February 2008
Volume VI, Issue IX

Frontiers

www.boeing.com/frontiers

A BETTER FUTURE, BY DESIGN

Boeing' s Carol Anway contributes to engineering both at work and in the community. Look inside for more about her and her engineering teammates.

Super Hornet Block II

IMMEDIATE CAPABILITY, ENDURING VALUE.

Ensuring next-generation capability today, the combat-ready Super Hornet Block II delivers the very best combination of performance, cost and life-cycle support. On-schedule and under budget, it's a model program the Navy can count on to provide uncompromising value for decades to come.

Raytheon GE NORTHROP GRUMMAN BOEING

This Hornet Industry Team print ad, developed by Integrated Defense Systems, supports the F/A-18E/F. The ad is designed to communicate the tremendous value and capability the Super Hornet Block II brings to the United States and to warfighters, while emphasizing that it is currently available to meet the United States' strategic needs. The ad will appear in key U.S. Navy and Congressional publications.

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ON THE COVER: Carol Anway is a physicist with Phantom Works in Seattle.

Photo by Marian Lockhart

Frontiers

ED TURNER PHOTO

COVER STORY

IT'S BY DESIGN 12

National Engineers Week takes place in the United States this month. Boeing employees such as Tamaira Ross (above) are contributing to engineering, both at work and in the community. Here's a look at Ross and some of the many other Boeing people who support the field of engineering.

AT THE CROSSROADS

42 Saudi Arabia is undertaking efforts to diversify its economy beyond oil. As a result, this Middle East nation is a key strategic and high-priority market for Boeing, as the company continues to build upon its six decades of presence and mutually beneficial relationships there.

FEATURE STORY

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22 From left, at Commercial Airplanes' new Test Operations Center are Flight Operations, Test & Validation leaders Joe Kranak, director of Test Programs Integration; Dennis O'Donoghue, vice president of FOT&V; and Tom Maxwell, director of Test Manufacturing & Quality Operations.

ED TURNER PHOTO

Making the grade

22 For the first time in Boeing history, more than 12 new and derivative airplane models will be in engineering flight test this year. Here's how Commercial Airplanes' Flight Operations, Test & Validation organization has geared up for this challenge. Also in this story: A look at what happens during an FOT&V production test flight.

Fast work

30 The development of hypersonic flight, at speeds of at least five times the speed of sound, currently stands at a crossroads amid uncertainty over funding and potential applications. Yet Boeing's involvement in hypersonics continues, most notably through two efforts that center on missile research and development programs.

Keeping cool

34 Last summer, a team from Satellite Operations and Ground Systems at Integrated Defense Systems installed and integrated a new Iridium Satellite Telemetry Tracking and Control ground station in far northern Norway—amid challenges such as cold weather, round-the-clock daylight and wandering polar bears.

Service, with pride

38 Boeing Service Company, an Integrated Defense Systems subsidiary, maintains and sustains customer communication and data systems. One of BSC's responsibilities: Modifying the 500 Minuteman missile sites around the United States. Here's a look at this particular task.

INSIDE

Keep 'em flying

40 The C-17 has become a workhorse for the Royal Air Force of the United Kingdom. Key to the aircraft's success is the Boeing C-17 Field Services team at an air base in the United Kingdom. The team is on call around the clock as part of the Globemaster Sustainment Partnership contract with the UK Ministry of Defence.

He picked up a title

41 Steve Earl, an overhead crane operator at the Boeing plant in Renton, Wash., recently earned the title of world's best crane operator for 2007. Although competitors represented companies in different industries, Earl's toughest competitors came from Boeing.

Looking at Singapore

50 What makes Singapore a fitting place for Boeing to increase its presence? Not only is this nation in a strategic location that provides easy access to other Asian countries, but its talented work force makes for productive partnerships with Singapore companies and organizations.

BOB FERGUSON PHOTO

30 George Orton, who leads hypersonic design and applications programs for Integrated Defense Systems' Advanced Systems organization, said Boeing's work in hypersonics programs will show that "high-speed flight with a missile-like vehicle really can be done."

ROYAL AIR FORCE PHOTO

40 Boeing will deliver the fifth and sixth UK C-17 aircraft in 2008. Royal Air Force representatives said the service has been using the aircraft at about 120 percent of the originally planned flight hours per year.

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"Maybe we should also ban soda and junk food. Is it all OK in the name of healthy living?"

—Daniel Miyamoto, Seattle

Where there's smoke…

Editor's note: *As part of the company's ongoing efforts to ensure a healthful workplace, Boeing will begin implementing a tobacco-free policy in 2008. Implementation will be phased in over the next few years, beginning with all U.S.-based operations. Below are comments from employees about the policy.*

I think it is a mistake to implement this policy. I do not use tobacco products and have never used them. It is a personal choice to use tobacco, not the choice of my employer. Smoking is already limited to designated outdoor areas at my workplace. I think the current policy is fair to both smokers and nonsmokers. Those who wish to quit using tobacco have programs offered to them by Boeing.

But most importantly, I feel it is an insult to Boeing employees as a whole—those who use tobacco, and those who do not. It is my legal choice to use tobacco, and my choice to take on any health risks.

If it is OK to ban tobacco, maybe it's all right to ban motorcycles and convertible cars; they are risky too. Maybe we should also ban soda and junk food. Is it all OK in the name of safety and healthy living?

—Daniel Miyamoto
Seattle

The policy is a total disrespect for approximately 20 percent of the work force. It's unfortunately not about tobacco, it's obviously about money in the form of insurance and other company expenses. And I'm sure your cross-organizational team (that is exploring the issue to assess the impacts as decisions are made) will consist of unbiased non-smokers. Right! When all toxins and fumes from vehicles such as trucks, vans, forklifts and cars are gone, then you can use health issues as your criteria for the ban.

— Chris Lincecum
Everett, Wash.

I am thrilled to hear this news, though I'm disappointed that my site in Huntington Beach, Calif., isn't up for implementation in 2008. My biggest reason? The environment. No matter how many Earth Days or California Coastal Cleanup Days we see, many smokers at my site never think twice about leaving a cigarette butt in the parking lot or on the ground next to an ash can—which is appalling given our proximity to both the beach and the Bolsa Chica Wetlands.

There are days when I have picked up as many as 100 filters during the brief walk from my car in the parking lot to the building in which I work. To me, this is unacceptable. Health concerns are private, but the ocean belongs to everyone, and I would like to see Boeing's employees behaving more responsibly where our relationship with the environment is concerned.

—Brandy Gaunt
Huntington Beach, Calif.

Thank you for the tobacco-free policy. If people are unable to quit tobacco, it's nice to see they will have help.

I have two parents who smoked and no longer can do so because of health problems. I brought up the new policy with my mom, who smoked for 25 years. I thought she would be on the side of the smokers. But she said, "I wish someone would have stopped me."

—Karen Davis
Philadelphia

Corrections

• The wrong month was stated in the December 2007/January 2008 issue's list of retired employees on Page 49. These employees retired in October.
• The authors of the story "Still going strong after 65 years" on Page 10 of the December 2007/January 2008 issue were misidentified. They are Robin McBride and Brenda Pittsley (robin.m.mcbride@boeing.com and brenda.pittsley@boeing.com).
• The caption on Page 26 of the December 2007/January 2008 issue misstates the type of glider shown. The glider is a Smyk PW5 glider.

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.

SNAPSHOT

START SPREADIN' THE NEWS **A C-17 Globemaster III flies over New York City in December after completing the first transcontinental flight of an aircraft using a blend of regular aviation and synthetic fuel. The airlifter flew from McChord Air Force Base, Wash., to McGuire AFB, N.J. According to the U.S. Air Force, the fuel blend is a mix of JP-8 military jet fuel and fuel produced using the Fischer-Tropsch process, which can convert virtually any carbon-based material into synthetic fuel.**

U.S. AIR FORCE PHOTO BY RANDY HEPP

QUOTABLE

"Because the 787 is out there with more efficiency than anything around, it's getting a lot of the sales."

—Paul Nisbet, aerospace analyst with JSA Research, in the Jan. 5 *Chicago Tribune*

"Quality improvements have helped Boeing regain its reputation."

—Marco Caceres, a space analyst for Teal Group, about improvements in Boeing's satellite business, in the Dec. 28 *Los Angeles Times*

"Obviously, they are developing the right products for the market."

—Bob Toomey, a financial analyst with investment brokerage E.K. Riley, on Boeing's three straight years of commercial airplane orders exceeding 1,000, in the Jan. 4 *Seattle Times*

IAM PROMOTIONS

No promotions listed for periods ending Dec. 7, 14, 21 and 28, and Jan. 4, 11 and 18

ETHICS QUESTIONS?

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An in-flight view of the original single engine No. 1 T2J-1. Some 609 T-2s were built between 1956 and 1977.

BOEING ARCHIVES PHOTO

Learning in good hands

50 years ago, the Buckeye naval training aircraft took to the air

By Erik Simonsen

It might not look like the flashiest aircraft around. Indeed, its appearance is utilitarian. Yet the Rockwell International T-2C Buckeye, which on Jan. 31 marked the 50th anniversary of its first flight, served proudly for more than 40 years, training more than 11,000 aviators for the U.S. Navy before being retired from active service.

In 1956, North American Aviation responded to a Navy request for information for a multipurpose jet trainer. The Navy sought data for a single aircraft type to cover a wide spectrum of flight training that included basic jet training, high-speed formation, day/night navigation, carrier qualification, gunnery/ordnance delivery and air-to-air combat tactics. The qualifying aircraft would also have to be equipped with under-wing hard points for gun pods and ordnance. There was strong preference for a rugged aircraft, yet one equipped with features for ease of maintenance.

The NAA configuration featured tandem seating, with the rear seat slightly elevated above the front seat. The instructor could operate from either seat. A high T-tail and 100-gallon (380-liter) wingtip tanks made the appearance more unusual. The design also included a refined configuration of the original wing and landing gear of the straight-wing FJ-1 Fury and an enhanced version of the T-28 Trojan flight control system. NAA hoped that proven systems would reduce testing time.

Engineers also incorporated waist-high ease of reach to the electronics bay for ground crews and easy servicing for the single 3,400-pound thrust Westinghouse J34-WE-48 turbojet engine.

Previous military trainer experience with the AT-6/SNJ and T-28 entered the picture, as NAA won the industrywide competition and was awarded a contract on June 29, 1956. NAA's Columbus, Ohio, Division would be the center of production for the design and production of six YT2J-1 (NA-241) jet trainers. Initial planning progressed so well that by October of that year, the Navy increased its order by 121 aircraft.

First flight of YT2J-1 took place at Columbus on Jan. 31, 1958, followed by evaluation at Naval Air Station Patuxent River, Md., and carrier suitability tests aboard the USS *Antietam* (CVS-36) in May 1959. Shortly afterward, the T2J-1 was approved for introduction to the Training Command, and acquired the name "Buckeye" through a naming contest held by the Navy.

Deliveries to the Navy commenced on July 9, 1959, and the T2J-1 began earning a reputation as an excellent platform with stable flight characteristics—vitally important for new flight crew training. However, one exception to performance began to emerge: The T2J-1 was underpowered. Originally, the J34 with inherent technology dating back to the late 1940s had been

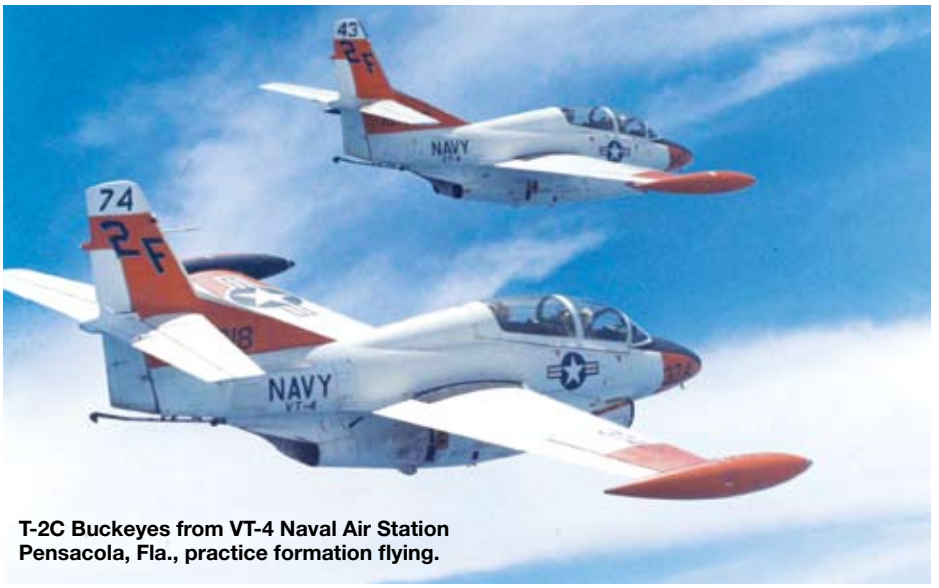
the only available engine compatible with the YT2J-1 airframe. By the 1960s it was technically obsolete, and newer engines were available.

NAA was awarded a contract in January 1962 to modify two aircraft to a twin-engine design utilizing the Pratt & Whitney J60-P6. Engineering and modifications were not difficult, thanks to the excellent original engine bay design characteristics. The two new engines provided a combined 6,000 pounds of thrust—an 88 percent increase over the single-engine version.

This performance boost was significant—especially for the safety of carrier qualification training when the tail hook misses all the arrestor cables and the pilot must initiate a go-around (bolter) in full power without the benefit of afterburners. In addition, the T2J now used 1,800 feet (550 meters) less runway to take off from land bases.

