and offer value propositions that can result in a Lean and affordable manufacturing operation."

PILOT PROGRAMS ALL AROUND

Several NEMO implementations are focused on the 737, 777 and 787 assembly processes at Boeing Commercial Airplanes, Salour said. But the NEMO philosophy is being applied to research and development projects company-wide. Fastening projects for the F/A-18, for example, involve several team members.

"The plan is to build an architecture that applies to the whole enterprise," Salour

said. "At the same time, we are working closely with our program customers and support functions to make sure that R&D investment dollars are applicable to the needs of these programs."

Sidney Ly, an Associate Technical Fellow and lead engineer responsible for Factory Information and Automation Technology R&D in the BCA Material & Process Technology organization, is working with his team to make sure the NEMO technology-development mission is aligned with the technology needs of the factory. He also is participating in the development and hands-on testing of NEMO architecture.

"It's great to be part of a team taking on the challenge of making all that possible—initially through the success of the pilot projects and technology breakthroughs, then through technology transitions and replications," Ly added. "Ultimately we're hoping to see resulting cost savings—and happy customers."

NEW LOOK WITHIN 5 YEARS

Full implementation of the NEMO concept is five to 10 years away, Dods said. But he added: "I believe within five years you'll see a different look on our shop floor as far as how we manage manufacturing."

In the meantime, there's no shortage of ideas, and many of them are derived from the growing use of electronic communications tools in the commercial marketplace and other industries.

"All the technologies that teenagers are playing with today in terms of social networking are being fed into the enterprise," said Chris Riegel, an advanced technologist in the Networked-Systems Technology Group with Phantom Works and the chief architect for NEMO. "This makes for better collaboration, problem solving and replication across the enterprise."

Certainly, the team is drawing on every resource. Aisha Neal, a Phantom Works electrical engineer, is using experimental sensors to test F/A-18 wire bundles on the shop floor. Boeing just hired two doctoral graduates from Missouri University of Science and Technology as advanced technologists: James Fonda, who is working on wireless technologies, and Jonathan Vance, who is working network controls and "how to bring the network to the shop floor."

"We have people in Southern California and the Puget Sound region working on various projects associated with NEMO. But this is more than just a project or program. It is becoming a culture, a philosophy among our employees," Dods said. "This is an exciting time. NEMO promises to be a revolution in manufacturing, and I'm proud to say it started right here at Boeing." ■

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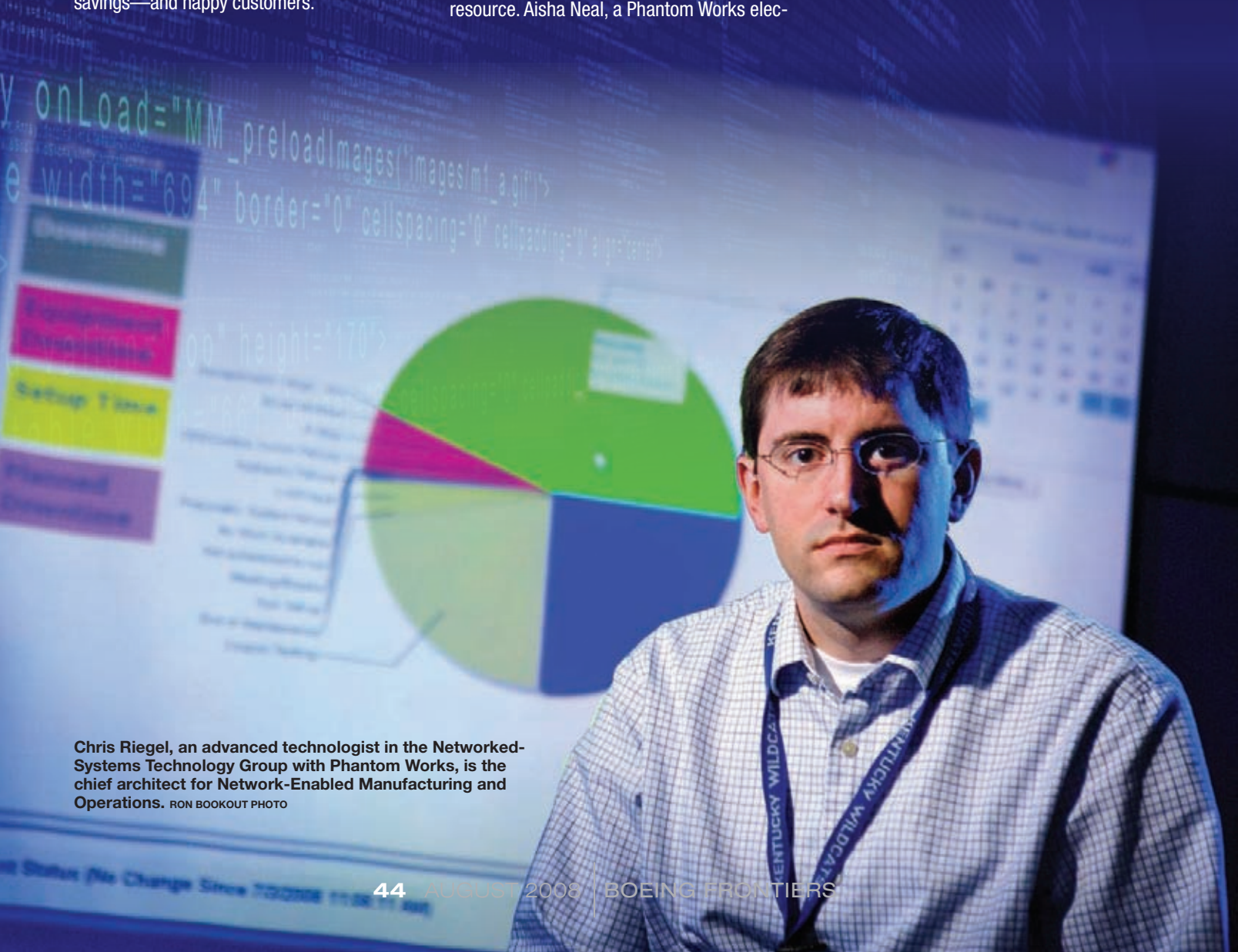

Chris Riegel, an advanced technologist in the Networked-Systems Technology Group with Phantom Works, is the chief architect for Network-Enabled Manufacturing and Operations. RON BOOKOUT PHOTO

In Renton, Wash., Sidney Ly (from left) and Joe Fletcher, Associate Technical Fellows; Russ Tice, contracting engineer; and Sujith Mally, assembly technology engineer, discuss the 777 Gemcor Real-time Machine Monitoring Dashboard application—one of the Network-Enabled Manufacturing team's pilot projects.

MARIAN LOCKHART PHOTO

Pilots for the future

Network-Enabled Manufacturing & Operations pilot projects and devices are currently being demonstrated at Boeing facilities. They include

Point-of-Use Kit Tracking: Sensors mounted on factory walls detect movement of valuable assets in real time. Other sensors are attached to materials received from suppliers and automatically report to inventory tracking systems as they pass through dock doors or when they leave storage cribs in the factory.

Wire integrity testing "motes": Devices that continuously monitor the health of airplane wire bundles through shipping, receiving and during factory installation. Currently the devices are being used to check F/A-18 wire bundles in St. Louis.

777 and 737 Gemcor machine monitoring: Machine monitors that report machine downtime and reasons for the downtime, which will result in better scheduling.

737 sealant cure-time monitoring: Temperature and humidity sensors to keep track of sealant cure times.

737 wheel-well B-nut installation: Location sensors integrated into torque tools to help ensure 100 percent installation of tubing prior to functional tests.

Smart tools: Drilling and installation tools adapted with sensor electronics for user authentication, setup information, calibration status, and interactive go/no-go functions.

Facilities condition–based monitoring: Sensors attached to electric motors for monitoring the operation and health of plant and facilities equipment such as heating and cooling systems, air compressors, paint booths, ovens, and exhaust fans. These sensors help ensure functionality and provide prognostic capabilities.

Nondestructive evaluation and defect collection: Integrated plans to collect nondestructive test and defect data from the ultrasonic scanners, report as-built conditions, and maintain records.

Time- and temperature-sensitive materials control: Sensors added to sealant freezers to accurately track inventory and usage, and the supporting infrastructure to streamline receiving process transactions and reduce material waste.

—William Cole

Now I understand

Multilingual employees help build and sustain Boeing's presence as a global enterprise

By Kathrine Beck

Here's your Boeing trivia question of the day: Who was the company's first multilingual employee?

Here's a hint: He spoke French and German as well as English. At a visit to a 1910 California air show, he had the chance to chat with the star of the event, French flying ace Louis Palhaun.

The answer: Bill Boeing. That talk with Palhaun inspired him to get into the airplane business.

The tradition of global awareness and knowledge at Boeing literally was established at the company's founding, and it remains essential to Boeing's worldwide success today. This knowledge manifests itself in various ways. Among the most fundamental of them: multilingualism. The language skills of both U.S. and non-U.S. Boeing employees, including those based in the United States, continue to strengthen the company's global presence and help to build its knowledge and relationships to support growth and productivity objectives.

Today, the company has employees in 70 countries and customers in 90. Even the company's products speak many languages. Boeing jetliners sport interior cabin signs in 21 languages, including multiple dialects of Arabic, Chinese, French, Spanish and Portuguese.

Around the globe, non-U.S. Boeing employees use both English and their native languages to further the Boeing business and to provide cultural know-how to Boeing business-unit representatives.

Antoine Bois, the Boeing office manager in Paris, is a 25-year Boeing employee. He uses his native French to manage the office

Lawson Robinson studied Korean as a teenager. Today, he uses his knowledge of this language to support the F-15K program. PETER GEORGE PHOTO

When he worked for Boeing China, Tom McLean, International Corporate Communications director, learned when were the right times to speak in English or Chinese. FRED TROILO PHOTO

and uses English to ensure his U.S.-based business partners and his home organization, Shared Services Group, support the local business needs. "Mornings are in French. At about 2 p.m. every day, I switch to English, when our U.S. contacts begin their day," he said. Bois lived in London from the ages of 5 to 12, and said that as a child he learned a lot of English from watching cartoons on television. Bois also speaks Spanish because he loves to travel in South America.