As the service years ensued, additional performance added to the longevity of the Buckeye. In 1962, the T2J was redesignated T-2, with the new twin-engine version designated T-2B. The Navy continued to order blocks of the T-2B through the early 1960s.

In 1967—the same year NAA became North American Rockwell—the new General Electric J85-GE-4 engine became available at lower cost per unit to the Navy. Although not providing any significant increase in thrust, the newer technology and cost were the driving factors in procuring the GE engine. Thus was born the T-2C. The venerable "C" variant entered service in early 1969.



T-2C Buckeyes from VT-4 Naval Air Station Pensacola, Fla., practice formation flying.

BOEING ARCHIVES PHOTO

In addition to the original NAA servicing features, the engines could be self-started without auxiliary ground equipment and changed out in less than three hours.

In 1973, North American Rockwell changed its name to Rockwell International, and from that same year through 1977, 24 T-2Ds were delivered to the Venezuelan Air Force. And in 1976 and 1977, 40 T-2E variants were delivered to Greece for use by the Hellenic Air Force for training. A total production run of 609 T-2s were built between 1956 and 1977.

Today, naval aviators in training transition from the turboprop T-6A Texan II to the Boeing T-45C Goshawk. The T-45 began to gradually replace the T-2C beginning in the late 1980s, with a T-2C making its final landing, or "trap," aboard the USS *Harry S. Truman* on July 25, 2003. ■

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In this unusual view, a T-2C sports a gray aggressor paint scheme. The aircraft is taxiing at Naval Station Norfolk, Va.

U.S. NAVY PHOTO

Thinking greener

Boeing unveils 5-year environmental targets

By Chaz Bickers

Boeing's newest set of performance targets will help everyone at the company tackle a challenge of global proportions: the environment.

Five-year targets rolled out in January will reduce energy use, greenhouse gas emissions and hazardous waste to more than offset Boeing's increase in production rates. They'll also boost recycling of waste that would go to landfills.

The targets are the first major actions from Boeing's new Environment, Health and Safety unit, which is part of Engineering, Operations & Technology. EHS was formed last year with a charter to continuously improve safety and environmental performance for every aspect of Boeing's operations, including sourcing, design, manufacturing and recycling. EHS also will provide strategic direction for Boeing to sharpen its focus and accelerate development of more environmentally progressive products and services.

"We must take bold action, and at Boeing we know that targets work," said Mary Armstrong, EHS vice president. "First, we can measure and improve the most important areas of concern. But perhaps more importantly, we can get everyone at the company thinking about the environment. That's critical to achieving new advances in our products and services."

Boeing's record of improving environmental performance at its operations is good. Since 1998, the company has cut energy use by 37 percent and hazardous waste by more than half. The challenge for the coming five years, however, will be to hold down waste and emissions while production rates grow significantly.

The new targets aim at 25 percent improvement goals for solid waste recycling rates, energy efficiency and carbon dioxide emissions intensity; and a comparable goal for hazardous waste reduction. By meeting those goals, Boeing will reduce its current total energy use, carbon dioxide emissions and hazardous waste by 1 percent—even with a significant production increase.

"Three years of record-breaking success of our Commercial Airplanes (business) has an effect that we need to acknowledge and address," Armstrong said.

As a technology leader, Boeing is pioneering a number of aviation solutions for reducing greenhouse gases at the heart of climate change concerns. Among them:

• Making its airplanes more fuel-efficient. The fast-selling 787 Dreamliner, which will be 20 percent more efficient than the airplanes it will replace, continues Boeing's long-term efforts to improve fuel efficiency.

• Investigating and spurring development of alternative fuels considered more environmentally friendly, such as biofuels.

• Driving efforts to improve the global air transportation system, in order to shorten flight times and reduce congestion.

Environmental responsibilities are not only a BCA concern. Integrated Defense Systems is working with defense customers to strike the right balance between mission requirements and environmental considerations. "The priority for meeting the requirements of men and women in the armed services will always be to help them carry out their vital missions and return safely home. But as the military increasingly focuses on energy efficiency and the environment, we are working with them," said Jim Albaugh, IDS president and CEO. "One item of interest that is often overlooked is that much of today's understanding of global environmental challenges to the planet comes from Earth observation space programs we have supported for the past half-century."

While a portion of the company's improvements are made at a companywide or site level, employees are encouraged to identify how energy efficiency, waste or recycling could be improved at their workplace or through their own actions.

An important tool for sites to improve environmental performance is Boeing's adoption of the worldwide ISO 14001 standard for environmental management systems. Company sites in Exmouth, Australia; Everett, Wash.; and Portland, Ore., already have embraced the standard, which emphasizes knowledge of environmental policies and commitment to continual improvement. ISO 14001 is being rolled out at all Boeing's major manufacturing facilities in 2008, and many employees will see local communication about opportunities to help and responsibilities for knowing how to achieve certification.

Employees will also see improvements from tools they already know, such as Lean+. That's because the best way to beat the improvement targets is to build on the company's existing strengths, said Armstrong. "Everyone at Boeing knows that there's no silver bullet for making production or design improvements. And it's going to be the same with the environmental challenge. Employee talent and knowledge, coupled with the continuous improvement culture we know so well, is what will achieve real results." ■

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By the numbers

Boeing recently unveiled five-year targets for reductions in energy use, greenhouse gas emissions and hazardous waste.

25
Percentage increase in energy efficiency

25
Percentage reduction of hazardous waste per unit produced

25
Percentage reduction in carbon dioxide emissions intensity

100
Percentage of major Boeing manufacturing facilities that will achieve the ISO 14001 environmental standard by the end of 2008.

So you think you know your order book…

For the third straight year, Boeing set a record for most airplane orders received in a year. In 2007, the company registered 1,413 net orders. That figure smashed the previous mark of 1,044 in 2006—which itself topped the then-record-setting total of 1,002 in 2005. Boeing Commercial Airplanes now has a backlog of more than 3,400 airplanes.

In total, 80 different customers ordered Boeing airplanes in 2007, including passenger airlines, cargo carriers, leasing companies, and unidentified customers. But how well do you know your Boeing airline customers? Here's a short quiz about the 2007 orders.

JIM ANDERSON PHOTO

1. What identified customer ordered the most airplanes? (Hint: It's a leasing company)
2. What identified airline ordered the most airplanes?
3. What identified airline ordered the most widebody airplanes?
4. What model received the most net orders?
5. How many 787s were ordered?
6. What single identified airline ordered the most 787s?
7. Excluding orders for Boeing Business Jets and from leasing companies, the identified airlines of what nation ordered the most airplanes?

Need a cheat sheet? Visit the BCA Orders and Deliveries page on the World Wide Web, at http://active.boeing.com/commercial/orders, and click on one of the three options in the left column: Recent Annual Orders, Standard Reports or User Defined Reports.

Boeing in 2007 registered a record-setting 1,413 net orders from customers including Lion Air (clockwise from left), British Airways and Qantas.

Answers: 1. Dubai Aerospace Enterprise, 100 **2.** Lion Air, 62 **3.** Qatar Airways, 35 (30 787s and five 777s) **4.** The 737, with 846 **5.** 369 **6.** Qatar Airways **7.** China, 109 total

P-8A assembly starts

The Boeing-led P-8A industry team ended 2007 with a bang, starting production of the first Poseidon aircraft Dec. 11 at Spirit AeroSystems' Wichita, Kan., facility.

During a team celebration, U.S. Navy, Spirit and Boeing executives "delivered" the first 737 fuselage components to Spirit mechanics, who installed them in a holding fixture.

Bob Feldmann, Boeing vice president and P-8A program manager, said the milestone highlights the program's transition from design to build. "Our team is now hard at work assembling the first of five System Development and Demonstration aircraft," he said.

The initial P-8A parts and other assemblies eventually will come together on Spirit's existing Next-Generation 737 production line. In the first quarter of 2008, Spirit is scheduled to ship the first P-8A fuselage to Commercial Airplanes in Renton, Wash., for final assembly. "The program will benefit from and continue to build on the proven production efficiencies and performance of more than 5,550 Boeing 737 jets delivered to date," said Mo Yahyavi, vice president and general manager for BCA's P-8A team.

The first test aircraft will be delivered to the Navy and fly in 2009. ■

SPIRIT AEROSYSTEMS PHOTO

Spirit AeroSystems mechanic Brent Maxwell installs the first P-8A Poseidon fuselage components into a holding fixture on the factory floor in Wichita, Kan. The installation marked the start of production of the first P-8A for the U.S. Navy. Spirit will ship the fuselage to Boeing for final assembly later this year.

Shaping our future

Meet some Boeing employees who contribute to engineering at work and in the community

Engineers make a world of difference.

That's this year's message for National Engineers Week, being celebrated throughout the United States and at most Boeing locations. Nationally the event is being held Feb. 17 to 23, but at some Boeing locations events will continue Feb. 25 through 29.

John Tracy, senior vice president of Engineering, Operations & Technology and Chief Technology Officer, said that Boeing engineers have improved the quality of life for millions of people everywhere. "The technical accomplishments of our engineers are embodied in the Boeing airplanes, defense systems and space technologies that are household names around the globe," said Tracy. "But equally important are the community and classroom efforts of our engineers to inspire students to take up math and science, pursue technical careers and help shape a better world in the future."

Mike Denton, vice president of Engineering at Boeing Commercial Airplanes and leader of the Enterprise Engineering Function for Boeing, said Engineers Week has special significance. "Our customers and suppliers are very important to Boeing," he said. "But we need a strong and diverse work force in order to meet our goals for productivity and growth in the future. We're relying on today's engineers to help produce the engineers of tomorrow."

Nan Bouchard, vice president of Engineering and Mission Assurance for Integrated Defense Systems and co-leader of the Enterprise Engineering Function for Boeing, said that the Engineers Week events will allow Boeing to reach out to and inspire all segments of the student population. "We need to spread the word that talented young engineers who join Boeing will be given engaging, challenging work and a clear path to future learning and career development. We need to send a message to everyone that this is a great place to work."

On the following pages, nine people who support engineering at Boeing talk about their work—and their roles in the community.

JOHN **FOGARTY**

Most of John Fogarty's work involves exploring and making decisions about materials and technologies that lie 10 years or more into the future. What helps drive Fogarty, a St. Louis–based engineer specializing in structural analysis in the Manufacturing Technology division of Phantom Works, is to see something his team has worked on become part of an actual product. "Boeing gives me the freedom to be innovative," he said. "Not every idea I've come up with has turned into something real, but I've never been told that my idea didn't deserve consideration." And it's not just Boeing that benefits from Fogarty's visionary talent and expertise. He participates in Future Trek, a community program sponsored by the Academy of Science of St. Louis, where technical experts share with the city's middle-school kids what their jobs entails. This, he explained, introduces them to possible technical careers they've maybe never heard of, why they're fun, and how the right training can help them achieve an engineering career.

RICH RAU PHOTO

TAMAIRA ***ROSS***

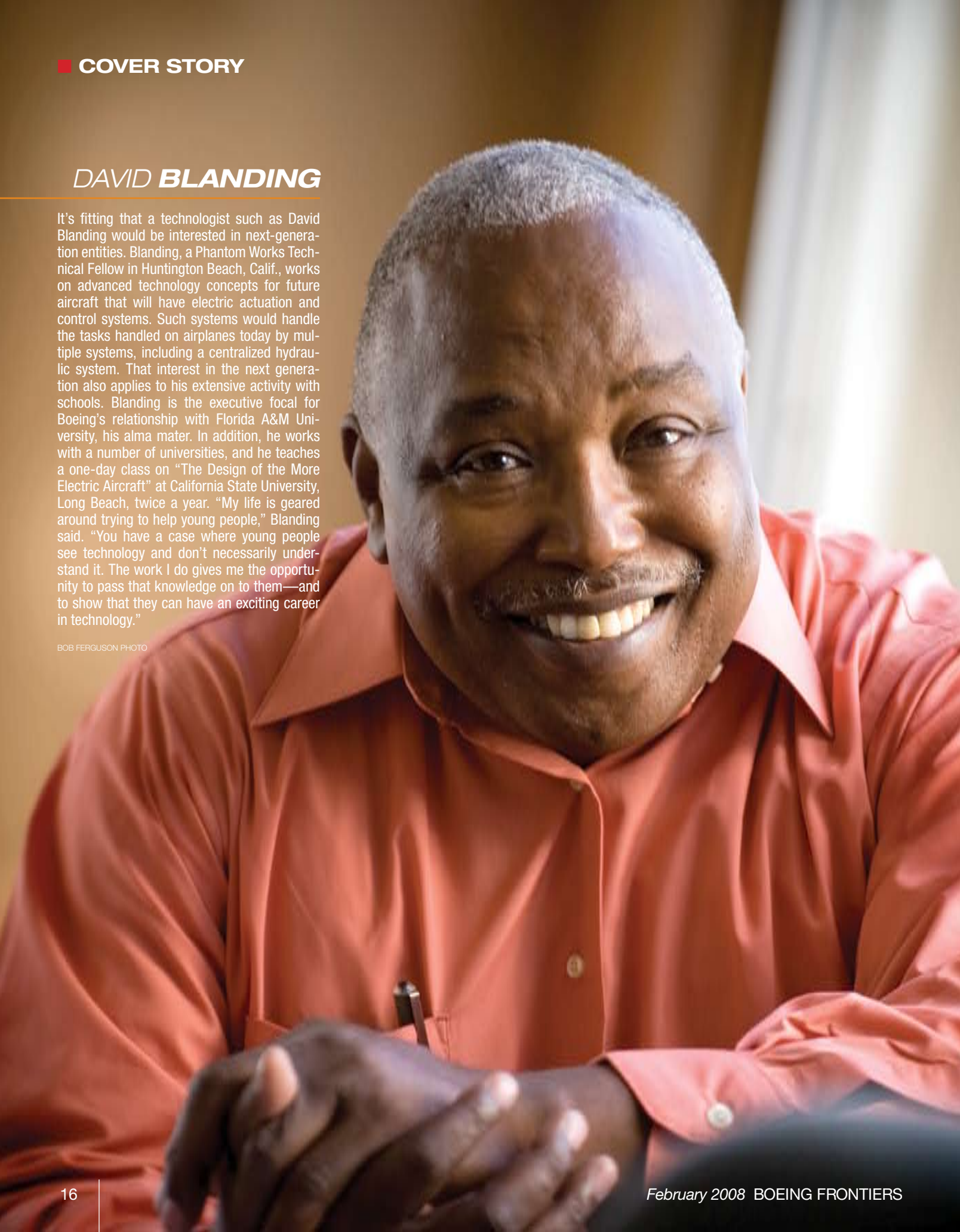
Like many of us, Tamaira Ross appreciates the feeling of accomplishment when she helps things come together. As a design engineer in the Advanced Technology Development organization of Integrated Defense Systems, she's in charge of coming up with the complete vehicle design of an aircraft or a spacecraft. "I get a great deal of satisfaction from designing products, building those designs as prototypes, and seeing the prototypes get tested," said Ross, based in Kent, Wash. And through her efforts in teaching and mentoring, Ross is also helping the careers of budding engineers come together. She's taught classes and seminars through the American Association of University Women's Expanding Your Horizons program, in which middle-school girls attend college campuses for a day to take classes in science and technology areas. She also has established a mentoring program for engineering students at the University of Washington and Seattle University through the Society of Women Engineers. "To continue to do amazing things at Boeing, we need to maximize all resources. And that includes women," Ross said.

ED TURNER PHOTO

CAROL **ANWAY**

Since lightning strikes the average aircraft once a year, the occurrence needs to be an ordinary event. That's one of the major focus areas of Carol Anway, a physicist with Phantom Works, and her teammates in the electromagnetic effects group. One key tool used to test a part's ability to withstand lightning is a Marx generator, which makes a giant lightning bolt. "We tie theoretical analysis to the testing, so that we can build a coherent analytical underpinning to the work," said Anway, based in Seattle. "You can test and test parts, but if you don't have that analytical underpinning, you can't prove that you've tested enough." Before joining Boeing, Anway said she once envisioned herself being a professor. She still works with students—though they're younger than college age. She's been a guest speaker at a sixth-grade class in a suburban Seattle school and at a program for high schoolers at the DigiPen Institute of Technology in Redmond, Wash. "In a way, all kids are scientists, exploring the world around them. Some of us are lucky enough to keep our scientific side going as we grow up," Anway said.

MARIAN LOCKHART PHOTO



DAVID **BLANDING**

It's fitting that a technologist such as David Blanding would be interested in next-generation entities. Blanding, a Phantom Works Technical Fellow in Huntington Beach, Calif., works on advanced technology concepts for future aircraft that will have electric actuation and control systems. Such systems would handle the tasks handled on airplanes today by multiple systems, including a centralized hydraulic system. That interest in the next generation also applies to his extensive activity with schools. Blanding is the executive focal for Boeing's relationship with Florida A&M University, his alma mater. In addition, he works with a number of universities, and he teaches a one-day class on "The Design of the More Electric Aircraft" at California State University, Long Beach, twice a year. "My life is geared around trying to help young people," Blanding said. "You have a case where young people see technology and don't necessarily understand it. The work I do gives me the opportunity to pass that knowledge on to them—and to show that they can have an exciting career in technology."

BOB FERGUSON PHOTO

KAMI ***MOGHADDAM***

Behind the power of technology are the abilities of people. That fact has helped shape how Kami Moghaddam contributes to engineering. He represents Engineering Integration in Long Beach, Calif., for Global Mobility Systems, a segment of Integrated Defense Systems. Yet Moghaddam also takes part in activities rooted in the concept of helping others work together to excel. He's the lead in Long Beach Engineering for Employee Involvement, Employee Engagement and the Lean+ growth and productivity initiative. He also participates in other Long Beach and IDS program-level technical and collaboration-based activities. His philosophy: give back to the company and the community by using his advanced technical knowledge combined with his knowledge in strategic management and organizational leadership—the subject in which he received his doctorate. Moghaddam mentors many college students who are pursuing advanced degrees. He also helps organize a regional engineering-week event, in which hundreds of engineers visit schools to explain what engineers do and about "the value of engineers to society." "I've committed myself to make a difference in people's lives and their performance," he said.

BOB FERGUSON PHOTO

WILL ***PANG***

As a systems engineer on the 787 Dreamliner program, Will Pang has a front-row seat seeing this revolutionary airplane come together. "I like how my job gives me a top-level view of what's going on. I appreciate the opportunity to coordinate with design teams, so we can all work together to meet the airplane's requirements," said Everett, Wash.–based Pang. His job also dovetails with his interest in figuring out how things work—and why they work the way they do. During National Engineers Week in recent years, Pang made presentations to high school classes in the hopes of inspiring students to become engineers. He'll be doing the same this year. Pang said he gives these presentations to inspire students to continue pursuing their education, to do his part to help Boeing fill its future need for engineers, and to instill pride among co-workers. "Boeing isn't just making airplanes, it's making a difference in the community," he said.

ED TURNER PHOTO

BEAR ***McLAUGHLIN***

As Bear McLaughlin sees it, the Boeing of today is more responsive to adopting a Lean+ culture. In his role as an organizational Lean+ leader with the Technical Services–Modification Engineering group of Commercial Aviation Services within Commercial Airplanes, McLaughlin works with teams, as well as managers at various levels, to help them work toward continuous improvement of their processes and their value streams. "People know it's not punitive and it's not taking away their time. And they can get their work shown to higher levels of people who recognize and appreciate their efforts," said Everett, Wash.–based McLaughlin. "So now the perception of Lean+ is, 'This isn't so bad.'" McLaughlin also is active in the Boeing American Indian Society's Puget Sound chapter. "We're looking at how do we work with future engineers and help tribal members and communities understand what value they bring to Boeing and what value Boeing brings to them," he said.

BOB FERGUSON PHOTO

BOB **ROBINSON**

What does Bob Robinson, an Integrated Defense Systems Advanced Systems associate technical fellow in embedded software in Huntsville, Ala., enjoy about his career? The challenging work and the opportunity to expand his capabilities through networking with subject-matter experts in various fields across Boeing, he said. But he also shares his technical knowledge with the community. Robinson stages robotics contests, builds Web pages and organizes engineers to help in local, regional and statewide science and technology events for students of all ages. "Huntsville and Boeing have top-notch engineering talent, and tapping into those resources is important for the future of science and technology in the U.S.," Robinson said. "I enjoy working with the students, who are our future technologists and who will very likely build a better world tomorrow."

ERIC SHINDELBOWER PHOTO

KAREN **REINSVOLD**

Karen Reinsvold's mother was a teacher, and her father was the first person in his family to attend college. So it's fitting that her job at Boeing and her community activities revolve around learning. As a staff analyst in Huntington Beach, Calif., for C3 Networks Engineering in Integrated Defense Systems, Reinsvold supports engineering teams by coordinating university training programs. She's also assisting diversity efforts in engineering by participating in events conducted by technical organizations such as the National Association of Black Engineers and the Society of Women Engineers. In the community, Reinsvold supports the organization TEAM Science, which works to help teachers educate students about science and to increase student interest in math and science. Not only does the organization offer teachers experience and tools for teaching science, but it also runs summer science camps, where Reinsvold has taught classes. "We've found that if kids think by sixth grade that science is fun, they're more likely to decide on a science and engineering career in high school," she said.

BOB FERGUSON PHOTO

Testing the limits

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

ED TURNER PHOTO

Inside

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

By Sandy Angers

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

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

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

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

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

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

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

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

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

THE BIG PICTURE

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

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

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

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

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

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

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

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

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

NEW ROLES

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

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

continued on page 25

The making of a transformation

Flight Test employees use Lean+ processes to redesign operations

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

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

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

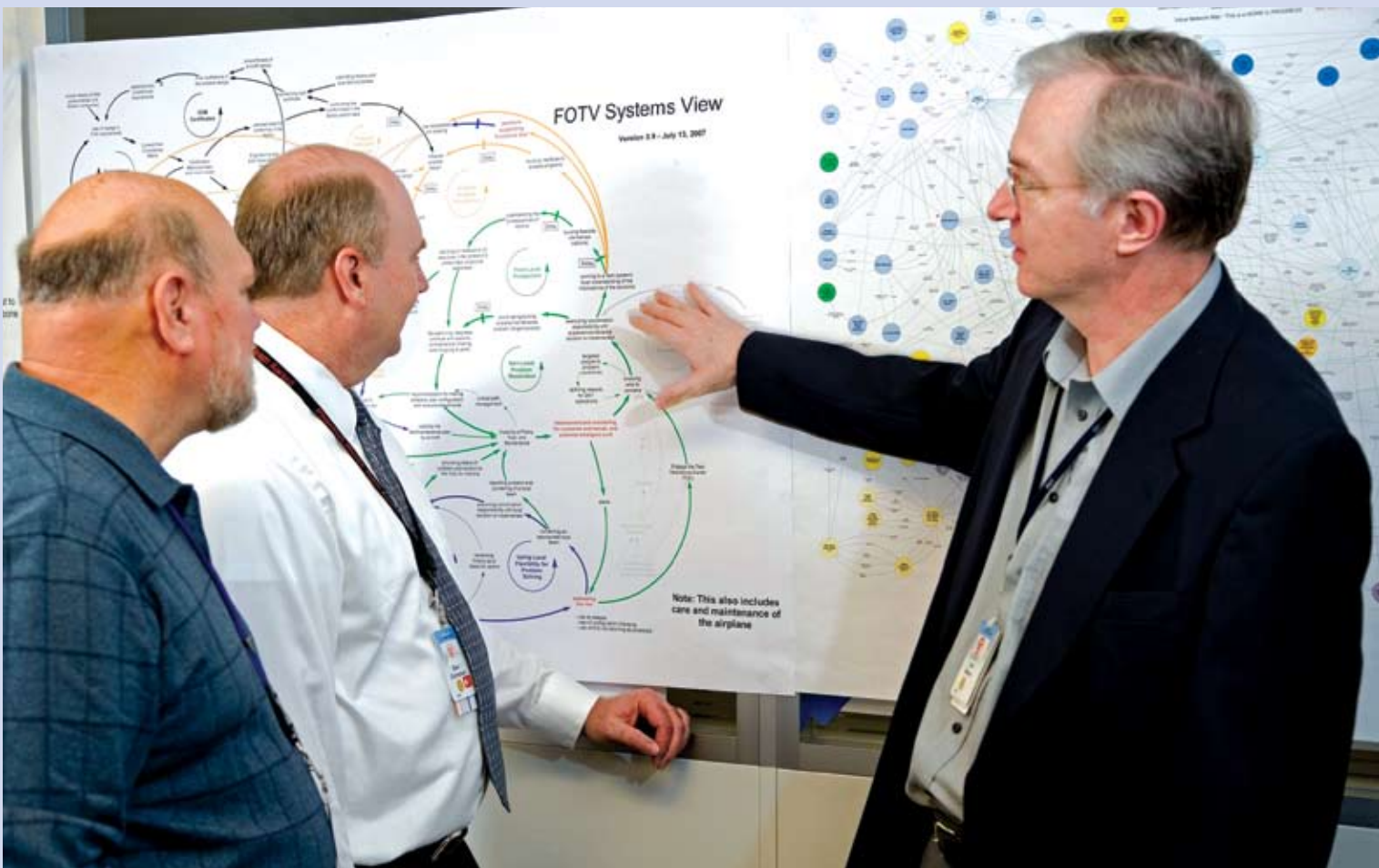
In order to take the steps necessary to create a new Test Operations System, FOT&V created an Integrated Roadmap.

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

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

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

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



ED TURNER PHOTO

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

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

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

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

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

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

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

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

—Kamara Sams

ED TURNER PHOTO

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

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

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

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

SHALL WE DANCE?

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

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

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

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

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Types of flight testing

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

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

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

By the numbers

1,683

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

3,558

Number of flight hours logged by these flights.

325

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

Flying in formation

Production test flights ensure safety, reliability of Boeing jetliners

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

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

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

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

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

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

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

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

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

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

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

—Debby Arkell

Making the grade

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

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

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

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

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

Step 1

ED TURNER PHOTO

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

Step 2

ED TURNER PHOTO

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

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Step 3

ED TURNER PHOTO

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

Step 4

JIM COLEY PHOTO

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

Step 5

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

ED TURNER PHOTO

Step 6

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

ED TURNER PHOTO

Step 7

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

ED TURNER PHOTO

‘Pretty cool’ vehicles

George Orton, who leads hypersonic design and applications programs for Advanced Systems at Integrated Defense Systems, had a key leadership role in the X-43A Hyper-X program. The X-43 set two world records by reaching speeds of more than seven times the speed of sound.

BOB FERGUSON PHOTO

Despite questions over funding and uses, Boeing's work in hypersonics continues

By Daryl Stephenson

Hypersonic flight is fast flight—at least five times the speed of sound and beyond, or Mach 5+. Vehicles that operate in space—the Space Shuttle, launch rockets and boosters—do this routinely. Their power is derived from traditional rocket engines, which burn lots of fuel and liquid oxygen, then flame out when the propellants are exhausted.