Brussels employee Fabienne Jacob, HR staffing specialist for Europe, the Middle East and Africa, uses four languages on the job. Her father is a Flemish-speaking Belgian, and her mother is German, so she learned both those languages in the family. She learned French growing up in a French-speaking area of Brussels and attending a French school. She learned English at school and improved it during a previous job at a multinational company that often communicated in English. Jacob speaks Flemish, French and English in the office, and English with colleagues in other European countries, Russia and the Middle East. After a lifetime of multiple languages, she has no problem switching from one to another many times a day.

AN EAR FOR LANGUAGE?

How easy is it to learn a new language? Elaine Tarone, director of the Center for Advanced Research on Language Acquisition at the University of Minnesota, said research shows that when we are born, our brains are wired for us to be multilingual. "So those who are exposed to a second language in early childhood seem to learn two languages quite easily," she said.

When puberty hits, certain aspects of language acquisition—most notably pronunciation—become harder. Tarone cited Arnold Schwarzenegger, the Austrian-born governor of California, as an example. "If you didn't hear his accent, you'd think he's native," she said. Tarone added that grammar and vocabulary are "more than achievable by adult learners," but that a realistic pronunciation goal is to be "clear and intelligible."

Lawson Robinson, F-15K offset manager in St. Louis, agreed with this statement. "It's easier for a young person, but anyone willing to make the commitment can learn just about any language," he said. Robinson learned Korean as a teenager when his family moved to Korea for two years. Later, he served as a linguist with the U.S. Army. As an aerospace engineer, he continued his study of Korean because he loved the language.

Robinson was working in the Apache helicopter program when he learned that poor translation during F-15 aircraft negotiations with the Republic of Korea Air Force had led to a misunderstanding of the Boeing position. A week later, he was working as an interpreter and a negotiator on technical matters. He said the toughest part is getting English-speaking colleagues "not to talk for a half hour straight," but to pause for translation.

Brian DeLuca, currently a Puget Sound systems engineer in F-22 training development, heard Italian spoken while growing up in Clifton, N.J. When doing business with the Italian airline Alitalia in the 1980s, he found that using an Italian phrase here and there in a social context made a big difference. And, when the customers spoke Italian to each other to seek clarification of an English technical term, he could understand and help. "They knew I wasn't fluent, but they still appreciated my attention to their concerns," he said.

Knowing when to speak a second language is important. Chinese speaker Tom McLean, director of International Corporate Communications in Washington, D.C., previously served as director of communications for Boeing China. "Many Chinese officials spoke wonderful English, but the minute they spoke on official business they went right to Mandarin, because they wanted to be very accurate and wanted to make sure their Chinese colleagues knew what was being said," McLean recalled. For anything unofficial—entertaining or building relationships—McLean used Chinese. He welcomed press conference attendees in Chinese, then switched straight to English to ensure that the company position was being reflected as accurately as possible.

Susan Miller, a web developer project lead in Seattle, calls herself a "language freak"

and has studied a handful of languages. She's used her skills to help produce Boeing web sites in Arabic, French, German, Spanish, Italian, Russian, Japanese, Chinese and Korean.

Miller's family was skeptical when she majored in Spanish but didn't want to teach. Now, she's using those skills on the job. "It's interesting that the computer languages I studied back when I studied Spanish and French are now deader than Latin will ever be," she said. "But the real satisfaction comes from exchanges with employees and contractors in whatever non-English language we have in common. It creates a personal bond that otherwise wouldn't exist." ■

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English vs. *English:*

Barriers within a language

It's British English that's taught around the world to non-native English speakers. American English speakers need to realize that can cause some confusion.

In UK English, for example, the term "local hire" for a Boeing employee serving outside the United States can sound disrespectful to non-American ears. "Hire" has a connotation of temporary work, like hiring casual day labor to perform home repairs.

Some American terms are simply confusing. When an Ethics training scenario mentioned a Slurpee, Boeing employees in the Berlin office were stumped. Their English was terrific, but unless they'd been to a 7-Eleven convenience store in the United States, they had no way of knowing that Slurpee was the brand name of a slushy iced drink.

Jan Graham, Customer Relations manager in the UK for the Commercial Airplanes Sales organization, also takes care when writing English words that are spelled differently. "For words like 'centre' and 'programme,' I change the spelling depending on who's receiving the e-mail—someone here in the UK or in the U.S.," she said. Nevertheless, Graham said she's found that the language of aerospace has become universal.

That's a hopeful sign, but then there are all those acronyms, which can challenge even the most seasoned Boeing employee. The best advice: Visit the online acronym site, http://termbank.web.boeing.com, hosted by Library and Learning Center Services.

And of course, as at any large organization, there are words that exist only at Boeing. If there's a squiggly red line in a Microsoft Word document when you type the word "focal" for a designated employee advancing a new program or initiative within a work group, that's because it's not a real noun, but a Boeing noun. It started out as the term "focal point," and eventually got shortened.

—Kathrine Beck

As a UK-based employee, Jan Graham speaks the same language as her U.S.-based Boeing colleagues. But she takes care to adjust the spelling of words that are written differently in the United Kingdom and the United States.

ADRIAN BROOKS PHOTO

Want to **boost** *your* **language skills?**

As Boeing's global enterprise grows, so do the opportunities for employees to experience and learn other cultures and languages.

Learning, Training and Development and its Learning Together Program (LTP) have partnered with Fontbonne University of St. Louis and Berlitz Languages to bring language courses to Boeing employees. Boeing employees can choose from eight languages—Arabic, French, German, Italian, Japanese, Mandarin Chinese, Russian and Spanish.

Berlitz instructors teach the courses, and college credit is awarded through Fontbonne. The courses are available to all Boeing employees through interactive, online sessions with a live instructor. International employees can participate but need to make sure classes will work for their time zone. Employees in St. Louis also have the option of attending classes at either Fontbonne or the Berlitz Learning Center. Each language curriculum consists of four progressive levels, each lasting 10 weeks. Students earn three college credits for each level. Classes meet for two hours, once or twice per week. Students can enroll at any time, with new classes forming throughout the year.

Registration information is available on the LTP Web site at http://learningtogether.web.boeing.com on the Boeing intranet. Non-U.S.-based employees should access the LTP International Web site at http://ltp-intl.web.boeing.com on the Boeing intranet. For more information on the Fontbonne program, visit www.fontbonne.edu/berlitz on the school's Web site.

—Kathrine Beck

'They se

By Maureen Jenkins

Turkey literally exists in two worlds, as the Bosporus waterway divides the city of Istanbul, with one portion standing in Europe, the other in Asia. What a perfect analogy to present-day Turkey, a proudly Muslim but staunchly secular country that reveres its storied past while striding confidently into a technologically capable, global future. The country views its East-meets-West orientation as a strategic strength.

Go anywhere in Turkey, from its most cosmopolitan cities to its smallest towns and you see the influence of Mustafa Kemal Atatürk, who in 1923 transformed the nation into a secular republic. His likeness and legacy are ever-present, still guiding the country's course more than 80 years after the modern state's founding. In the midst of accession negotiations with the expanding European Union, Turkey has been evolving to enhance its bid for full membership. And one byproduct has been the country's economic liberalization and proactive policy of pursuing foreign investment.

"We can generate new jobs, new technologies, new visions," said Alpaslan Korkmaz, president of the new Investment Support and Promotion Agency of Turkey. His job—one that reports directly to Prime Minister Recep Tayyip Erdogan—is to present investment opportunities to the global business community and serve as a "one-stop shop" that makes it easy for foreign companies to thrive here.

e the future'

Welcome to Turkey, a nation that bridges East and West—and is working to instill high-tech skills into its young population. It's a nation where Boeing is strengthening long-lasting partnerships.

Majestic mosques and minarets dot the landscape of Istanbul, Turkey's largest city. With its European and Asian sides linked by a bridge across the Bosporus strait, Istanbul represents the country's proud past and its global future—a future Boeing hopes to help shape through long-term partnerships.

SHUTTERSTOCK.COM PHOTO

Inside

Over the past six years, he said, foreign direct investment in Turkey totaled $55 billion. "We are young, motivated and have worldwide experience," he said. "Turks like me come back to this country. Why? Because they see the future."

With about 400,000 university graduates annually and an overwhelmingly young population (65 percent are 34 and under), the country is working feverishly to equip its labor pool with high-tech skills valued in the global marketplace.

And that's where Boeing, which has done business in Turkey since the 1960s, plays a role by teaming with world-class, in-country aerospace industry suppliers. As it does around the globe, Boeing takes a cross-enterprise approach to doing business here, with Commercial Airplanes and Integrated Defense Systems offering 21st-century solutions to their private-industry and government customers. These include Istanbul-based Turkish Airlines and its new low-cost subsidiary AnadoluJet, and low-cost carrier Pegasus Airlines. They also include the Turkish Air Force, whose AEW&C (airborne early warning and control) Peace Eagle program takes a true "one Boeing" approach, featuring a Next-Generation 737-700 and a variety of IDS advanced radar, communications and navigation systems on a sophisticated military platform.

"We're looking for a long-term partnering relationship, not a simple supplier relationship," said Boeing Turkey President Greg Pepin,

Boeing Turkey President Greg Pepin is versed in Turkish culture and fluent in the Turkish language. He sees his role as helping create connections between Boeing and Turkish industry. ALI UNAL PHOTO

who joined the company as country director in 1999.