For nearly 50 years, engineers have imagined that airplanes, space planes and missiles, powered by airbreathing scramjet engines, could fly at hypersonic speeds, too. These hypersonic vehicles would operate primarily in near space—the upper atmosphere at altitudes of up to 150,000 feet (about 45,500 meters). The vehicles would be economical, because the scramjet engines would have few moving parts and would use less fuel than rocket engines.

The theory was validated in 2004, when the NASA-Boeing X-43A Hyper X vehicle, powered by a scramjet engine, set two world speed records for air-breathing vehicles with flights at Mach 6.83 and Mach 9.68. Boeing was a major contributor to the X-43A program, as it has been for virtually every other hypersonics technology and systems development program since the X-30 National Aerospace Plane that lasted from 1986 to 1995.

"If you take the hypersonic problem and pick it apart into its constituent pieces, we still don't know the basic fundamentals of hypersonic flight—flow, fluid mechanics, etc."

—Kevin Bowcutt, Boeing's chief scientist for hypersonics

Although the X-43 program was closed in 2006—and although observers say the development of hypersonics technology currently stands at a crossroads amid uncertainty over funding and potential applications—Boeing's involvement in hypersonics has continued.

Two efforts are based on missile research and development programs in the Advanced Systems organization of Integrated Defense Systems. One is the X-51 WaveRider Scramjet Engine Demonstrator for the U.S. Air Force. The intent of this aircraft: to demonstrate a hypersonics propulsion system in flight that could be applied to space access, reconnaissance-strike and global reach. The other program is the Hypersonic Flight or HyFly missile demonstrator for the Defense Advanced Research Projects Agency and the Office of Naval Research (ONR), which is maturing a dual combustion ramjet (DCR) strike missile concept.

Recently added to the Boeing hypersonics portfolio is a collaborative venture with Australia called HIFiRE—or Hypersonic International Flight Research Experimentation. Boeing Phantom Works and IDS Advanced Systems are jointly funding the company's involvement in HIFiRE. In this effort, Boeing is working with Australia's Defence Science Technology Organization and the University of Queensland on critical flight tests and is contributing to the design of a free-flying, WaveRider-type hypersonic vehicle.

Plans for the HIFiRE program call for 10 total flight tests over five years in Australia. The first flight test is planned to take place this spring.

"Most work to date on hypersonic vehicle designs has been focused on two-dimensional scramjet engine concepts, whereas the HIFiRE flight tests planned by Boeing and its Australian partners will focus on advanced three-dimensional scramjet concepts and other performance-enhancing technologies," said Kevin Bowcutt, Phantom Works Senior Technical Fellow and Boeing's chief scientist for hypersonics. He's also the company's technical lead on HIFiRE.

"The whole focus of HIFiRE is to do fundamental hypersonic physics flight experiments—hypersonic aerodynamics, hypersonic propulsion, hypersonic heating and materials," Bowcutt said. "If you take the hypersonic problem and pick it apart into its constituent pieces, we still don't know the basic fundamentals of hypersonic flight—flow, fluid mechanics, etc."

Indeed, Bowcutt has been trying to understand the fundamentals of hypersonic flight since 1984, when he wrote a doctoral thesis on optimum aerodynamic shapes as part of a fellowship in hypersonics at the University of Maryland.

Bowcutt said he believes the development of hypersonics technology has progressed to the point "that we're getting close to where we could actually implement this technology into an operational system. After the X-51 and the HyFly programs have successful flight tests, we'll have a very strong basis for developing a hypersonic missile. That's kind of a natural first step—some kind of hypersonic cruise missile that will go 500 to 600 nautical miles in about 10 minutes."

How soon development of a hypersonic missile will take place "will depend largely on the rate of spending applied to fundamental research, technology maturation and flight system demonstration," Bowcutt said. "It could happen within 10 years with sufficient funding. On the other hand, it could take 15 or 20 years if funding is steady but smaller, as in the current situation."

HYFLY IN FLIGHT

John Fox, IDS Advanced Systems Program Manager for HyFly, agrees that the best chance of any near-term application of hypersonics technology would be a missile program.

DARPA and the ONR are conducting HyFly strictly as a research and development program, Fox said. "There's no commitment by the military services to use this technology in a real missile-development

BOB FERGUSON PHOTO

John Fox, program manager for the hypersonic HyFly missile, said the most likely application of hypersonics would be on a missile program.

program. That's what we'd like to do—win a next-generation cruise missile program for Boeing, which we think could well be a high-speed missile," he said.

Fox said the team's biggest challenges were to get the DCR engine operating properly using a conventional missile hydrocarbon fuel and developing a material system for the engine that will withstand very high temperatures. Engine supplier Aerojet has developed a new ceramic matrix composite material for the engine, which DARPA considers breakthrough technology, he said.

Other major challenges were integration of this complex engine into the titanium airframe, and providing thermal protection of the avionics and other subsystems from the severe thermal environments, both internal and external to the vehicle. The HyFly guidance system is based on technology used on the Boeing Joint Direct Attack Munition.

The HyFly program has had three flight tests so far, all launched from an F-15E operated by a Boeing flight crew at the U.S. Navy's missile test range at Pt. Mugu, Calif. These included an unpowered separation test of a HyFly vehicle (without a DCR engine and booster); a test flight with a live rocket booster, which has the job of propelling the HyFly vehicle to a fast enough speed (about Mach 3.5) for the DCR engine to ignite and operate; and a flight test of the HyFly vehicle powered by the DCR engine. The final flight test, with a goal of achieving Mach 6 cruise, is scheduled for early 2008.

X-51 MAKES PROGRESS

Joseph Vogel, IDS Advanced Systems program manager for the X-51, has been involved with hypersonic vehicles his whole career, having worked on the Space Shuttle and International Space Station programs for Boeing after joining the company from NASA.

The X-51 program itself is making significant progress, Vogel said. It's been through a Critical Design Review, which validated the design, assembly, integration and flight-test plan for the Air Vehicle Demonstrator; and numerous successful firings of the demonstrator hydrocarbon-fueled scramjet engine built by Pratt & Whitney. The program is on track to start flight tests in August 2009.

"The integration of the whole system into this air vehicle, which has the potential to fly at speeds of Mach 6 and above, has been a challenge that our team has met successfully," Vogel said. "We've learned a lot about unpredicted vibration and acoustics, and it appears overall that we're turning the theoretical into reality. Looking at the data and seeing what we have, I don't think we have anything in front of us that we can't overcome."

A unique feature of the X-51 will be how long it will actually fly by itself, Vogel pointed out. "The duration of flight for the X-51A will be about 300 seconds," he said. "That's substantially longer than a lot of the other hypersonic vehicles that have been flying (such as the X-43A, which flew for 10 seconds). Basically, the X-51's a pretty cool vehicle."

'REALLY CAN BE DONE'

George Orton, who leads hypersonic design and applications programs for IDS Advanced Systems, said programs "like X-51 and HyFly can show that a very high-speed missile is practical. These are primarily propulsion technology programs, but they'll demonstrate that high-speed flight with a missile-like vehicle really can be done. That could provide a real shot in the arm for the Air Force and Navy in terms of future missile programs."

Like Bowcutt, Orton has worked on hypersonics programs since the National Aerospace Plane program and was directly involved in the X-43 program in a key leadership role. He also worked on the Gemini, Space Shuttle and International Space Station programs.

"Without question, the X-43A Hyper-X program was a great accomplishment," he said. "We set two world records with a combined NASA-ATK-Orbital Sciences-Boeing team. It was the first time that a scramjet was integrated onto an airframe. And it proved that the scramjet really can produce acceleration and could be a viable engine for the future. It was really a breakthrough."

The success of the X-43A generated excitement as well, Orton recalled. "When the Hyper-X flew, there were a tremendous number of hits on the NASA Web site. The only other recent experience like that was the Mars rovers. In spite of that, we have to wait and see and be a little patient about the development of this technology."

Kevin Bowcutt, Boeing's chief scientist for hypersonics, believes hypersonics technology has progressed to the point that it could be implemented into an operational system.

BOB FERGUSON PHOTO

"If [the Combined Cycle Demonstrator] were to get going, I think that could be a tremendous shot in the arm for future aircraft as well as for space access."

—George Orton, hypersonics leader, IDS Advanced Systems

There is a major challenge today for hypersonics in "establishing a need for high-speed flight," Orton said. "Without a compelling need—whether it's a reconnaissance/strike aircraft, a high-speed missile or space access—to do this research, it's very difficult to find funding for it. Does it provide an advantage in terms of cost and the way we do business over other assets that we have? Technically, we've proven that scramjets work. I think we can do the technical things—but we have to have a need and a focus."

Vogel said he sees the development of hypersonics technology "at a crossroads. I think the technology is at the point where it can be matured into something, whether it be a weapon system, a reconnaissance vehicle, or the next phase into access to space or low Earth orbit. But it's going to take a lot more time and investment (by government and industry) to get over the next hurdle, which is integration with other technologies."

DARPA and the U.S. Air Force are currently considering a program that could provide such a need and focus, Orton said. The program, called the Combined Cycle Demonstrator, would involve the design of a hypersonic aircraft that could take off from the ground, fly to a speed of Mach 7, then fly back to Earth and make a powered landing.

"If this program (the CCD) were to get going, I think that could be a tremendous shot in the arm for future aircraft as well as for space access," Orton said.

DARPA and the Air Force have not issued a go-ahead for such a program yet, Orton said. "But the technology work we're doing now with the Air Force, NASA and DARPA is laying the groundwork for a program like that," he said. ■

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A totally COOL job!

Last summer, a team from Satellite Operations and Ground Systems at Integrated Defense Systems installed and integrated a new Iridium Satellite Telemetry Tracking and Control ground station in far northern Norway. Here, an antenna radome is transported to the Earth Terminal site. The radomes had to be constructed in a protected area to avoid being damaged by high winds.

KEN MCCUE PHOTO

How a Boeing team braved blizzards, polar bears to install a satellite ground station above the Arctic Circle

By Bill Seil

What did you do last summer to beat the heat? A group of Boeing employees from Arizona and Virginia found an unusual way to stay cool: They took a challenging job north of the Arctic Circle.

The team from Satellite Operations and Ground Systems (SOGS) at Integrated Defense Systems was given the task of installing and integrating a new Iridium Satellite Telemetry Tracking and Control ground station in the archipelago of Svalbard, Norway. The station needed to be relocated from Iceland to Svalbard to provide better coverage for the Iridium satellite constellation, which serves the Iridium satellite telephone system.

Working in an Arctic climate is no picnic, even in the summer. The team had to contend with snowstorms, freezing temperatures, and even the threat of polar bears. Although 24 hours of summer daylight permitted long workdays, team members sometimes found it difficult to sleep. And the daily commute to the work site involved a steep van ride up a narrow, winding road to a plateau above the town of Longyearbyen, famous as the northernmost town in the world.

Despite encountering these and other obstacles, the team met its July 6 deadline. In fact, members adopted the motto "No problems, only challenges and solutions." They put into practice the Boeing leadership attribute that challenges employees to "find a way" to overcome setbacks and succeed.

FROM 115 TO ZERO

Tom Valentine, the team's interfacility communications lead, said that the six employees who traveled to Svalbard were all engineers and technicians from the SOGS Ground Systems Services group. In addition to Valentine, they were Ken McCue, systems integration lead; Shawn Feeney; Kevin Proffitt, project coordinator; Robert Rossing; and Curtis Webster. They maintained frequent contact with their team lead, Dave Vohs, who coordinated the mission from Arizona.

Valentine, based in Chandler, Ariz., found the climate change dramatic. Arizona temperatures often hover around 115 degrees Fahrenheit (46 degrees Celsius) during the summer months. In Longyearbyen, thermometers in summertime sometimes dip down to zero (-18 C). The team had considered getting Arctic survival training, but decided against it, given the nearness of the town to their site and the relatively mild summer conditions.

Longyearbyen has about 1,800 people, primarily Norwegians. But there are also people from Russia, Ukraine, Poland, Sweden, Denmark, Germany, Thailand, and the United States. Unfortunately, there are limited guest accommodations. During the summer, the town is crowded with tourists enjoying the scenery and wildlife and with people attending academic programs at the University Center in Svalbard.

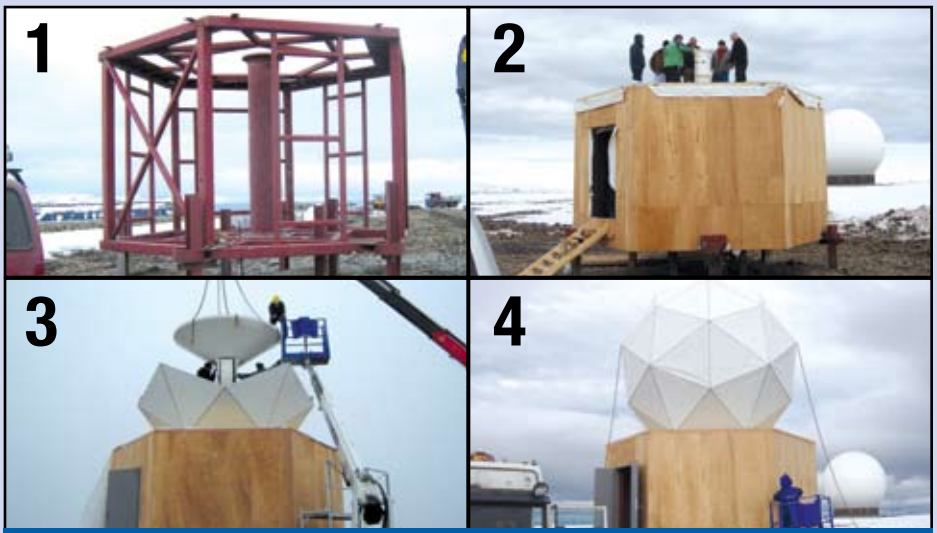
Because of uncertainty about the arrival date of equipment, the Boeing team was not able to make advance reservations. So hotel hopping became part of the adventure.