He sees his role as one that helps Boeing business units navigate Turkish bureaucracy—and that helps build bridges between Boeing and Turkish industry. "We're developing those based on capabilities and technologies that enhance both Turkish industries and Boeing." The goal: a relationship built on "equal respect, equal exchange of ideas, equal footing." It's why Boeing's a high-level sponsor of the American-Turkish Council, where corporations work to initiate and facilitate investment and trade between the two countries and to boost commercial, defense, technology and cultural relations.

But it takes more than technologically advanced products and programs to build these bridges. Pepin, who's lived for decades in Turkey as a U.S. Army officer as well as a Boeing executive, brings personal relationships and fluent grasps of both Turkish language and culture to the table on Boeing's behalf.

"The advantages it brings are the long-term customer knowledge," he said. "I think [knowing] the language opens up many more doors. From the customer side, they feel comfortable with you because they know you. You're not just here for business, but you want to be here. They also trust that you do understand them and their system, and trust you'll be able to help them work with Boeing."

Today, Boeing employees living and working in Turkey are embracing the local culture, working to build bridges with supplier-partners such as Turkish Aerospace Industries (TAI) and HAVELSAN that stretch beyond the office and factory floor.

"The Turkish people are very proud, have a very strong national sense—and that rubs off on you. You appreciate it," said Doug Proctor, a Kent, Wash.–based member of the AEW&C Peace Eagle team. An Overseas Mod Support IPT Leader who's responsible for the program's subcontract work with Turkish Aerospace Industries, he wears a TAI pin along with his Boeing badge. "As you work with them more, you gain a sense of their identity."

And it's that Turkish identity—and the tireless quest for upward mobility and global acceptance—that's at the heart of doing business in this rapidly changing land.

"The keys to future success," said Boeing International President Shep Hill, "will be to ensure we act as 'one Boeing,' working as a single team aligning Boeing business objectives and Turkey's requirements.

"If we continue and strengthen our approach in this regard, Turkey will remain an important focus of both our growth and productivity plans into the future." ■

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Turkey at a glance

Official name: Republic of Turkey

Modern state founded: Oct. 29, 1923

Location: In southeastern Europe and southwestern Asia bordering the Black Sea, and bordering the Aegean Sea and the Mediterranean Sea

Area: 780,580 square kilometers (301,384 square miles), slightly larger than the U.S. state of Texas

Population: nearly 72 million (July 2008 estimate)

Median age: 28.3

Official language: Turkish

Religion: More than 98 percent Muslim

Government: Secular, democratic

Capital: Ankara

Other key cities: Istanbul, Izmir, Antalya, Adana

Gross domestic product, 2007: $663.4 billion

Estimated GDP growth rate, 2007: 5 percent

Key industries: Textile manufacturing, petroleum refining, agricultural processing, tourism, automobiles, electronics, mining, steel, construction

Major export partners, 2006: Germany, United Kingdom, Italy, United States, France, Spain

Major import partners, 2006: Russia, Germany, China, Italy, France, United States

Military spending as part of GDP, 2005: 5.3 percent

Sources: CIA World Factbook, Investment Support and Promotion Agency of Turkey

Suited to a *Tea*

Boeing, Turkish Technic share Lean lessons—and cultural traditions

By Kathrine Beck

"They are the warmest people," said Joy Cassady of her Turkish teammates. "The country is beautiful. There is so much history! And the food!"

Cassady, who works in the Commercial Airplanes Lean Enterprise Office, has been traveling to Turkey since 2006 as the team leader for the Lean consulting that Boeing has provided to Turkish Technic. A subsidiary of Boeing customer Turkish Airlines, Turkish Technic delivers maintenance, repair and overhaul services to its parent company and other global customers on a 24-hours-a-day basis from two vast hangars at Istanbul's Atatürk airport.

Cassady has conducted Lean activities at Turkish Technic's heavy maintenance and line maintenance operations, back shops, stores, shipping and receiving, engineering and planning offices. Her team has taught Lean tools such as 5S (sorting, simplifying, sweeping, standardizing and self-discipline), Accelerated Improvement Workshops, Value Stream Mapping and Production Preparation Process (3P). Cassady said that although each tool has a different purpose, all are used to create flow and a just-in-time pull production system.

"Our goal is to help Turkish Technic learn how to identify and eliminate waste throughout the entire value stream, to improve their turnaround times and reduce costs," Cassady said.

Cassady's last visit, in May, included a one-week 3P class, followed by two 3P workshops. During the workshops, one team built a prototype for a right-sized X-ray stand for heavy maintenance. (X-ray technology is used on various parts of the airplane.)

Turkish Technic had been mounting the equipment on a heavy tripod, which wasn't well designed ergonomically and was bigger than it needed to be. The team came up with a foam and cardboard mock-up of a right-sized, ergonomically designed piece of equipment.

Another team built a right-sized ultrasonic cleaning machine for fuel pump parts. This equipment cleans parts by submerging them in a vibrating tank filled with cleaning solution. Before, they had used a shared tank line that was much too big for fuel tank parts, and it was stored far away from where it was used. Now, Turkish Technic has a dedicated, right-sized machine, about the size of a dishwasher, within the fuel pump shop so that equipment isn't traveling back and forth.

"We use the method of learning by doing," Cassady explained. "We practice using the tools where the actual work is being done."

Aeronautical engineer Yuksel Bozkurt is Quality Improvement and Productivity chief engineer at the Istanbul Turkish Technic Maintenance Center. She said that 3P is "a tool to improve our processes and work area—a different kind of tool for us," adding that participating mechanics, engineers and managers enjoyed the 3P process and are "really supporting our lean journey."

Turkish Technic has six engineers working full-time on lean implementation and plans to train 120 lean agents—four for each department—in two years. Turkish Technic also attended the Boeing Fall Lean Conferences in 2006 and 2007 to share best practices with other Boeing customers and partners.

"We have good relations with the consultants on the Boeing Lean team," Bozkurt said, adding that multiple team members add value to the process. "We have a chance to see each of them in every workshop, and it's a nice experience to work with all the different consultants."

Cassady, who leads Lean activities all over the world, said the Turkish workshops have a special touch that she really enjoys. During breaks, Turkish tea is served to all in bell-shaped glasses that are miraculously not too hot to handle, accompanied by small spoons and sugar cubes. "Tea time is very important," she said. ■

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Boeing Lean consultant Joy Cassady (second row kneeling, right) took part in a visit to Turkey in May to share Lean practices with a Turkish Technic team. TURKISH TECHNIC PHOTO

Peace Eagle *and more*

The first 737 Airborne Early Warning and Control aircraft modified by Turkish Aerospace Industries for Turkey's Peace Eagle program is shown just after landing on its first flight July 16.

TURKISH AEROSPACE INDUSTRIES PHOTO

Turkey puts a premium on having forces that are strong yet agile. That's where Boeing comes in

By Maureen Jenkins

Want to see Boeing's cross-enterprise teams put pedal to the metal? Visit Turkey, home of the AEW&C (airborne early warning and control) Peace Eagle program. It features a Next-Generation 737-700 and a variety of Integrated Defense Systems advanced radar, communications and navigation systems to create a sophisticated military platform for the Turkish Air Force.

Turkey is currently under contract for four Peace Eagle aircraft, with Nos. 2, 3 and 4 undergoing modifications at Turkish Aerospace Industries' (TAI) Ankara factory. "Green" Peace Eagle No. 2 made its long-awaited first flight last month, with No. 3 soon after.

"The Turkish Air Force has done a lot of its planning around having [these] assets," said Mark Ellis, Peace Eagle program manager.

Political realities in Turkey's part of the world mean that strong yet agile defense forces are key. While Boeing views Peace Eagle as a foundation of IDS business here, it's also signed and extended a memorandum of understanding with software and systems producer HAVELSAN on regional and global ballistic missile defense. In fact, HAVELSAN is a key Peace Eagle supplier and maintains a colocated codevelopment office in Kent, Wash., allowing the company's and Boeing's Peace Eagle teammates to use a Lean approach to jointly produce Peace Eagle software. Conversely, about 30 Boeing employees work at HAVELSAN's Ankara headquarters.

Although Boeing and its heritage companies have had a defense presence in Turkey since the 1970s, Boeing continues to look for ways to support the country's evolving needs.

"We've got certainly some opportunities ahead of us, especially in terms of the CH-47 Chinook," said Howard Berry, regional manager/Near East for IDS Business Development. "The Turks are taking a strong look at it, [as it] brings capabilities they don't have today. We not only have a healthy portfolio in place, but there's potential for growth across the spectrum."

Joe McAndrew, IDS vice president of Business Development for Europe, Israel and the Americas, said he sees opportunities for "performance-based logistics for Boeing-built and other platforms" as potential growth areas in the Turkish defense market, as well as network-centric operations.

And Turkey is eager to partner with multinational aerospace firms. "The longer the American engineers and managers stay here, the better they communicate with TAI's team," said Bekir Ata Yilmaz, head of TAI's Aerostructure & Space Group.

"What the Turks bring to the table is strong engineering expertise, which makes our lives easier," McAndrew said. "We use Turkish engineering and know-how, whether it's software or hardware. Today, when you do business in Turkey, you have to be prepared to leverage that expertise."

Indeed, HAVELSAN General Manager Faruk A. Yarman noted that the nation has evolved from a market for aerospace products to one that wants to participate in production—to one that "wants to be part of generating high-level skills for our participation in the program."

That's increasingly the way business is done globally, with governments and private industry requiring in-country investment from multinational company partners.

But ultimately, Boeing-Turkish partnerships mean improved opportunities for both sides. In fact, Ellis said, one of the Turkish defense procurement agency's "key goals, as much as capability, is [advancing] Turkish industry. They want to be able to sustain this [program] 30 years into the future."

And this work boosts Boeing business in the United States. "There are 1,000 people [in the United States] working on AEW&C in very key high-skilled jobs," Ellis said. "That doesn't even count work that will go into making the 14 737s at BCA (for AEW&C aircraft for Turkey, Australia and South Korea). It's a broad mix of skill bases as a result of these international sales. We are able to improve our Boeing processes to make us more competitive." ■

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Turkish Aerospace Industries engineer Ersen Koc works on a 737-700 being modified into an AEW&C/Peace Eagle platform.