"During the three weeks we were there, I don't think we stayed in one place more than two nights in a row," Valentine said. "Hotel space there is very sparse and often rustic. Since we couldn't book in advance, it left us out in the cold—so to speak."

Before joining Boeing, Valentine had spent five years in Alaska designing and installing satellite telecommunications systems. Be-

TOM VALENTINE PHOTO

Among the challenges the Boeing team faced during this installation: polar bears, as indicated by this sign on the road to the work site from Longyearbyen, Norway, where the team stayed.



As shown in this sequence of photos documenting the installation of Earth Terminal 1, the Boeing installation team made sure and steady progress.

We're just *chillin' in Norway*

Team members from Satellite Operations and Ground Systems (SOGS) at Integrated Defense Systems who installed and integrated a new Iridium Satellite Telemetry Tracking and Control ground station in northernmost Norway had a full work schedule and little time for sightseeing.

But during their three weeks in Norway, they did get a chance to meet many residents and experience daily life in Longyearbyen, the town where they stayed. Had they arrived during the Arctic winter, they would have found 24-hour darkness. But the extra daylight of June and July allowed them to get a good view of their surroundings and snap some photographs.

cause he had experience driving in frigid climates, he was selected to make the daily uphill drive to the work site—in a beat-up Toyota van and over a hazardous route.

"The real danger was the drive up the mountainside," Valentine said. "To get to the plateau, you had to go up this winding road that went back and forth across a sheer cliff face."

The team made the daily commute without mishap, but the Boeing people saw spots along the way where vehicles had plunged over the side. In poor weather, visibility could be as short as 20 feet (6 meters). Sometimes the road was snowy or icy. Sometimes they drove over a fine powder that turned to mud when it rained. But despite the hazards, all agreed that the view was tremendous.

"I enjoyed the ride up every day," Valentine said. "The scenery was so dynamic. It constantly changed from crystal-clear days to low-hanging clouds. The sun filtering down to the Arctic glaciers was definitely a sight to see."

MOUNTAINS IN THE DISTANCE

The work site at the top of the plateau was a section of Kongsberg Satellite Services' (KSAT) Svalbard facility called SvalSat. Various organizations maintain equipment at this strategic location, including NASA and the U.S. National Oceanic and Atmospheric Administration. KSAT staffs a main communications facility around the clock, seven days a week. The communications building also provides shelter for workers and a big-screen television for those who find time for a break.

From SvalSat, the team had a tremendous view of the distant mountain ranges, glaciers and the Arctic Ocean. The terrain of the site itself was ice and volcanic rock, with no vegetation of any kind.

The equipment to be installed by the Boeing team had been disassembled at its original location in Egilsstadhir, Iceland, by another Boeing team led by Ken McCue. It was then packed by subcontractors and shipped to Svalbard. The primary units were two 3-meter antennas used in the tracking and control operation. With the equipment moved farther north, operators will have far better access to the 66 Iridium satellites, circling above in six low earth orbits. Svalbard is ideal because all six of the orbital planes can be seen from the same site.

The installation project is the first phase of an effort to enhance Iridium satellite telemetry tracking and control. Boeing plans to return to Svalbard this summer to install three more antennas. This will increase the technological capabilities of the system and add redundancy. Proposals to build a similar Iridium ground station in Antarctica in the near future are also being considered. A station to the south would provide more continual contact with the satellites, which will become more important as the system ages.

To get the equipment to its new site at the top of the plateau, the subcontractors had to remove it from its cargo containers and use various types of vehicles to haul it up the narrow road. The construction of antenna buildings and shelters was not completed before the team arrived, so the antenna project got off to a slow start.

"That first week was especially difficult because we were all quite sleep-deprived," Valentine said. "This was compounded by the fact that we had to jump from hotel to hotel every night. And even though the hotels had darkening curtains, the sunlight would still shine in. It was difficult to get a decent night's sleep."

At the site, the team had to work in varying weather conditions, occasionally taking shelter in the communications building. "The weather in that area can

A view from inside the Earth Terminal looking out across the arctic tundra.

TOM VALENTINE PHOTO

Although Longyearbyen has several thousand polar bears in the surrounding area, animal life near the town includes reindeer and arctic foxes. Ptarmigans are the most prominent birds. It's not uncommon for local wildlife to wander into town.

"You can be sitting in a restaurant and suddenly you'll see three or four reindeer pass by," said Tom Valentine, the team's interfacility communications lead.

He noted that the local food, generally very good, included reindeer steaks, whale, seal, fish and a variety of dishes common at home.

When members of the Boeing team finally got one full day off, they didn't rest. They used it to explore. One member went on a sightseeing expedition to the ocean, where he saw glaciers, polar bears, and other wildlife. Others went hiking or took drives on the dirt roads around the island.

Other than a few restaurants and pubs, entertainment venues in Longyearbyen are few. But the people are friendly, and a stay in the town can be enjoyable. Valentine said one of his most enjoyable moments in Longyearbyen came when someone loaned him a Harley-Davidson motorcycle.

"He handed me the keys and said, 'Here, take it for a drive,'" Valentine recalled. "So I actually got to go for a Harley-Davidson drive at 78 degrees north latitude, which is probably the farthest place north where you can drive on a road. That was fun."

—Bill Seil

KEN MCCUE PHOTO

Boeing employee Tom Valentine, the installation team's interfacility communications lead, is based in Arizona—where the summer weather is drastically different from that in northern Norway.

change from hour to hour," Valentine said. "Within an eight-hour period, we would experience everything from sunny skies to complete whiteout blizzard conditions."

BEAR DOWN

Then there's the threat of polar bears. Valentine said there are about 3,000 polar bears in the Svalbard area. Fortunately, summer is the season when polar bears head east to hunt seals on the ice floe. The Boeing team was working on the west side, but during this large migration, a number of hungry ursine adolescents get left behind.

"They feed off whatever they can to survive," Valentine said. "They can be quite dangerous and quite aggressive." Signs were posted around town to remind everyone about the dangers of these foraging polar bears. Local residents often carry rifles for protection. At the work site, local contractors hired by the Boeing team patrolled, always alert for signs of danger.

"When we were up on top of the plateau, the clouds would roll in and the whole area would vanish in haze and mist," Valentine said. "Those were the most dangerous times, because the polar bears take advantage of those conditions to sneak up on their prey."

Mother Nature's doings weren't the only obstacles the team encountered. When the team needed additional equipment, there was no possibility of receiving it in time. So team members found themselves rooting through a local salvage yard for alternatives.

One of the most difficult setbacks came when a subcontractor drilled several alignment holes on the antenna pedestal that were too large. The team spent half a day finding pieces and parts that could be adapted to correct the error. If they had not succeeded, they would have had to return home without completing the job.

"There were several times where obstacles could have prevented us from completing the project on time—if we hadn't found a way to overcome them," Valentine said.

The ultimate test of their work was whether all systems in the ground station would operate accurately. Alignment was critical. A surveyor was brought in to make sure the equipment was installed according to plan. Antenna alignment off by as little as a half degree would impair satellite tracking and control.

The team put in 24-hour days in early July to prepare the equipment for its July 5 operational test. This involved a "first pass" tracking exercise focused on the orbiting satellites. That test was a clear success, and the team celebrated completion of the assignment.

"There was a great feeling of satisfaction," Valentine said. "Everyone had stepped up and met all the challenges. While we each had our own jobs and areas of expertise, we worked well together and made a cohesive team. In fact, we had a good time up there. Our focus was on doing a good job and meeting our deadline, but we also found moments where we could joke around." ■

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Home on the range

AL MOORE PHOTO

Boeing Service Company helps keep U.S. ICBM system mission-ready

By Randy Jackson

As their pickup truck kicks up a cloud of dust along a remote Montana road, two military policeman scan the horizon as Boeing Field Supervisor Guy Halvorson and his Intercontinental Ballistic Missile (ICBM) field support team go to work.

They are en route to one of hundreds of Minuteman missile sites that stretch across the United States, from the coast of California across the open grazing lands of Montana and to the plains of North Dakota.

Halvorson and his team are part of the Boeing Service Company, a fully owned subsidiary of Integrated Defense Systems with approximately 1,500 people worldwide working to maintain and sustain customer communication and data systems. One of BSC's responsibilities is modification of the nearly 500 Minuteman missile sites that dot the United States.

Halvorson's team supports a $78.2 million contract that Boeing C3 Networks received last year from ICBM prime contractor Northrop Grumman Mission Systems to deploy a replacement Environmental Control System (ECS) for the U.S. Air Force Missile Alert Facility, Launch Facility and Class 1 trainer facilities.

The team is removing older air-conditioning units and replacing them with modern environmental-control systems. The ECS contract is part of a larger contract managed by Northrop Grumman to modernize and sustain the U.S. Minuteman III deterrent force.

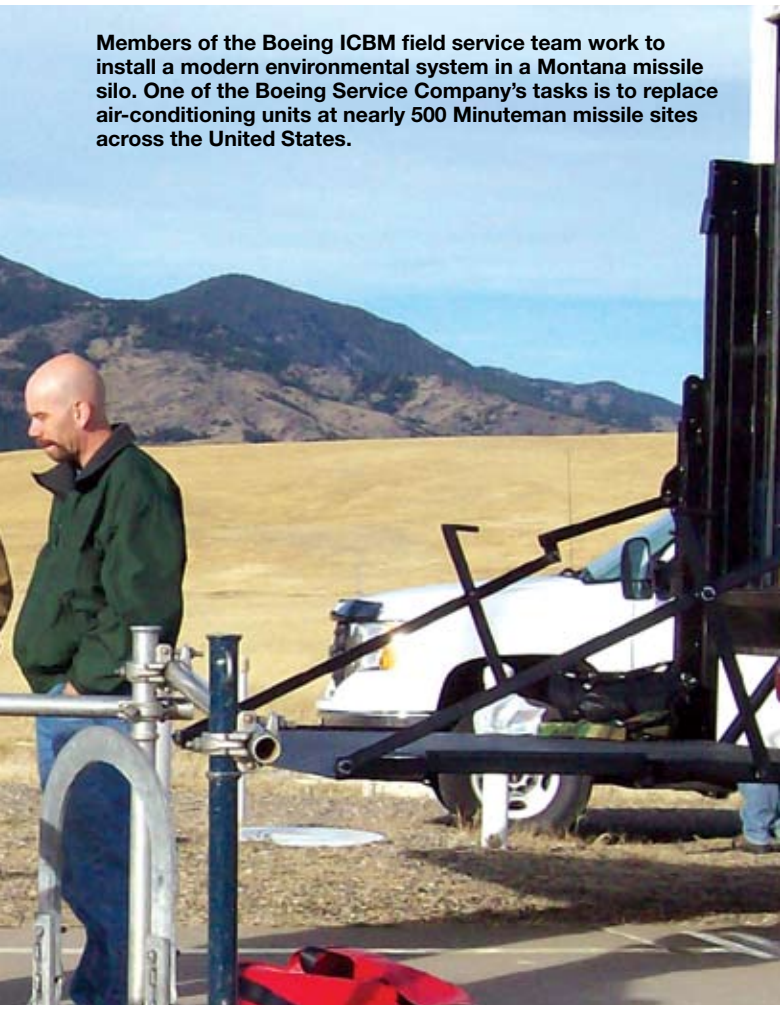
Regulating the environment inside the 25-foot-wide, 90-foot-deep (7.6-meter-by-27.4-meter) missile silos that house nuclear missiles is a critical task, Halvorson said: "Racks of electronic drawers in the silos are always 'live,' so environmental integrity is essential."

CUSTOMER CONFIDENCE

Boeing has been involved in upgrades for the Minuteman for years, but this is the first time in 20 years that a defense contractor has been chosen to perform major modifications at Minuteman launch facilities unescorted.

"The fact that we are working around nuclear weapons facilities unescorted illustrates the trust the Air Force has in the Boeing team," said ICBM Field Support program manager John Kobbeman.

He also emphasized that "unescorted" does not mean "unsecured." At predetermined intervals, Halvorson contacts a security team at an undisclosed location. They validate the Boeing Field Service team and provide permission to be on site. Additional security measures are employed while the team is underground to



Members of the Boeing ICBM field service team work to install a modern environmental system in a Montana missile silo. One of the Boeing Service Company's tasks is to replace air-conditioning units at nearly 500 Minuteman missile sites across the United States.

ensure that no unauthorized personnel approach them or the restricted launch facility.

"To qualify for access to the closely guarded defense silos, all Boeing field team members must pass strict security clearances including psychological, physical and medical screenings," Kobbeman said.

BSC field reps who travel among missile sites can boast their "office space" is thousands of miles of open country. Yet, said Greg Deiter, BSC director, "It's a tough life on the range!"

"Weather conditions can be brutal," added Kobbeman. "But this team is tough. A lot of the Boeing team members are retired 'missileers' from the U.S. Air Force, and missiles are in their blood."

Deiter said teammates can be away from their families and homes for weeks at a time, sometimes forgoing planned vacations and often working in extreme weather. Why? "One hundred percent readiness can't wait for summer," Deiter said.

By "readiness," he means the missiles—buried deep underground in hardened, blast-resistant silos and monitored around the clock by missile crews—are on alert continually.

"Out here on the range, we're kind of like the cavalry," Halvorson said. Where there's a need, we're there, and we'll find a way to get the job done." ■

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ICBM: Looking ahead

Maintaining the United States' safety and security is an important mission of the Boeing Intercontinental Ballistic Missile (ICBM) team.