TURKISH AEROSPACE INDUSTRIES PHOTO

Tourism, bigger fleets spur traffic growth among Turkish carriers

By Maureen Jenkins

In Turkey, you'll find renowned historical and biblical treasures, such as the legendary ruins of Ephesus and mythical Mt. Ararat. You'll also see charming villages. And let's not forget the beaches along the Mediterranean Sea.

It's an understatement to talk about how crucial tourism—especially from nearby European travelers—is to the Turkish aviation market. But unlike many struggling global aviation markets, Turkey is poised for growth.

In 2005, according to the Investment Support and Promotion Agency of Turkey, more than 20 million tourists visited the country, making this nation the world's ninth-most-popular holiday destination. Its largest carrier, Turkish Airlines (THY), is expanding both its domestic and international routes and recently joined the global Star Alliance. In late April, THY launched AnadoluJet, a low-cost subsidiary providing regular service to 20 major cities and underserved small towns across Turkey. Pegasus Airlines, a whimsical low-cost carrier that's become as known for its ad-splashed liveries as for its friendly crews and affordable fares, also has aggressive expansion in its sights.

And a spate of other airlines—including all-Boeing SunExpress (a joint THY-Lufthansa venture) and Sky Airlines (the first European and first Turkish carrier to order the Next-Generation 737-900ER)—are multiplying travel options. Scheduled service by Turkish carriers has more than doubled over the past 10 years, with 9 percent growth annually.

All the while, Boeing Commercial Airplanes has partnered with the country's airlines, working alongside to help them achieve their ambitious growth goals. And the 737 is the backbone of many airlines. All 17 Pegasus airplanes are 737s; the single-aisle jet represents about half of THY's fleet.

In Turkey, "in order for you to do business, you have to be a good friend and establish trust," said Aldo Basile, Commercial Airplanes vice president of Sales/Europe, who for the past 19 years has served as a sales director in Turkey. (New Sales Director Steve Aliment replaces Basile and Jean Thouin, who this summer became sales director for Air France KLM.)

"Being good friends, being close to the airline, understanding the airline—it's a long-term situation," Basile added, noting that Boeing has about 50 percent of Turkish market share.

But it's market liberalization that's helped spur Turkish aviation growth. Today, the government owns just 49 percent of flag carrier THY, allowing it to compete for passenger traffic. "Without competition, with government protection," said THY President and CEO Temel Kotil, "this means you are going to school but with no exam."

The airline wants to capitalize on Istanbul's location and THY's growing fleet to move passengers through Turkey on their way to the Middle East and Africa. "We're saying we combine Western efficiency with Eastern hospitality," Kotil said.

In June, Marlin Dailey, Commercial Airplanes vice president of Sales for Europe, Russia and Central Asia, reported the Turkish aviation market would need about $21 billion worth of 250 new airplanes over the next 20 years. The company's Current Market Outlook also forecasts Turkey increasing its market share in long-haul intercontinental flights.

"It's been a cultural shift as people [in Turkey] are getting used to the comfort air travel can provide. There's still a big potential for growth," said Sertaç Haybat, Pegasus general manager, who expects to increase the frequency of international flights on his airline's most popular routes. "Within the next five years, we want to have 30 planes."

Also playing a major part in the nation's aviation growth is Turkish Technic, a leading regional maintenance, repair and overhaul facility with hopes of becoming one of the world's top five MRO centers within 10 years. With annual revenues of $360 million, this independent company aims to achieve a 50-50 split in work for THY and third-party airlines.

"Our strategy is to go in the high-income areas—assembly and disassembly," said Turkish Technic General Manager and Board Member Ismail Demir. Next up: a new MRO facility called HABOM, this one housed at Istanbul's Sabiha Gökçen International Airport, for which Demir and his team are actively seeking investment. ■

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JIM COLEY PHOTO

PEGASUS AIRLINES PHOTO

Turkey's airlines include flag carrier Turkish Airlines (left), which recently joined the Star Alliance, and low-cost Pegasus Airlines, whose liveries bear colorful ads.

Kars school dedication
Last year, Boeing completely rebuilt the Kazim Karabekir Pasa Primary School in Kars, a small town in eastern Turkey. Here, students gather outside their school before a late April dedication ceremony thanking Boeing for its support.
MAUREEN JENKINS PHOTO

A passion to help

Boeing's efforts to support Turkish communities range from backing music fests to funding schools

By Maureen Jenkins

Boeing Turkey proves that it takes more than just manpower and money to help transform a country where one does business. It takes real passion.

From Commercial Airplanes' long-time sponsorship of the Istanbul Music Festival to archaeological digs to current Global Corporate Citizenship–funded school renovations, Boeing is a full-fledged partner of its host country when it comes to projects that make a difference in the lives of Turkish citizens. And much of it relates to some form of education, of broadening the minds and perspectives of those who call this country home.

Over the past eight years, Boeing has undertaken more than 50 education-related projects in 19 Turkish cities—funding computer and science labs, donating library books and sports equipment. It's helped sponsor more than 30 arts and culture projects across the country. It's helped renovate and provide medical equipment for more than 10 hospital projects in five different cities. And when natural disasters hit this earthquake-prone land in 1999, Boeing jumped in to assist Turkish hospitals and schools with the painstaking work of rebuilding.

But why?

"The first time you help somebody, it's because you want to help," said Boeing Turkey President Greg Pepin, who along with Office Manager

Ayça Karasu gets personally involved in allocating GCC funds across Turkey. "The second time you give, it's because you care."

Pepin estimates that between 10,000 and 20,000 Turkish schoolchildren have benefited from Boeing donations to the country's schools. He and his team follow up to ensure that 100 percent of Boeing-donated funds for schools and women's and children's hospitals go toward direct aid, not administrative costs.

"That's why I like doing things with children," he said. "Give 'em a chance and you'll be surprised at what they can do."■

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"The first time you help somebody, it's because you want to help. The second time you give, it's because you care."

– Greg Pepin, Boeing Turkey President

From left:

Ankara University Department of Pediatrics

Since 2003, Boeing has donated diagnostic equipment to this facility. Doctors here say these needed devices are saving lives. Standing next to a Boeing-provided infant incubator and warmer are Dr. Begum Atasay (left) of Ankara University and new mom Ozlem Uzun. ALI UNAL PHOTO

Çatalhöyük archaeological dig

One of the world's largest archeological projects is at Çatalhöyük, a town believed to be 9,000 years old. Over the past decade, Boeing has helped fund excavation projects there. In 2007, the company sponsored a yearlong exhibition of this site's latest finds at the Anatolian Civilizations Museum in Ankara.

Istanbul Music Festival

Just as it does around the world, Boeing recognizes the rich texture the arts and culture add to a nation's social fabric. That's why Boeing, in an initiative launched more than a decade ago by Commercial Airplanes, funds the Istanbul Music Festival each year, including this year's event in June (above). "The festival is appreciated to the point that it's a classic," said Aldo Basile, Commercial Airplanes vice president of Sales/Europe.

Merhaba (Hello) from Turkey

What's it like to live and work there? These Boeing employees offer a glimpse

Rifat 'Roy' Kocal

Field Service Representative, Commercial Airplanes

Years at Boeing: 28 (11 in Turkey)

Current job involves: Helps 14 airlines and three Maintenance, Repair and Overhaul facility customers in Turkey and northern Cyprus solve aircraft problems, from engineering to technical issues.

Why he left the United States to work in Turkey: Born in Istanbul but raised and educated in the United States. Assigned to Turkey while working for McDonnell Douglas in 1997.

What makes his job easier: "When you walk through that door, you have no idea what you're going to face. But Boeing really supports our requests from here to assist customers. Customers always come back and tell us how appreciative they are with our attention to detail support and how we go that extra mile."

Why he feels like a company "ambassador": "When you tell [Turks] you work for Boeing, they're very interested and want to ask questions. A regular 'hello' turns into a half-hour conversation."

Ayça Karasu

Office manager, Boeing Turkey office, Shared Services Group

Years at Boeing: 9

Current job involves: Supporting Boeing Turkey President Greg Pepin and Shared Services functions, and serving as Global Corporate Citizenship focal.

Challenges of being an international Boeing employee: "Sometimes, Boeing [employees] think these global [offices] are just like the U.S. But they're learning every country has [its] own customs, regulations, culture, history. When they start to travel, they experience it and we grow together."

Why she's proud to work for Boeing: "I was so impressed when I was in Seattle. We know that Boeing is big, but when you see it with your eyes, the big factories … It's beyond my limits. You're thinking it's very good for humanity, this technology and manpower, this organization."

What she enjoys most about her work: "GCC is my favorite hat because I'm helping kids. I'm helping the future, I believe. And if one of these kids opens his eyes and wants to be an engineer or a scientist or a doctor, it will carry them to a new dimension."

Burcu Köni Sanverdi

Administrator Officer, AEW&C Peace Eagle Program

Years at Boeing: 4

Current job involves: Doing English-Turkish translation of Peace Eagle contracts; serving as backup office manager

Why first interested in Boeing: "I wanted to work in a company that has got a worldwide reputation, that is respecting the employees. I find the feeling that I always have the opportunity to upgrade myself."

Challenges of being an international Boeing employee: "Mostly communicating because of [10-hour] time differences" between Ankara and Seattle.

How she maintains ties with colleagues around the world: "Actually, it's not very hard for me because my team [is] here frequently. When I go to Seattle, I feel that connection with my team. They make me feel like a part of the family."