Since the late 1950s, Boeing employees have played a major role in deterrent efforts by building, maintaining and upgrading the guidance and navigation system for the Minuteman weapon system. They've also provided overall integration, testing, assembly and deployment of Minuteman, the longest-serving U.S. operational ICBM system and a part of the U.S. security strategy for the future.

U.S. AIR FORCE PHOTO BY RODNEY JONES

In this 2005 photo, an unarmed Minuteman III intercontinental ballistic missile launches from Vandenberg Air Force Base, Calif. Such launches ensure the weapon system remains operationally effective. Boeing is constantly evaluating new ideas and concepts to make the Minuteman system more affordable, flexible, accurate and secure.

Boeing is constantly evaluating new ideas and concepts to make the Minuteman system more affordable, flexible, accurate and secure. These new concepts can help ensure Minuteman remains the best-value deterrent meeting national security needs well into the future.

In another effort, a complex and changing global security environment has led the U.S. Air Force to investigate options for a prompt global strike system carrying conventional warheads.

In August 2007, Boeing C3 Networks, Advanced Systems and Phantom Works engineers began working on an $8.9 million contract to study key elements of a conventional prompt global-strike missile demonstration. This contract is designed to mature conventional-strike missile concepts and technologies and reduce the risk associated with the technologies. It is scheduled to be completed by June 2009.

The study will help plan for a demonstration using a land-based Minotaur launch system and a payload delivery vehicle designed to carry and deliver various conventional payloads at global ranges in less than one hour of flight time. The contract is managed by the U.S. Air Force's Space and Missile Systems Center at Los Angeles Air Force Base.

"With more than 50 years of experience designing, delivering and deploying Air Force missile programs, our team looks forward to helping refine requirements leading to a demonstration program and will provide system-level analysis of one of the key concepts considered viable for a prompt global strike system," said Peggy Morse, director of Boeing ICBM Systems. "As a long-standing partner with the Department of Defense in defense of the United States, Boeing remains committed to providing solutions to the United States' deterrence and global strike mission needs."

—Cheryl Sampson

The delight is hours

The Royal Air Force uses the C-17 for strategic air transport of personnel and support equipment over long distances. RAF representatives said the service has been utilizing the aircraft at about 120 percent of the originally planned flight hours per year.

ROYAL AIR FORCE PHOTO

Field Services team keeps C-17s in the air —a lot—for the UK

By Madonna Walsh

Since 2001, Boeing has delivered four C-17s to the United Kingdom's Ministry of Defence. A fifth aircraft is due to be delivered this month, and another delivery is scheduled for June.

As a sign of the aircraft's durability—and as a testament to the support Boeing teams are providing on-site to the customer—the first two aircraft to date have clocked more than 10,000 flight hours, and the second two are following close behind.

"To say the C-17 is a workhorse is a massive understatement," said Wing Commander John Gladston, Officer Commanding 99 Squadron at the air base RAF Brize Norton, U.K. "The C-17 has filled an enormous need for the Royal Air Force in terms of supporting the operational air bridge to both Afghanistan and Iraq."

Key to the aircraft's success is the Boeing C-17 Field Services team at RAF Brize Norton. The team is on call 24/7 as part of the Globemaster Sustainment Partnership contract with the UK Ministry of Defence. Fully integrated with RAF maintainers, the Boeing team works to ensure outstanding dispatch reliability of the UK's C-17s.

"Having the Boeing team next door is vital," said Sgt. Baron Baker, avionics technician for the 99 Squadron. "If they weren't here, jets wouldn't fly. We know we can contact them any time of day or night, and they'll be there. Usually they have the part or the answer we need; but if not, they find a way to get it."

The Field Services team primarily provides engineering, supply support and support-equipment maintenance services. Field Service engineers located at main operating bases and forward operating stations hold post-production product review authority, which allows engineering disposition on-site.

"After the appropriate analysis, structural and mechanical repairs can take place on-site instead of having to return the aircraft to manufacturing or depot maintenance facilities," said Bob Rabbitt, Boeing engineering manager for the C-17 Field Services International Hub. "This gets C-17s back in the air in the least amount of time."

Field Services reps at Brize Norton communicate with counterparts at other C-17 bases regularly, providing input and updates on situations that might arise. "Once in a while, a rep at another base may identify an unusual problem," said Mike Joyce, a Boeing avionics engineer at the Brize Norton International Hub. "But because the problem is shared promptly with the rest of the team, we all know what to look out for."

Along with available engineering, consistent maintenance is key to keeping the UK C-17 aircraft flying. "We stock, store and issue everything needed for constant maintenance of the C-17," said Danny Rose, Boeing supply chain specialist. "We utilize an automatic requisition for replenishment to maintain a continuous inventory system of 7,300 parts and provide consistent maintenance." Added Tom Murray, senior aircraftsman and avionics mechanic: "This is crucial with less than six hours to turn an aircraft around."

"The Boeing field service team is an integral part of my squadron," said Wing Commander John Gladston.

Since making its RAF operational debut in Afghanistan in 2001, the UK C-17 has seen action in many areas of the world, providing strategic transport and airlift capability. More than 9,500 sorties have been flown, thousands of troops transported, countless supplies shipped, and 39,700 hours clocked.

"It's an amazing aircraft," said Flight Lieutenant Steff Marsh, C-17 captain at RAF Brize Norton. "Flying the C-17 and working with the Boeing team has made this assignment better than I could have ever dreamed." ■

His title: Champion

Renton employee named top crane operator for '07

JIM ANDERSON PHOTO

Steve Earl, a Renton, Wash., overhead-crane operator who won a world championship late last year for his crane-related skills, prepares for his shift. In addition to a trophy, Earl earned accolades from management.

By Ellen Whitford

He paced. And from time to time, he wiped his sweaty palms on his pant legs.

Steve Earl, who's been an overhead-crane operator at Boeing's Renton, Wash., plant for 13 years, was waiting for his turn to compete for the title of the world's best crane operator. And he was nervous. He'd made it through three competitions and was now head-to-head with another Renton operator for the title of world champion. Everyone was watching.

Earl slid into a mockup of a cab, clasped the controls of the simulator, and with eyes intent on the video screen lifted a virtual load and ran the course. His time was good. His score was perfect. But when the last contender took his seat, Earl had to turn away. "I was just too nervous to watch," he said.

Bob McKay, a first-level supervisor in Commercial Airplanes' crane operations in Renton, chuckles at the irony. "Every day, these guys lift airplane parts worth millions of dollars," McKay said. "They have just inches of room for error, yet they don't bat an eye or miss a beat. But in a little friendly competition on a simulator, they're so nervous they get sweaty palms and cotton mouth."

The contest—dubbed a "crane rodeo"—held late last year in Las Vegas, is part of an annual training forum on crane safety and procedures that draws several hundred operators from across the United States and other countries. It's hosted by the North American Crane Bureau (NACB), which provides training programs and products and services to the industry.

At the conference, participants refresh their skills and learn about equipment relevant to their work. The competition gives them a chance to test their mettle against colleagues.

To Earl's surprise, he won the title, beating out runner-up Bruce Weston, a Renton operator with 33 years of experience and a flawless work record.

"Normally," McKay said, "Earl's a serious kind of guy. He rarely cracks a smile. But that night, he wore a grin from ear to ear."

Boeing sent 11 operators to the event—six from Renton and five from the Everett, Wash., plant. They stole the show. "What impressed me was the caliber of Boeing's operators," said Joe Crispell, NACB executive vice president and rodeo moderator.

Ron Karnes, a senior manager in Renton's crane operations, was pleased but not surprised at the showing. He knows the safety and incident record at the site. Every month, Renton operators lift roughly 3,500 to 4,000 pieces—wings, stabilizers, fuselage assemblies, landing gears, spars and other parts. In the four years he's been senior manager, Karnes said, there's never been a major incident.

The competition included four rounds, each a little longer and more difficult than the preceding. More than 50 operators competed in the first round, and the 10 with the highest scores advanced to the second round. Seven were from Boeing.

They competed again, and the four contestants with the best scores moved to the semifinals. All were Boeing employees: Earl and Weston from Renton, and David Chaires and Dane Johnson from Everett.

Renton versus Everett. The rivalry between the operators was good-natured, but fierce. Everett had participated in the 2006 conference and one of its operators, Todd Campbell, was named world champion that year. Everett hoped to defend the title.

But Renton had other plans.

"We told them we were going to steal the trophy from them," said Scott De Lappe, a crane supervisor in Renton. "A little healthy competition is good, and it was fun joking with them."

Will they attend this year's conference for further knowledge-building and competition? They hope to, Everett and Renton operators said. But Johnson, in Everett, pledged that next time, the outcome would be different: "We want those Renton guys to know that Everett is coming for the trophy." ■

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At the crossroads

Millennia-old tradition and modernity co-exist in today's Saudi Arabia, a nation focused on economic development and diversification. Shown here is the capital city of Riyadh and the distinctive Kingdom Tower (at right), the nation's tallest building and one often called the "necklace" for its distinctive shape.

SHUTTERSTOCK.COM PHOTO

Inside

This comprehensive package of articles explores why Saudi Arabia is important to Boeing—and what Boeing is doing to position itself for long-term growth and success there.

A young, tech-savvy population. Interest in international investment, economic development, diversification. That's why Boeing sees Saudi Arabia as a market of extreme importance

By Maureen Jenkins

Saudi Arabia is a place of stunning contrasts, where a rich, millennia-old culture with Bedouin roots coexists with urban landscapes and familiar Western landmarks such as Starbucks Coffee and KFC.

It's a monarch-led country that owns 25 percent of the world's known petroleum reserves and exports more oil than any other nation. Yet it's seeking to move beyond its dependence on oil sales and equip its young citizenry with broad-based technological skills and well-paying jobs that will contribute to its pro-business economy.

Because economic development and diversification is a top priority for the Saudi government, it's encouraging international investment and private-sector growth. Plans to create six "economic cities," each with its own industry focus and located across the country, are helping lead the charge. In the past three years, for example, the kingdom has risen from No. 76 to No. 23 in the World Bank's "Ease of Doing Business" index and is currently ranked first in the Middle East.

"What we're seeing [in Saudi Arabia], as in other places around the world, is the expectation of partnerships versus simply sales."

—Shep Hill, President of Boeing International

That's where global corporate partners like Boeing come in, doing far more than just selling commercial airplanes and defense solutions to the nation. Instead, through a memorandum of understanding with the Saudi Arabian General Investment Authority, privately owned joint ventures such as Alsalam Aircraft Co., and university partnerships, Boeing is leveraging its cross-enterprise expertise to make itself a valuable resource to Saudi Arabia.

Make no mistake: Saudi Arabia is a key strategic and high-priority market for Boeing, and the company continues to build upon its six decades of presence and mutually beneficial relationships within the kingdom.

"What we're seeing [in Saudi Arabia], as in other places around the world, is the expectation of partnerships versus simply sales," said Boeing International President Shep Hill. "From Integrated Defense Systems' and Commercial Airplanes' own standpoints, Saudi Arabia has the '3Rs'—requirements Boeing can uniquely fit; the resources to pay for it; and the relationships with Boeing that should give us a competitive advantage."

But it takes more than just technical and business skills to succeed in Saudi Arabia, located in the often-volatile Middle East. It's equally important that Boeing people understand the kingdom's culture—one shaped by Islam, geopolitical change and shifting economic realities.

"To gain the know-how to operate in this kind of environment is going to take time, experience," said Ahmed Jazzar, president of Boeing Saudi Arabia. "It takes the right attitude and right personality. Some people see the differences as only negatives; others see them as richness and diversity.

"For us to make Boeing global," continued Jazzar, "we need to work very hard to make this understandable. We have to be accustomed to working in all these countries and different cultures."

And Boeing is replicating this business philosophy around the world. ■

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A Gulf 'giant'

ALSALAM AIRCRAFT CO. PHOTO

Workers at Alsalam Aircraft Co. perform inspections on an F-15 following a Programmed Depot Maintenance functional check flight. A Boeing-led consortium and local investors and companies founded Riyadh-based Alsalam 10 years ago.

Saudi Arabia might be IDS' largest market outside the US, but a one-company approach is critical for Boeing

By Maureen Jenkins

Stanley Roth, Boeing International vice president of International Government Relations, calls Saudi Arabia "the giant on its side of the Gulf."

This strategically important nation is the largest market for Integrated Defense Systems products outside the United States. With more than 100 F-15s, five AWACS (Airborne Warning and Control System) aircraft, seven 707 air refueling tankers, and 12 AH-64A Apaches that are being upgraded to D models, the Saudi military force is well-equipped with Boeing platforms.

Although IDS enjoys strong relationships in the kingdom, Boeing leaders said it's especially critical the company take a cross-enterprise approach to doing business there. Joint Boeing Integrated Strategy Teams were created in 2005 to address the Middle East, India and Japan, ensuring business units were on the same page in key strategic world regions.

"The number of decision makers in Saudi Arabia is very, very small," said Boeing Saudi Arabia President Ahmed Jazzar, and is the same for both IDS and Commercial Airplanes products. Any contract of $30 million or more has to be approved by King Abdullah Bin Abdulaziz. Moreover, HRH Crown Prince Sultan Bin Abdulaziz is the minister of defense and aviation—and the chairman of Saudi Arabian Airlines.

"When they look at us," Jazzar said, "they don't look at us as BCA or IDS. This is one place where we really have to be one team. I spend a lot of time with the teams from both business units on the business culture in the kingdom. I help in the strategies for different campaigns so there's an element that answers the (government) requirements."

One such current campaign is fleet modification of Saudi Arabia's massive F-15 fleet, which could include new fighters and the upgrade of existing jets, said Michael Probasco, president of Boeing Middle East Limited, which handles IDS business development in the kingdom. "We want to replace their airplanes with new ones," he said. Such a replacement sale could be worth $10 billion. Then there's the possibility of selling 12 additional Apaches.

"One of the benefits we have as a company is a nice portfolio of systems developed for the United States that have been exported to other countries," said Jeff Johnson, IDS vice president of Middle East and Africa business development. "That gives you a nice production run where Saudis can buy upgraded models off the shelf."

Another Boeing advantage, said Johnson: Linking the AWACS, upgraded Apaches and F-15s, so the Saudi services have much better situational awareness. "NCO (network-centric operations) can be a big idea, so we're real focused on phasing this in based on aircraft we have in theater," he said.

SECURITY AND GROWTH

For sure, the often-volatile Mideast region faces threats from terrorism just like other parts of the world, leading the kingdom to procure military products for self-protection.

"How do you stabilize the Gulf? You have to start with Saudi Arabia," Roth said. "They want jobs for their young people and a sustainable economy. That fits very well with the Boeing model—to be a partner, with an emphasis on the word *partner*. It's not just about sales."

In January, IDS President and CEO Jim Albaugh attended and spoke at the Saudi Arabian General Investment Authority's Global Competitiveness Forum in Riyadh. SAGIA sponsored this second Forum, featuring top executives from multinational firms and heads of state, to show companies the strategic benefits of locating and investing in Saudi Arabia.

Last spring, Boeing established a wholly owned subsidiary in Saudi Arabia, Boeing International Support Systems–Saudi Arabia Ltd. Its employees will provide engineering, depot maintenance, modifications and upgrade capabilities in support of several Royal Saudi Air Force programs, including AWACS and F-15.

The subsidiary was created to better support Boeing partner Alsalam, a leading maintenance, repair and overhaul (MRO) facility in the region. Alsalam, the prime contractor for maintenance programs to the RSAF, was founded in 1988 by a Boeing-led consortium and local investors and companies as an MRO service provider for the RSAF and regional commercial customers.

ALSALAM'S SIGNIFICANCE

When it comes to growth opportunities for Boeing within the country, Johnson said the past five years have been focused on support services and systems. Much of that work currently is performed by Alsalam, which performs heavy maintenance on F-15s and will complete upgrades on the Saudi AWACS fleet after the first is finished in the United States.

In Saudi's economic transformation efforts, "the human element is the core," said Fahd M. Hamidaddin, general director of SAGIA's Marketing Sector. Thanks to work performed by Alsalam's 2,600 employees—with the average worker in his 20s—Saudi fleets achieve self-sufficiency.

"These things that can be done more efficiently locally met [the government's] objectives of industrial growth and jobs," said Probasco of Boeing Middle East Limited. "You're creating a job that's not going to be done in the States, yet you're sustaining jobs in the States" by keeping aircraft lines open.

In addition, Probasco said this partnership takes "the direction of moving Boeing presence closer to the customer and facilitating solutions to the Kingdom's problems." It also helps the U.S. government's relationship with a key Gulf ally, he noted.

With a profitable business since 2001, Alsalam President and CEO Mohammed Fallatah said the company enjoyed about 10 percent sales growth over the past two years. While 70 percent of its work is performed on Boeing platforms, Alsalam services Sikorsky UH-60 Black Hawks and European-built Tornado aircraft, among others.

"What we really want is to take this to the second level, assembling airplanes and getting into the manufacturing," Fallatah said. "We'd like to get into the support of airplanes in their totality and we have the resources available to do this, including a lot of young Saudi talent who are eager to enter the growing aviation industry in Saudi Arabia."

Saudi officials have recognized the capabilities Alsalam has developed, Fallatah said: "When they come and see with their own eyes what we are doing and what we have done, they cannot believe we can do this in Riyadh." ■

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Saudi Arabia *at a glance*

Official name: Kingdom of Saudi Arabia

Location: Middle East, bordering the Arabian Gulf and the Red Sea. Bordered by Iraq, Jordan, Kuwait, Oman, Qatar, the United Arab Emirates and Yemen. (Bahrain, an island, is linked by the King Fahd Causeway.)

Area: About 2,250,000 square kilometers (868,730 square miles). Nearly one-fourth the size of the United States.

Population: 27 million, including about 5.6 million non-nationals (July 2007 estimate)

Language: Arabic

Religion: Islam

Capital: Riyadh

Other key cities: Jeddah, Dammam, holy Islamic cities of Mecca and Medina

Gross domestic product, 2006: $371.5 billion (2006 estimate)

Estimated gross domestic product growth rate, 2006: 4.3 percent

Major export partners, 2006: Japan, United States, South Korea, China, Taiwan, and Singapore

Major import partners, 2006: United States, Germany, China, Japan, United Kingdom, Italy, South Korea

Key industries: Crude oil production and petroleum refining (which represents 45 percent of GDP and 90 percent of export earnings). Oil is located in the country's Eastern Province.

Military spending as part of GDP, 2006: 10 percent

Sources: CIA World Factbook, Saudi Arabian General Investment Authority, Saudi Arabia Information

Taking to the air

Riyadh-based Sama, a low-cost airline that flies leased Boeing 737-300 jets, has become the kingdom's second largest carrier two years after launching service. Sama executives plan to aggressively grow the airline with additional airplanes and destinations.

SAMA PHOTO

Strong aviation forecast as kingdom emphasizes transportation growth

By Maureen Jenkins

Ever since the DC-3 first landed in Saudi Arabia in 1945—a gift from U.S. President Franklin D. Roosevelt to Saudi King Abdulaziz Al-Saud—Boeing, the kingdom and commercial aviation have been indelibly linked. This single airplane inspired the king to order more DC-3s, which led to the creation of Saudi Arabian Airlines, a state carrier that currently flies 83 Boeing single- and twin-aisle airplanes.

Much has changed since then, but what remains are strong relationships between Boeing and Saudi airlines. Those relationships put Boeing in an ideal position. With the government focused on economic expansion and sustained growth beyond oil revenues, the Saudi Arabian General Investment Authority (SAGIA) has pegged transportation as a "priority sector" for investment and privatization.

The Saudi Arabian General Authority of Civil Aviation has opened competition and licensed two private low-cost airlines, Sama and NAS Air (a National Air Services company), to operate within the country. It's expected shortly to let private airlines operate chartered flights within the nation. And like neighboring nation the United Arab Emirates, Saudi Arabia intends to capitalize on its location at the crossroads between Europe, Asia and Africa.

"We think our geographical location is ideal not just to serve our region, but to be a launch pad [from] the region," said Abdulaziz Y. Al-Babutain, SAGIA Director General of the Transportation Sector. "We can leverage our location between East and West."

"This is a big country, with no railroad system to talk about," said Boeing Saudi Arabia President Ahmed Jazzar. "And there are no water channels. The only practical means for transportation in the kingdom is aviation. It has the people and the sustainable market from within."

What does this mean for Boeing? Sama operates six leased 737-300 jets and is looking to bolster its fleet. Saudi Arabian Airlines is considering adding the 787 Dreamliner to its fleet. And Boeing Business Jets has had success placing VIP jets in the kingdom.

Outside the United States, the Middle East region has the largest business jet presence in the world, with 485 VIP aircraft currently in operation or on order. Boeing owns 57 percent of the single-aisle VIP market and 64 percent of the twin-aisle category, giving this region the largest combined Boeing Business Jets presence in the world. Within the Middle East, Saudi customers own the largest number of VIP jets.

With Saudi Arabian Airlines, "the opportunity for us is really with the 787 because it's perfectly mated to replace some of their Airbus A300 aircraft," said Marty Bentrott, Commercial Airplanes vice president of Sales for the Middle East and Africa. He added that Boeing hoped "to have an indication from the airline" within six months.

"There are a number of opportunities in work for VIP 787s," Bentrott continued. "That will help put us in a competitive position. For Sama, we think the 737 Next-Generation will be a great tool of expansion. From the cargo standpoint, what you're going to see is some replacement possibilities. There may be a market opportunity to place converted freighters into Saudi."

BCA's Current Market Outlook forecasts that the Middle East will need 1,160 new airplanes, valued at $190 billion, over the next 20 years. And the potential market for airplanes inside Saudi Arabia over the same two decades is at least 150.

HERITAGE, PRIVATIZATION

Just like the rest of Saudi industry, Saudi Arabian Airlines is embracing privatization as a means of long-term growth. And airline leaders believe competition from other domestic airlines will make the carrier stronger over time. As part of this effort, its maintenance, repair and overhaul, catering, cargo and ground service will be spun off into a subsidiary owned by a consortium of Saudi and other investors.

"We're excited because the holding company will own substantial interest in a lot of businesses," said His Excellency Khalid Abdullah Almolhem, the airline's Director General. He said this new business model will not only offer more comfortable service and lower flight costs for fliers, but will allow the carrier to more actively pursue the lucrative haj and umrah market that delivers Muslim pilgrims to the holy cities of Mecca and Medina.

As the airline shifts its brand strategy, said Abdulaziz Al-Hazmi, executive vice president of marketing, it will spend $350 million to upgrade its Boeing 777 interiors and first-class cabins. It's also overhauling its information technology system, upgrading its Web sites and call-reservation centers, and its Alfursan loyalty program. "That's where it's really going to be adding a lot of competitive advantage for us," he said.

But one key trait won't change: the airline's commitment to education. It sends some workers for university degrees; some are sent to school for pilot or certified mechanic training. Even degree-holding employees "need to know what accounting, marketing, selling is all about, whether he's an engineer, systems person, or a pilot," Almolhem said. "We're putting a lot of emphasis on training, because we are changing and we need to get people to change with us. All of this is moving toward getting people in shape to compete."

The airline also is competing successfully in the cargo market. Flying eight 747-200s, -400s and MD-11s, its cargo operation has grown 6 percent in the last two years, said Cargo Sales & Services Vice President Fahad A. Hammad.

"Privatization can only improve the efficiency of our operation," he said, "because it will modernize our infrastructure, our fleet and our ground support."

SAMA RIDES LOW-COST WAVE

Inspired by long-time Boeing customer Southwest Airlines, Sama founders took advantage of the kingdom's privatization push and beat out 15 other potential airline startups for a license. With $15 million from 30 private and institutional investors, this low-cost carrier started flying leased Boeing 737s at the end of 2005.

In just two years, Sama has become the kingdom's second-largest carrier. "We've really been picking up unsatisfied demand," said Sama CEO Andrew Cowen, noting that the airline carried 500,000 passengers in its first six months. Sama employs pilots from Malaysia and Indonesia (they tend to be Muslim—and thus better fit with Saudi culture) and Brazil, and its call center in Riyadh is staffed entirely by Saudi women.

"We deliberately called it an Arabic name," said Cowen about Sama, which colloquially refers to the "sky" or "majestic heavens." "We wanted to create a homegrown Saudi brand. We wanted to get a buzz going, and I think it's working." Borrowing from the lighthearted spirit Southwest made famous, Sama remains respectful of its Saudi heritage while incorporating whimsy into its brand, from its Saudi National Day livery to its lively offices.

Very recently, the airline started flying international charter flights to seven destinations, including Sharjah and Abu Dhabi in the United Arab Emirates; Beirut, Lebanon; and Amman, Jordan—and Cowen said more will follow. To accommodate growing demand, Sama executives plan to boost their fleet to 35 airplanes by 2010. ■

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Saudi Arabian Airlines—which operates the Boeing 747-400 (above)—is in the midst of a groundbreaking privatization effort. While this will lead to increased competition for the large state carrier, airline executives believe the strategy will lead to strong, long-term growth.

TIM STAKE PHOTO

Lesson well learned

How Boeing's role in a new university illustrates the value of building partnerships

By Maureen Jenkins

A physics instructor (right) assists two students from King Faisal Foundation's University Preparatory Program in preparing a lab report. Top-performing students at UPP will be able to pursue college studies at the new Alfaisal University, which officially opens its doors in September with Boeing as a corporate "founding member."

For Boeing in Saudi Arabia—as in other countries—doing business is about more than merely selling products and services. It's also about helping the kingdom develop a high-tech and aerospace infrastructure so that Saudi companies can support the products the nation buys, including those from Boeing. It also will help these companies develop technologies that will help them create—and compete in—new markets worldwide.

This assistance positions Boeing as a partner with the kingdom as it develops a key asset: its young population. And a well-trained future work force benefits the Saudi Arabian and Boeing high-tech supply chains, highlighting the company's global strategy of working with top technology providers across the globe.

That's the main factor behind Boeing's support of Alfaisal University, a Riyadh-based school scheduled to open officially in September, and that counts Boeing as a founding member. Boeing Saudi Arabia President Ahmed Jazzar is on the school's Board of Trustees. Not only does this involvement allow Boeing to be viewed as a long-term corporate partner of the kingdom, but it's one of the tangible outcomes of Boeing's industrial participation program in Saudi Arabia.

It's important that the company "look at offsets not as an obligation, but as an opportunity," said Boeing International President Shep Hill. "You can access resources, talent and innovation."

One objective of this first private Saudi university is "Saudization," or the government's goal of increasing the percentage of Saudi nationals in the work force while reducing its dependence on international employees. Today, about 20 percent of those living in the country are foreigners.

With its young population—the Saudi Arabian General Investment Authority says that 50 percent of the kingdom's citizens are age 25 and younger—Saudi Arabia knows it must develop viable, long-term employment options. Universities like Alfaisal, which will equip students with skills they'll need for the high-tech 21st century, play key roles in this strategy.

"Countries want technology; they want to move up the value chain. They don't just want to buy," said Stanley Roth, Boeing International vice president of International Government Relations.