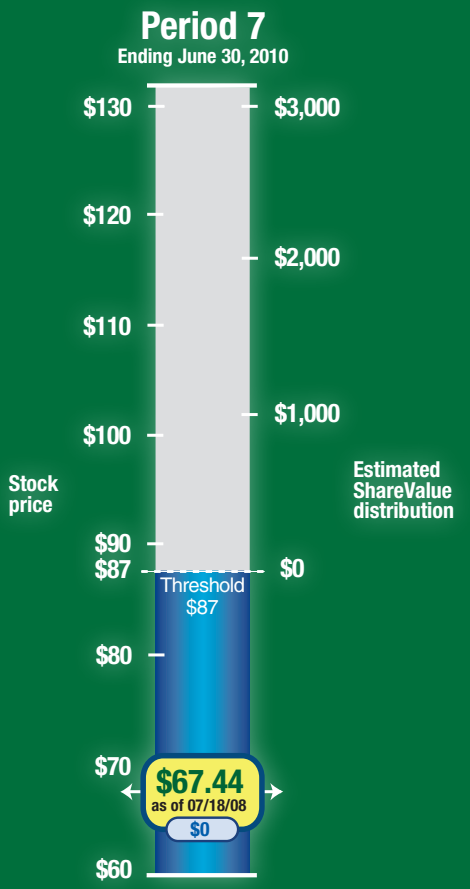
What she enjoys most about her work: "From the beginning in this office, I always felt like I was in a family. When Ayça is gone and Mr. Pepin is gone, they trust me that I can handle" managing the office.

TOP: PHOTO COURTESY OF TURKISH TECHNIC CENTER, BOTTOM: ALI UNAL PHOTO

Boeing stock, ShareValue Trust performance

ShareValue Trust is an employee incentive plan that allows eligible employees to share in the results of their efforts to increase shareholder value over the long term.

The program—which runs for 14 years and ends in 2010—features seven overlapping investment periods. The program is currently in Period 7.



The above graphs show an estimate of what a "full 4-year participant" ShareValue Trust distribution (pretax) would be for Period 7 if the end-of-period average share prices were the same as the recent price shown.

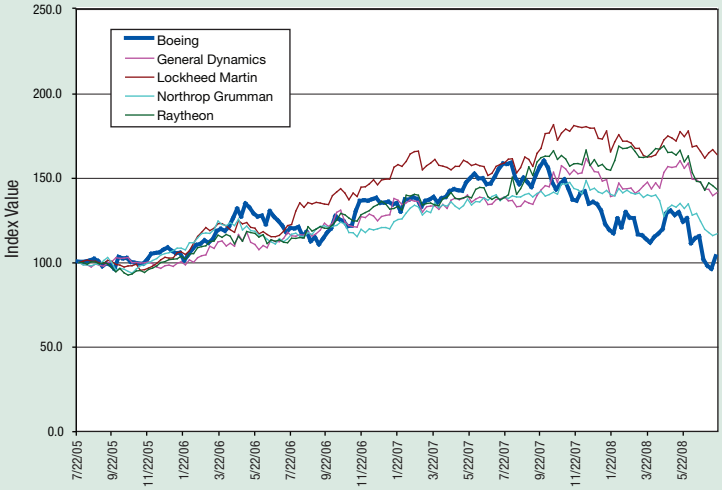
The share price shown is the average of the day's high and low New York Stock Exchange prices. Updates to participant/employment data will be made periodically.

For more information on the ShareValue Trust, visit http://www.boeing.com/share.

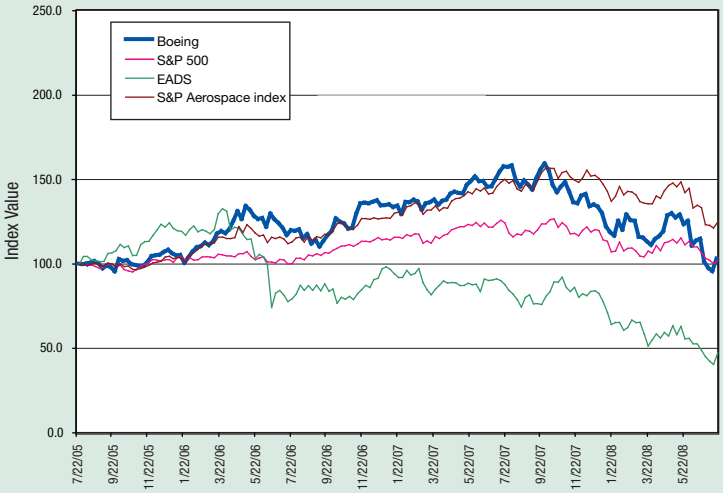
STOCK WATCH

The chart below shows the stock price of Boeing compared to other aerospace companies, the S&P 500 index and the S&P 500 Aerospace and Defense index. Prices/values are plotted as an index number. The base date for these prices/values is July 22, 2005, which generates three years of data. The prices/values on that date equal 100. In other words, an index of 120 represents a 20 percent improvement over the price/value on the base date. Each data point represents the end of a trading week.

Boeing vs. U.S.-based competitors



Boeing vs. stock indexes and international competitors



Comparisons: 4-week, 52-week	Price/value as of 7/18/08	Four-week comparison		52-week comparison	
		Price/value as of 6/20/08	Percent change	Price/value as of 7/20/07	Percent change
BOEING	**68.14**	**75.83**	**-10.1%**	**103.86**	**-34.4%**
U.S. COMPETITORS					
General Dynamics	82.07	85.50	-4.0%	80.65	1.8%
Lockheed Martin	100.99	102.07	-1.1%	97.89	3.2%
Northrop Grumman	65.65	69.71	-5.8%	77.70	-15.5%
Raytheon	56.17	57.89	-3.0%	54.30	3.4%
INT'L COMPETITORS					
EADS *	12.80	13.18	-2.9%	23.37	-45.2%
U.S. STOCK INDEXES					
S&P 500	1260.68	1317.93	-4.3%	1534.10	-17.8%
S&P 500 Aerospace and Defense Index	368.40	393.15	-6.3%	441.80	-16.6%

* Price in Euros

SERVICE AWARDS

Boeing recognizes the following employees in August for their years of service.

50 Years

George Tharalson
Henry Zebroski

45 Years

Kenneth Caen
Richard Eggers
William Hausner
David Irons
Richard Ladd
John Lohman
Leland Rhodes
David Rois
David Roscoe
Stephen Swyers
Conley Thatcher
Lew Wingert

40 Years

Dennis Banks
George Batchelor
Gerard Bathon
David Berra
Kenneth Braucksick
Richard Brewer
Howard Chandler
Judith Ciaramitaro
Lorenza Day
Linda Dolsen
John Ennes
Gerald Folken
Barry Fuller
Juris Gaidulis
John Gerardi
Gerald Giosa
David Goldenberg
Clifford Hogstedt
Michael Hubert
Terry Kinkelaar
David Kosmal
Kenneth Lee
Francis Leslie
Ellis McCoy
Michael Mohaghegh
Dennis Morden
Kathy Myers
Charles Nichols
Nancy Peters
Madeline Rosario
Stanley Rupe
Gordon Saiki
Gary Selby
Shirley Stoppleworth
Larry Summers
Grace Thompson
Alvin Williams
Kenneth Wollbrink

35 Years

Sharon Birge
Dale Bolen
Gregory Bowlin
Gwen Brady
Patrick Brogan
Jeffrey Burns
Lavera Byas
Michael Byrne
Gary Collings
David Cox
Michael Cramer
Wendell Cunningham
Jack Day
William Deaton
Leonard Ellis
Michael Fleming
Leon Gillenwater
Barbara Graves
David Harpring
Frankie Hernandez
Thomas Hinmon
Pamela Humiston
Francis Ingelsby
Martin Ingwersen
Steven Johnson
Francis Johnston
Wayne Kerbaugh
John Langer
John Layton
Charles Matthews
Ron McConnell
Timothy McCoy
Carl Mealy
Selvino Mencias
Mary Muffler
Richard Nelson
John Nemchick
Michael Neuman
Randall Noxsel
Joe Ornelas
Gordon Owens
Clement Pasquarella
Bruce Perry
David Phillips
Ronald Renteria
Randy Roberds
Ronald Ruppe
Kathleen Schroeder
Donald Sebben
Bruce Sims
Eloise Stanton
John Steimley
David Tarantola
Daniel Tiemann
Terry Tompkins
Edward Trierweiler
Susan Tsuji
David Twersky
Jose Valdez
John Vandeven
Richard Vonwald
Julie Walker
Jacalyn Weil
Ernest Woods

30 Years

Mark Adams
Deborah Ake
Alfred Alegria
Ameen Ali
Jesse Allen
Leona Allen
Stephen Allen
Lance Alongi
Scott Alspach
Dwight Anable
Gary Anderson
Mark Anderson
Timothy Anderson
Anthony Arena
Dale Armstrong
Richard Atchison
Mary Bacon
David Baer
Cynthia Bailey
Mark Bailey
Allen Ballinger
Tom Balut
Robert Batiuk
Rob Bay
Edward Bayne
Eric Beall
Carol Beck
Joseph Beretti
Edward Berg
Ricky Beverage
John Biciocchi
Wesley Birge
Donald Black
Jennifer Bluml
Frank Boldissar
Joseph Booth
Valerie Bradley
Daniel Brane
Johnny Brazzle
James Brennan
Richard Breuhaus
Michael Brinker
John Brooks
Arlene Brown
Clyde Brown
David Brown
Kevin Brown
Ronnie Burtis
Jonathan Calapp
William Cameron
Theresa Campbell
Glenn Caplin
Richard Caravelli
Ward Caretti
Albert Carranza
David Carter
Frederick Cartwright
Philip Chandler
Abigail Chang
Gerald Chapman
Renee Charleston
James Cho
Sheryll Christianson
Kenneth Chromy
Andrew Chumney
Toni Ciccanti
Martin Cline
Yvonne Cocks
Donal Cole
Rhonda Coleman
Robert Collin
Martha Cooper
Stephen Copeland
Francis Coulthard
Theodore Cowan
Donna Cox
Richard Cramer
Scott Crandall
George Cressman
Dianna Damon
Richard D'angelo
Charles Davis
Janice Davis
Paul Davis
Henri De La Garrigue
Dan Deardorff
Jon Defonce
Albert Del Toro
Deborah Delafuente
Miguel Delgado
Guy Delong
Paul Devereaux
Dwight Dewitt
Janice Dickherber
Joe Diffee
Colleen Diggs
Karl Doerner
Mark Douglas
John Doyle
Douglas Dubois
Phillip Dunning
Steven D'Urso
Michael Dwyer
John Eash
Larry Edwards
Pat Egbert
Gregory Engberg
Steve Engelmeyer
Edward Estabrook
Cynthia Evans
Kevin Evans
Michael Evans
Timothy Evans
E.C. Everroad
Raymond Evers
Sheree Faulkner
David Fay
Jean Fedor
Andrew Feiling
Jane Felland
Raymond Ferrari
Karen Fischer
Thomas Flagg
Perry Fleming
Larry Floyd
Jay Fodor
Joseph Foley
James Forbes
Melvin Fortson
Steven Foster
James Francisco
Julie Furnish
Timothy Gatzke
Steven Geiger
Steven Gekko
Steven Genczo
Marrietta Gendive
Kent Gibbs
Robert Gibbs
Gerald Gilbert
Stephen Goodale
Mary Goodau
Timothy Grant
Robert Gratzer
Michael Green
Donald Guarnieri
Isabel Gulamali
John Haack
Donald Hagebusch
Miles Hagestad
Darlene Hale
Carol Haley
Bradley Hall
Michael Hankes
Carl Hansen
Wade Hansson
Alfred Hardy
Jerald Harper
Garret Hawn
Dennis Heidner
Linda Hendrickson
Joann Henry
Angela Hoard
Katherine Hooser
Kenneth Horan
Henry Horton
William Howard
Ching-Long Hsu
Steven Huber
William Humble
Paul Hunter
William January
Richard Jensen
Douglas Johnson
James Johnson
John Johnson
Joseph Johnson
Richard Johnson
Lecester Jones
Michael Jones
Ronald Jones
Terry Jones
Mi Kang
Leo Kaschmitter
Dennis Kasprzyk
Robert Kazen
William Kearns
Emily Kelley
William Kelly
Raymond Kempf
David Kerr
Timothy Kilgore
Randall Kinney
Diane Kirchner
Kenneth Kirsch
Mary Kleinsasser
James Kochbeck
Karl Kubota
Paul Kyriss
Joseph Lagoe
Kenneth Lamury
Mark Langenwalter
Anna Langseth
Gregory Lanier
Shirley Lara
Don Lariviere
Michael Larkin
Steven Larsen
David Laudan
Richard Lawson
Tuan Le
Joseph Leang
Joyce Lebouef
Chanho Lee
Terance Leers
Manfred Leinz
Ralph Leslie
Thomas Lettic
Patricia Lewandowski
Murray Lewis
Stephen Lewis
Norman Locke
Robert Lorbeski
Michael Ludwig
Gregory Lusk
John Lyons
William Main
Jon Malmberg
Janet Markham
Steven Marshall
Steven Marshall
Philip Mattson
Gregory Mayhew
Henry Mayorga
David McDonald
Charlene McDougall
Brien McElroy
Paul McGrath
Thomas McGuff
Lori McLauchlin
Leland McLean
Scott McMahill
Sonseeahray Meadows
Edgar Meeks
Moosa Mehter
Paul Mendiola

Dean Michelson
Robert Miller
Stephen Miner
Eric Mohr
Sharon Montgomery
Lorraine Murray
Stephen Neason
Steve Nelson
Thomas Nelson
Terry Nesbit
Deborah Newton
Kim Nicotra
Ronald Nies
Ricky Nixon
Ronald Oberle
Michael O'Brien
Isaak Olfert
Dwight Olson
Terry Onder
Jeffrey Oney
Randolph Oughton
Bruce Palmer
John Palmer
Brian Parry
Douglas Passey
Karen Payne
Richard Pedersen
Robert Pedersen
Jon Perenchio
Alan Perkins
Lynda Pettit
Justin Pirak
John Pollard
Richard Potter
David Powell
Terry Pratt
John Price
Michael Quinn
Richard Ramsey
Gary Randall
Glen Rasmussen
Robert Read
Kenneth Reece
Gail Reed
Laura Reyes
Anthony Ristine
Corine Roberts
Michael Roberts
Charles Robinson
Frederick Robinson
Russell Roy
David Ruddies
John Rudnicki
Frans Ruijters
Terry Rush
Michael Russell
Owen Sakima
Roger Sampair
John Sandvig
Sharon Santillanes
Reinhart Schaefer
Dorothea Scherer
Harris Schurmeier
Joseph Scott
Michael Seck
Laura Sei
Cherie Severa
Diana Sewell
Subhash Sharma
Gregory Shaver
Thomas Shollar
Patricia Shultz
David Siebenaler
Denis Siefert
John Simpson
Michael Sirignano
Anthony Slee
Emanuel Smith
Jack Smith
Lena Snarr
Gregory Snider
Christopher Stair
Ronald Stanko
Dennis Statz
Michael Steele
Susan Sterling
Gene Stokes
Timothy Strandrud
Randolph Straub
Ashok Sundarraj
Sichul Sung
Roberta Swanson
John Sweitzer
Kurt Sykes
Dorothy Takasumi
Jimmy Takeuchi
Laurence Talley
Jeffery Taylor
John Thompson
Robert Thornton
Dennis Tinsley
Dawn Todd
Gary Toomb
Raymond Trautman
Sandra Traverse
Timothy Trudeau
William Tsai
Tylan Vallelunga
Rodney Van Assche
Richard Vossler
Larry Wagner
Bruce Waletzko
Billy Walker
Lettie Weeks
Jeffrey Weiser
Michael West
Richard Westby
Paul Whealen
Jennice White
William Whitesell
Frederick Wikstrom
William Winter
Daniel Wood
Eloise Wright
Frank Wright
Loran Wright
Fred Young
George Youngwirth
Dennis Zerkel

25 Years

Bradley Actipis
Annabella Amundson
David Avaritt
Tommie Ayala
Dana Babin
Mark Baca
Christal Baker
Peter Balcewicz
Joann Banks
Donald Bartosch
Ralph Bazil
Sharon Beasley
Eugene Beckles
Dwight Behrend
Byron Beitel
Barrett Belian
David Bennett
Sheryl Berner
Connie Bertholl
Susan Bhangoo
Mark Birchim
Ronald Bjornson
Marian Black
Lauri Blanchard
David Blue
Scott Boe
Gary Boley
Harold Booker
Priscilla Brick
Gordon Brockerman
Roberta Brooks
Gregory Bruin
Steven Burpo
Ron Calhoun
Dennis Cannon
Michael Carroll
John Cawley
Randal Chalberg
George Champlin
Steven Chin
Dub Clark
Mark Clark
Richard Cloninger
Douglas Cook
Roger Corey
Ronald Cottingham
Melvin Cotton
Christine Craig
Gary Craig
Richard Creeden
Thomas Croft
Michael Crow
Robert Cunningham
John Dagostino
Carl Dahl
Darrell Dalton
Joseph Dalton
Douglas Darin
Claude Davis
Kathleen Davis
James Dawson
Stephen Dayen
Jan Degroot
Heber Deland
Pearl Dennis
Warren Densmore
Mark Dige
Donald Dike
Lonnie Divelbiss
Mauro D'Onofrio
Kevin Donegan
Charles Duquette
Dale Dvorak
Cynthia Eastwood
David Edwards
Randy Ellena
Michael Elmlund
Gregory English
Marcia Everett
Clayton Everhart
David Ezmirly
James Farwell
Brian Fechtelkotter
Byron Fette
Alice Fields
Joseph Finn
Thomas Firpo
Robert Fischer
Julian Flores
Laura Fluder
Chester Fong
Mary Foster
Leslie Francisco
Kerry Frank
Lloyd Franklin
Susan Franklin
Jon Freeman
Julie Galucia
Donna Gates
Carl Gaul
James Gemmill
Linda Gerard
Tracy Gertino
Thomas Gianino
William Gillette
Danny Gossett
Patricia Gray
Russell Gresham
Jay Griffin
Alexander Guevara
Christopher Haahs
Jerry Hamilton
William Harden
John Harrington
Edward Harris
Mark Harsha
Carrie Hatten
Kelly Haymes
Edward Heffernan
Gerard Heffernan
Janice Heide
Karl Helton
Richard Hernandez
Cory Hitchcock
John Hixson
Kay Holmes
John Holt
John Houseman
Ellick Huang
Tamra Hughes
Robert Jackson
Donald Jarvis
Jack Jerson
Terry Jeske
Kathleen Johnson
Pamela Johnson
Duane Jolliffe
Edward Kalesnik
John Kauffman
Mark King
William Kirsanoff
Steven Klaus
Bobbie Klement
Steven Klunk
Albert Knight
David Kondo
Thomas Krauser
Brian Kugler
David Kuntz
Lawrence Kunza
Bridget Lammers
Gregory Lang
Ronald Lawrence
Loi Le
William Leach
Jeff Levine
Jeffrey Lewis
David Lien
Douglas Lingenbrink
Robert Loving
Salvatore Lucarelli
Duane Luke
Fred MacMichael
James Majors
Wayne Martin
Ian Martindale
Thomas Massoth
Lucile Matheis
Carol McClain
Micheal McNamara
James Mecklenburg
Greg Meintz
Larry Mellick
Lynne Merrill
Ed Mijares
Carl Miller
Steve Miranda
James Moore
Thomas Morgan
Christopher Morris
Stella Morris
Richard Morrisson
Guy Mosley
Lynda Moss
James Mullarkey
Maureen Mulloney
Michael Murdock
Charles Murphy
David Nelson
Nicholas Nelson
Tammy Nixon
Michael Nolan
Esther Nugent
Kevin Nunimaker
Steven O'Neal
Larry Patt
Lisa Peck
Gleeann Pendleton
Ronald Peterson
Willard Phelps
William Phillips
Davis Phung
Kenneth Pierce
John Pitts
Charlie Powers
William Purpura
Michael Quinn
Gerald Ramey
Robert Rattray
Kantilal Raval
Jerome Redhouse
Mary Reed
Micheal Rhein
Walter Rice
Jack Rico
Paul Riechers
James Rike
Katherine Riley
Stephen Rinella
Gary Robinson
Richard Rodriguez
April Roeschen
Ron Roy
Joseph Roznos
Robert Rupp
Rickey Russell
Talmadge Ryan
James Salazar
Santos Sanchez
Sandra Sanford
William Scherer
Eric Schetne
Marlon Schmelling
Steven Schoen
Jerry Schultz
Mark Scutti
Brian Searfass
Michael Sharp
Scott Shearer
Danny Sherman
Vicki Sholtes
Gregory Skillman
Troy Slaughter
Scott Sleeper
Kent Smith
Mark Smith
Randy Smith
Timothy Smith
Russell Stencel
William Strever
Peter Sturmer
John Suarez
Teresa Swanson
Nadine Terry
Jeffrey Thomas
Arlene Thompson
Iris Thompson
Robert Thompson

(Continued on Page 62)

SERVICE AWARDS

Boeing recognizes the following employees in August for their years of service.

Terry Tiefenauer
Darryl Tillman
Rebecca Timmerman
Natalie Tolliver
George Tondell

Michael Tsutsui
Meletumusa Tuaniga
Samuel Turk
Richard Ulrich
Richard Urton

Dean Van De Laare
Joseph Veile
Marlene Ventresco
Victor Villanueva
Rodolfo Villareal

Luis Vinuelas
Kelly Vittitoe
Michael Walsh
Thomas Walter
Marla Ward

Sharon Ward
Happy Watson
John Waymire
Joel Weaver
Mark Webert
Kelly Welch
Herbert Wheeler
Michele White
Randy Williams

Darl Winston
Ronald Witte
David Young
Robert Zabielski
Edward Zachar
Thomas Zamora
Masoud Zargaraf
Gordon Zimmerman

RETIREMENTS

The following employees retired in June from The Boeing Company.

Margaret Albin, 30 Years
Randall Anderson, 28 Years
John Antonio, 13 Years
David Arnold, 24 Years
Charles Ballard, 38 Years
Judy Bare, 13 Years
Henry Barr, 2 Years
Paul Bishop, 31 Years
Ivar Blomquist, 31 Years
Vernell Blue, 22 Years
Stephen Boak, 26 Years
Mark Boatsman, 27 Years
Larry Bogan, 32 Years
Christopher Borland, 40 Years
Daniel Brooks, 21 Years
Richard Burns, 26 Years
Harold Burrows, 24 Years
Judy Byers, 11 Years
Janie Cain, 20 Years
Harry Cannell, 42 Years
Thomas Carlin, 22 Years
Ronald Chaffins, 29 Years
James Cho, 27 Years
Alexander Chrivniz, 18 Years
Dale Claxton, 25 Years
Robert Closson, 8 Years
Harvey Cohoon, 21 Years
Jerry Cooper, 28 Years

Thomas Delgott, 23 Years
Carol Derosier, 25 Years
Gregory Dillon, 42 Years
Steven Dinkel, 32 Years
Matthew Dougherty, 25 Years
Robert Dunning, 5 Years
Robert Eide, 27 Years
Mark Engskov, 30 Years
Clifford Farm, 5 Years
Clement Favre, 32 Years
Nathaniel Foote, 37 Years
Kenneth Foster, 28 Years
Janet French, 25 Years
Frankie Gant, 42 Years
James Georges, 44 Years
Paulla Gordon, 31 Years
Joseph Greco, 22 Years
Gary Green, 7 Years
Richard Greifzu, 41 Years
Albert Grigsby, 22 Years
Nancy Grinzel, 26 Years
Robert Halverson, 20 Years
Bobbea Harlan, 10 Years
John Hart, 30 Years
John Hosea, 21 Years
Nancy Ickes, 5 Years
Linda Inkelaar, 18 Years
Robert Iwasaki, 35 Years

Guillermo Jalomo, 9 Years
Edgar Jefferis, 25 Years
Ivan Jines, 14 Years
Ronald Johnson, 31 Years
Yoy Johnson, 16 Years
Linda Jones, 20 Years
Charles Kanning, 22 Years
Karl Koenig, 21 Years
Richard Kotyluk, 35 Years
Denis Kuwahara, 16 Years
Lawrence Lauckner, 23 Years
Tien Le, 22 Years
Susan Lebowitz, 21 Years
Noreen Lerner, 20 Years
Larry Linscheid, 41 Years
William Lipscomb, 31 Years
James Long, 24 Years
Jack Loudon, 27 Years
Gary Luper, 24 Years
Ralph Lytle, 40 Years
Adelinda Malkinson, 28 Years
Duane Martin, 17 Years
Darwin Mattingly, 26 Years
Michael Mauhl, 23 Years
Jerry Maw, 30 Years
Meredith Means, 18 Years
David Metcalfe, 26 Years
Richard Miller, 42 Years

Terry Mills, 20 Years
Timothy Mish, 28 Years
Robert Mitchell, 20 Years
Marie Morneault, 18 Years
Marie Mueller, 35 Years
Earl Muren, 22 Years
John Myers, 35 Years
Lawrence Nardini, 20 Years
Donald Newman, 11 Years
Louvetta Newman, 19 Years
Tam Nguyen, 6 Years
David Nielson, 41 Years
Virginia Nix, 35 Years
Thomas Odell, 18 Years
David Odom, 25 Years
Richard Peer, 45 Years
Clifford Perrin, 20 Years
Wayne Peters, 21 Years
Victor Plaza, 30 Years
Karen Pope, 42 Years
Charles Preston, 26 Years
Danny Rausch, 14 Years
Leroy Raymond, 10 Years
Cathy Richardson, 32 Years
Phyllis Rippee, 20 Years
Hilton Roberts, 39 Years
Robert Rumpp, 23 Years
Julius Sadilek, 31 Years
Gerald Sahlberg, 46 Years
Hidemi Sakairi, 19 Years
Robert Sams, 21 Years
Richard Schee, 26 Years

Denton Schimming, 21 Years
Bruce Schnelle, 42 Years
Charles Schubert, 39 Years
William Scroggin, 30 Years
Robert See, 28 Years
Jimmy Seely, 33 Years
David Shelton, 31 Years
Gary Simerly, 28 Years
Lila Simmons, 23 Years
Robert Smith, 19 Years
Michael Stephenson, 28 Years
William Strahl, 8 Years
Paul Sturzenegger, 17 Years
John Taylor, 21 Years
Becky Troughton, 23 Years
Jerry Troughton, 37 Years
Joe Tyree, 33 Years
Sandra Vaughn, 32 Years
Eileen Villegas, 35 Years
Garcia Wade, 25 Years
Cynthia Wagner, 7 Years
Paul Walters, 12 Years
Cheryl Whelply, 26 Years
Laurence Wicklund, 46 Years
Thomas Wiczynski, 18 Years
Ronnie Williams, 29 Years
Charles Wolff, 30 Years
Judy Woodburn, 24 Years
Floyd Worthen, 42 Years
Patricia Wright, 15 Years
William Wunschel, 35 years
Fred Yust, 15 Years

IN MEMORIAM

The Boeing Company offers condolences to the families and friends of the following employees.

William Bowen, contract and pricing administrator; service date Nov. 11, 1996; died June 16

Stetson Cowan, systems engineer; service date Nov. 4, 1996; died July 6

George Dirks, manufacturing engineer; service date June 19, 1980; died June 12

Edward Dobkoski, systems and data analyst; service date March 26, 1979; died June 27

Christine Gilgan, materials processing/requisition facilitator; service date April 18, 1988; died July 9

Angela Howard, aircraft test technician; service date Dec. 5, 1996; died June 30

Eric Jansen, manufacturing planner; service date June 30, 1988; died July 11

Jones Kaohelualii, facilities plant maintenance specialist; service date Jan. 2, 2001; died June 28

Henry Koelker, tooling/machining inspector; service date Sept. 25, 1978; died June 24

Norman Knobloch, test and evaluation engineer; service date June 27, 1957; died June 28

Ralph Leonard, product repair/modification technician; service date April 10, 1986; died July 9

Ramiro Martinez Jr., expediter; service date Oct. 24, 1980; died June 17

Connie Nicholson, assembler–sheet metal; service date June 6, 1988; died July 5

Norm Phillips, analysis developer; service date Jan. 2, 1997; died July 15

Sandy Scott, tank test and repair mechanic; service date Feb. 9, 1987; died June 24

Robert Skrivan, aviation maintenance technician and inspector; service date Aug. 17, 1956; died July 13

Michael Smith, facilities technical designer; service date June 9, 1972; died June 23

Christopher Whalum, technical data designer; service date Oct. 21, 2005; died July 8

Michael Wolbert, expediter; service date March 26, 1985; died July 10

Please note the names on In Memoriam are of people who were full-time employees at Boeing at the time of their death—or were such employees on medical leave.

AROUND BOEING

SAUDI AWACS GETS COMMUNICATIONS UPGRADE

The first of five Saudi E-3 Airborne Warning and Control System aircraft to receive a major communications upgrade by Boeing took off last month from Boeing Field in Seattle. The enhancement, known as Link 16, is a secure, jam-resistant, digital data link that lets military aircraft, ships and ground units exchange tactical pictures in near real time. Boeing partner Alsalam Aircraft Co. will upgrade the remaining four aircraft in Riyadh, Saudi Arabia, with Boeing on-site support. The fleet upgrade is scheduled to be completed in December 2009. JIM ANDERSON PHOTO

VOLUNTEERISM AWARD NOMINATIONS DUE AUG. 15

Nominations for Boeing Global Corporate Citizenship's updated employee volunteer service award, which will provide a $10,000 grant to the non-profit organization designated by the winner, are due Aug. 15.

The award, known as the Boeing Award for Exceptional Volunteer Service: The William Allen Chairman's Cup, recognizes the important role employee volunteers play in building vibrant communities. The new criteria reflect the growing emphasis in skills-based volunteering. Nominees must be current Boeing employees (or current employees of one of its wholly owned subsidiaries—direct or indirect) in good standing on the active payroll for at least one year.

The Boeing Award for Exceptional Volunteer Service is the top honor for employee volunteerism at the company. It's the only companywide, non-job-related award for individual achievement at Boeing. This award represents an updated version of the William Allen Award, which was founded in 1987 and celebrated the deep commitment to community life of William M. Allen, Boeing president and chairman from 1945 to 1968.

For more information, including how to obtain an entry form and where to send it when it's completed, visit http://community.web.boeing.com/employee_involvement/vol_wacc_overview.cfm on the Boeing intranet.

BOEING HELPS FORM GERMAN RESEARCH CENTER

Boeing and three German companies—EOS Electro Optical Systems, Evonik Industries and MCP HEK Tooling—have joined with the University of Paderborn in Germany to form the Direct Manufacturing Research Center (DMRC) to further the development of direct manufacturing technology.

The agreement, signed June 24, aims to further the development of direct manufacturing processes and systems, which allow for the automatic, layered fabrication of component parts on the basis of a computer model (selective laser sintering). Direct manufacturing technologies such as this have been developed over the past decade. These methods can significantly reduce parts production and process costs, shorten cycle times, and better enable demand-driven production of spare parts. The DMRC is scheduled to open this fall.

ALSO AROUND BOEING:

• Boeing on July 22 announced an agreement to acquire Insitu Inc., a pioneer and market leader in the design, development and manufacture of unmanned aircraft systems. Boeing and Bingen, Wash.–based Insitu together developed the successful ScanEagle unmanned aerial system program, which has more than 100,000 operational flight hours with the U.S. Department of Defense and international customers. Once acquired, Insitu will operate as a stand-alone subsidiary under Integrated Defense Systems' Boeing Military Aircraft business. This transaction is anticipated to close by the end of September, following regulatory approvals.

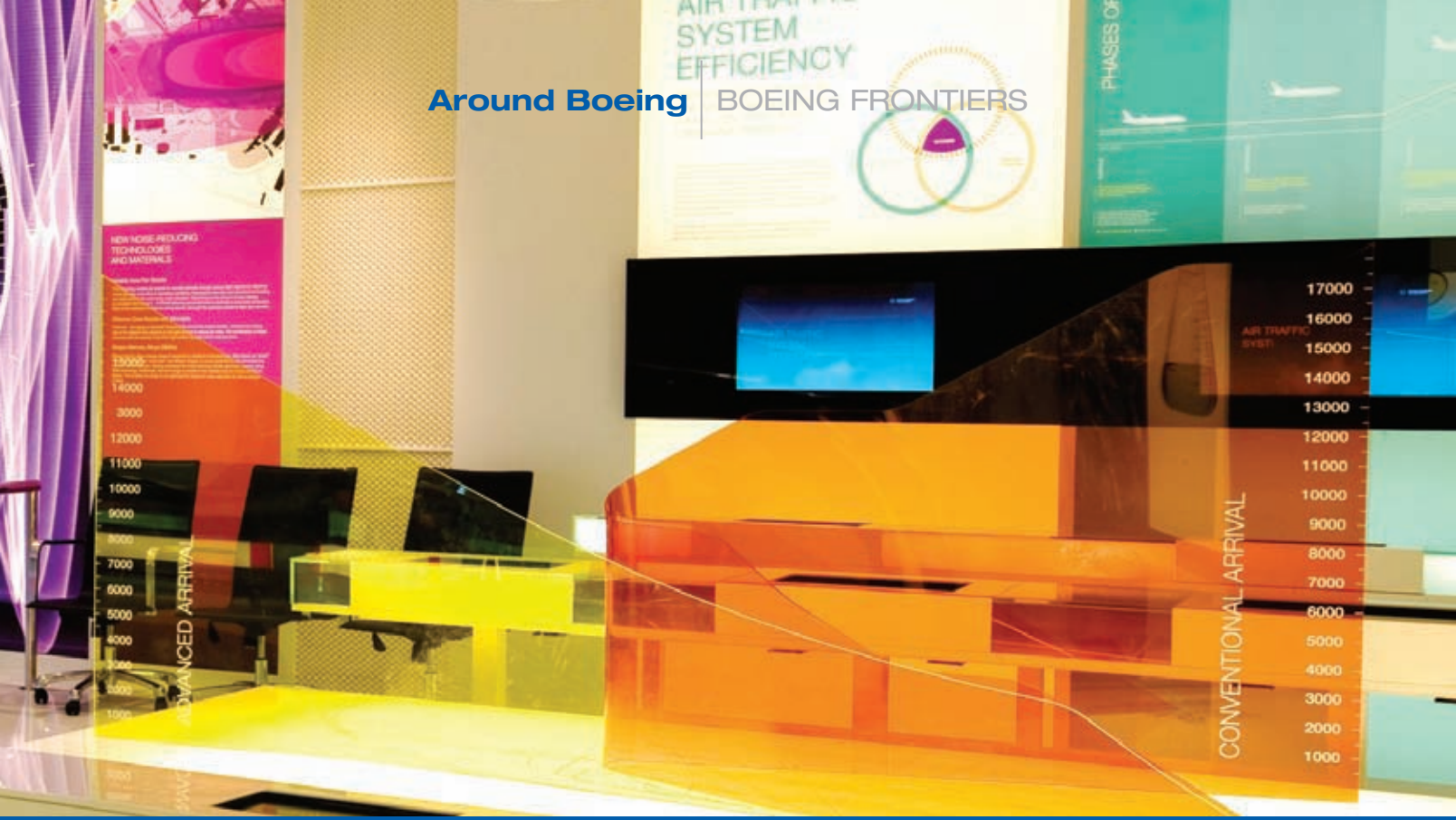
• Boeing last month launched the EnviroBlog to share information and hear from employees about the company's actions to advance environmentally progressive technologies and reduce Boeing's impact on the ecosystem. "Many employees are looking to learn about Boeing's environmental strategy and action as well as contribute their ideas and experience—and this is a great venue for that exchange," said Mary Armstrong, Environment, Health and Safety vice president. The blog is at http://environment.blog.boeing.com on the Boeing intranet.

Boeing at Fa

All eyes in the aerospace industry last month were upon the United Kingdom's Farnborough International Airshow, one of the industry's biggest global events. As demonstrated by the photos on these pages, Boeing people and teams were busy during the show building relationships and telling the Boeing story.

Top photo: Boeing unveiled an exhibit that explained how the company is harnessing its technology to develop products and services that support the environment. ED TURNER PHOTO

Above three photos, from left: Air India's newest Boeing 777-300ER (Extended Range) lands at Farnborough ahead of the show's opening. The jetliner was on display during the show. ED TURNER PHOTO **Billy Glover, managing director, Environmental Strategy for Commercial Airplanes, gives a presentation on Boeing's commitment to the environment.** ED TURNER PHOTO **What's an air show without a flying demonstration? Among the highlights of the daily demonstrations: the flight of the F/A-18 Super Hornet.** KEVIN FLYNN PHOTO



arnborough

In addition, Boeing Commercial Airplanes announced airplane orders from these customers:

- FlyDubai: 50 737-800s
- Etihad Airways: 35 787-9s and 10 777-300ERs
- Arik Air: 7 737-800s
- Air China: 15 777-300ERs and 30 737-800s
- Malaysia Airlines: 35 737-800s
- Aviation Capital Group: 15 737-700s

Above three photos, from left: Surrounding Pat Shanahan, vice president and general manager of the 787 Dreamliner Program, are reporters asking follow-up questions after his presentation on the airplane program. ED TURNER PHOTO **Among the Boeing aircraft on static display at Farnborough was the C-17 Globemaster III military airlifter.** ED TURNER PHOTO **Within the spacious environs of the C-17, Dave Bowman discussed future development of the C-17B airlifter. Bowman last month was named vice president and general manager for Tanker Programs, after having served as vice president and general manager, Global Mobility Systems.** KEVIN FLYNN PHOTO

AROUND BOEING

LOOK … UP IN THE SKY!

The Advanced Systems organization of Integrated Defense Systems and SkyHook International last month announced a teaming agreement to develop the JHL-40 (Jess Heavy Lifter), a new commercial heavy-lift rotorcraft. The JHL-40 is designed to address the challenges and expense of transporting equipment and materials in remote regions. The capability could be attractive to many industries, including energy, mining and logging. The neutrally-buoyant aircraft combines a helium-filled envelope sized to support the weight of the vehicle and fuel without payload, and four Chinook helicopter rotors dedicated to lifting the payload. The aircraft is projected to carry up to 80,000 pounds (36,300 kilograms) of payload and fly up to 200 miles (320 kilometers) without refueling. JOE NAUJOKAS GRAPHIC

Global corporate citizenship refers to the work Boeing does—both as a company and through its employees—to improve the world. These efforts, combined across the enterprise, can yield sustainable improvement in the communities where Boeing employees live, work and support. This ad illustrates Boeing's commitment to early learning, which promotes the development of social, emotional and cognitive skills in children.

"Temple Lake" is the first in a new series of advertisements reinforcing Boeing's partnership with Japan, a relationship that began more than 50 years ago. "Temple Lake" highlights Boeing's collaboration with Toray Industries on the composite materials used in the wing and fuselage of the 787 Dreamliner. The ad currently is running in Japanese publications including Nikkei Business, WING, Nikkei Shimbun, President *and* Toyo Kezai.