Alfaisal will use an engineering curriculum developed by international consultants from the Massachusetts Institute of Technology and the United Kingdom's Cambridge University.

"When we design curriculum, we are not hampered by old ways," said College of Engineering Dean Ashraf M. Alkhairy.

And as technically skilled classes graduate from Alfaisal and move into the work force, Boeing hopes eventually to tap into this expertise. Since September, many high-achieving high school graduates have been attending King Faisal Foundation's University Preparatory Program (UPP), which offers English language training and intensive academic coursework in key subjects. High-performing students at UPP, affiliated with Alfaisal, can pursue college studies at the new university or at other Saudi and international higher-learning institutions.

Maher A. Alodan, Alfaisal vice president for research, said he hopes to establish corporate-sponsor scholarships for students—as the university's cost is high relative to others in the region, which often are free. Another goal: exchange programs between students and corporations, which would send professionals to lead classes, workshops and conferences.

"What we would very much like," Alkhairy said, "is for systems engineers at Boeing to come on site and teach and build internships into this. In addition, we want our students to be able to be licensed in the U.S. and the U.K. The outlook is really global. We want to be a world-class university that takes care of problems that are global concerns." ■

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When in Riyadh, do as the people there do

Boeing Frontiers **writer Maureen Jenkins stands next to an aircraft display case at the Boeing Middle East Limited office in Riyadh, Saudi Arabia. She recently spent several days in the kingdom reporting on Boeing business activities.**

How a Saudi Arabia trip relates to Boeing as a global company

By Maureen Jenkins

Editor's note: In this article, Boeing Frontiers writer Maureen Jenkins offers her opinions on how working in Saudi Arabia connects to the importance at Boeing of respecting cultural and social differences.

As a writer for *Boeing Frontiers*, I've been fortunate to visit many countries. But when I told friends and family that I'd be traveling to Saudi Arabia, the reactions varied from fascination to fear.

The more adventurous couldn't wait to hear about my experience. Those who viewed the visit with trepidation wondered if I'd encounter danger as a Western woman traveling alone to a Middle Eastern nation with conservative views on female roles in society.

Nothing could have been further from the truth. From the moment I arrived at King Khaled International Airport in Riyadh, I was treated like an honored guest. When Boeing employee Mohammed Ali greeted me, he presented me with an elegant *abaya* from Boeing Saudi Arabia President Ahmed Jazzar, as I would don the black floor-length gown and head scarf during interviews with Boeing executives, at Alsalam Aircraft Co., and with key Saudi customers in Riyadh and Jeddah.

(To comply with Saudi requirements that women be covered when out in public, I brought a couple of borrowed *abayas* with me from Chicago to wear when deplaning.)

As someone who's traveled—and moved—to the other side of the world by herself, I saw the trip to the kingdom as a welcome journey. After all, this should be what it means to work for a global company: a willingness to interact with people and cultures different from one's own. Rather than shrinking from such opportunities, why not embrace them as a chance to make one-on-one connections with customers who support our livelihood—and with diverse colleagues who share the same passion for their work, albeit half a world away?

Granted, life is different in the kingdom for women—even professionals. They must be escorted by male relatives when out in public; they don't drive; they don't mingle with men socially or in the workplace. In restaurants, they must eat in "family sections," whether alone or accompanied by men. Although I'm an independent American woman, I could feel the general respect and courtesy afforded to females in Saudi culture, and during my short visit learned to appreciate the anonymity offered by my *abaya*.

Know that age-old adage, "When in Rome, do as the Romans"? I translated that to "When in Riyadh …" and had a far richer experience than I would have if I'd tried to view everything through an Americanized cultural lens.

For sure, visiting Saudi Arabia is different from a work assignment in Italy, Spain or Japan. Indeed, it's nearly impossible for non-Muslim independent travelers to enter the kingdom. (Because the Boeing Middle East Limited office handled my visa application—and because I would be the guest of a well-regarded corporation—it was processed with no problem.) But that difference is the point. If we Boeing employees are going to be successful business partners around the globe, it's imperative that we become adaptable and willing to step out of our comfort zones. It's all about being respectful of cultural, social and religious differences, even when we don't always understand them. And that's just as true in our Boeing offices with our own colleagues, whether we work in Seattle, Seal Beach, Calif., or Seoul.

Months before my visit, retired Boeing International President Laurette Koellner traveled to Saudi Arabia and met with high-level officials, Saudi executives and Boeing and Alsalam staff during what Boeing International Vice President Stanley Roth called an "extremely positive" visit. The warm reception Koellner received from her Saudi hosts, Roth said, stemmed from her willingness and desire to fit in culturally during her stay.

Boeing builds products that connect the world and make it a smaller place. How appropriate it is for those of us who work here to build bridges of our own, one cross-cultural visit at a time. ■

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Right place, *right time*

The gleaming towers of the Singapore skyline convey the economic strength of this small Asian nation. Boeing has worked to bolster its presence in Singapore.

CORBIS PHOTO

Why Singapore is a fitting place for Boeing to boost its presence

By Junu Kim

Among the highlights of Singapore's National Day Parade, which commemorates this Asian nation's independence, is the flying of an enormous Singapore flag over the tens of thousands of people below. And what's the aircraft that's trusted to display the flag? Republic of Singapore Air Force Chinook helicopters, built by Boeing.

As the gateway to Southeast Asia, Singapore is an important market to Boeing. Despite having an area and a population that are more akin to a city than what people envision for a country, this city-state has a vibrant, highly developed economy that grew at about 8 percent last year. Its work force has developed expertise in high-tech areas that align with Boeing's needs. And it's located amid a region where the aerospace industry is growing rapidly. Indeed, the Singapore aerospace industry has consistently recorded a double-digit annual growth rate over the last 20 years, according to Singapore's Agency for Science, Technology and Research (A*STAR), a government organization that promotes and supports research and development activity in that nation.

That's why Boeing is increasing its presence in Singapore, which this month will host the Singapore Airshow 2008, Asia's largest air show. That presence goes beyond Boeing sponsoring the last two National Day Parades and having Singapore customers operating Boeing commercial jetliners and defense aircraft. Indeed, that increase is reflected in a growing presence that Boeing has on the ground in Singapore, through growth in facilities there and the creation and expansion of partnerships with firms in that nation.

"Because of Singapore's skilled work force, technology leadership and standing in the world, Boeing sees a bright future for its relationship with Singapore," said Joe Song, Integrated Defense Systems vice president of International Business Development for Asia-Pacific. "We believe there is potential to expand our partnership with Singapore not just through additional sales in-country, but also through the joint pursuit of opportunities in other markets in the region and around the world.""

ON THE GROUND

Among the recent developments in Boeing's relationship with Singapore is the company's opening of a new Integrated Materials Management Asia Regional Center (ARC) to help maintain and manage the spare parts inventories of IMM customers.

The IMM team manages supplier-owned inventory at airline maintenance locations, which reduces the airline's inventory holding and other supply-chain management costs. The IMM team doesn't house spare parts; instead, it more efficiently manages spare parts for its customers.

In the IMM business model, the team sends a message to a supplier to send specific parts to an IMM customer as those parts are needed. The supplier picks and packs the part, and then ships it to the customer—which stores it until it's needed. The customer isn't invoiced for the part until a mechanic pulls it for use. IMM currently has 13 customers, including Singapore Airlines.

The Singapore IMM office, which opened last March, is IMM's first regional center. Jeff Waterfall, IMM global operations manager, said the ARC—developed using Lean principles to standardize processes and reduce the variation in inventory planning—helps the IMM team better serve its customers by improving the support of IMM personnel who are on site at customer locations worldwide. It also facilitates communication and increases the visibility of inventory within the IMM network, he added.

"The regional center focuses on the supply base. And that helps our teams at

airlines focus on customer needs," Waterfall said.

Even though IMM customers are located worldwide, IMM representatives said the organization elected to open this facility in Singapore to be close to where its primary core business is. In addition, the organization chose Singapore because of the potential to grow and the skilled work force, among other factors. "Everything pointed at Singapore," Waterfall said.

The Asia Regional Center is at Schenker Singapore's Megahub facility in the Airport Logistics Park of Singapore, where Boeing maintains a Spares Regional Distribution Center. This distribution center is one of eight worldwide locations where the Material Management organization—part of Boeing Commercial Airplanes' Commercial Aviation Services business—stores spare airplane parts, ready to be shipped as needed.

Mark Owen, vice president of Material Management, said Singapore is an ideal location for this center because of the number of flights and frequencies offered to cities within the region—which extends from India to Japan to Australia. "It offers good transportation options, which helps us move products quickly to our customers," Owen said. "The sooner we can get parts to our customers, the sooner they can get their airplanes back in revenue service."

That proximity of the Singapore site to customers' airplanes is critical to Material Management: Its vision calls for the right part to be in the right place (the dock) within four hours of the customer's request.

As a sign of this location being in the right place at this time, the Singapore center in recent years has seen a healthy jump in activity. Material Management executives said it shipped more than 136,000 orders in 2007—a 58 percent increase over the 86,000 shipped orders in 2004.

To support the growing demand for parts in Asia, the Singapore site was moved in 2006 to a larger facility. The new location—which has an area of about 53,400 square feet, making it more than 50 percent larger than its previous facility—offers about 30,000 part numbers.

Boeing is also establishing facilities in Singapore to support airline crews.

Alteon Training, a wholly owned subsidiary of Boeing, opened its Singapore Training Center in January 2007. The facility offers six full-flight simulators, including a Boeing 777-200/300, a Boeing 737-300/400/500, an Airbus A320, a Fokker 100, a Boeing 737-800 and an Embraer 170/190. A Boeing 787 simulator is scheduled to arrive in 2008. In addition to flight simulators, the training center hosts a cabin emergency evacuation trainer and other advanced-technology training devices such as flat-panel trainers. The Singapore Training Center has the capability to train more than 6,000 pilot crews per year as well as maintenance and cabin crew personnel.

Alteon established this Singapore facility—among the newest of its 20 locations—to capitalize on the growing need in that part of the world for the training company's services, company executives said. Indeed, the Singapore site is Alteon's largest facility in Asia. "The Singapore center greatly expands our capability to meet the increasing demands for aviation training in the region," said Alteon President Sherry Carbary.

PARTNERSHIP GROWTH

Yet Boeing's increased activity in Singapore is manifesting itself not just through expanding structures but by strengthening its partnerships with entities in that nation.

Last March, Boeing tapped ST Aviation Services Company Pte Ltd. (SASCO), a wholly owned subsidiary of Singapore Technologies Aerospace Ltd., to perform certain passenger-to-freighter conversions under the 767-300 Boeing Converted Freighter (BCF) program. Under this contract, SASCO will perform aircraft maintenance and the passenger-to-freighter conversions with data provided by Boeing.

In October, ST Aerospace inducted the first aircraft from All Nippon Airways, Boeing's launch customer for the 767-300BCF program, at its SASCO facility in Singapore for conversion. The prototype redelivery is expected in June, upon U.S. Federal Aviation Administration certification.

ST Aerospace has handled successful conversions for 757-200SFs, DC-10s and MD-11s. In fact, SASCO was named one of Boeing's 2004 Suppliers of the Year. Also, ST Aerospace is working to be certified to overhaul and repair CH-47 transmissions.

These Singapore partnerships appear not only in the conversion business, but also on the R&D front.

Singapore may not be renowned for natural resources. Yet what it offers the global

Singapore *at a glance*

Official name: Republic of Singapore

Location: Southeast Asia; islands between Malaysia and Indonesia

Area: 692.7 square kilometers (267.5 square miles). About one-fourth the size of Rhode Island, the smallest of the 50 United States.

Population: 4.6 million (July 2007 estimate)

Main languages: English, Mandarin, Malay, Tamil

Main religions: Buddhism, Islam, Christianity

Estimated gross domestic product, 2006: $122.1 billion

Estimated gross domestic product growth rate, 2006: 7.9 percent

Key industries: Electronics, chemicals, financial services, oil drilling equipment, petroleum refining, rubber processing and rubber products

Estimated military spending as part of GDP, 2005: 4.9 percent

Source: CIA World Factbook

Proudly in service

Here's a quick look at Boeing products that are in the fleets of customers in Singapore.

BOEING GRAPHIC

Singapore Airlines is the largest customer for the 777 Family, including the 777-300ER (above).

Ministry of Defence, Singapore

Type of customer: Defense

Boeing aircraft in its fleet: 20 AH-64D Apache Longbow attack helicopters; 4 KC-135 Tankers; 16 CH-47 Chinook helicopters

Major orders placed in recent years
October 2007: 12 F-15SG jet fighters
December 2005: 12 F-15SG jet fighters

Singapore Airlines

Type of customer: Airline

Boeing models in its fleet: 777-200, -300, -200ER, -300ER, 747-400, 747-400 Freighter

Major orders placed in recent years:
October 2006: 20 787-9s
December 2004: 18 777-300ERs

Deliveries in recent years:
2007: 5
2006: 7
2005: 4
2004: 6
2003: 11

BOC Aviation

Type of customer: Leasing company

Boeing models in its owned fleet: 737 Classic, 737 Next-Generation, 747-400 Freighter, 777-200ER and -300

Major orders placed in recent years:
December 2006: 20 737-800s
April 2006: 10 737-800s
May 2005: 17 737-800s and 3 737-700s

Deliveries in recent years:
2007: 7
2006: 3

BOB FERGUSON PHOTO

The Apache Longbow helicopter is among the Boeing aircraft in the fleet of the Ministry of Defence, Singapore.

economy is its collective intellect and "an environment that's conducive to the development of technologies," said Peter Hoffman, director, Global R&D Strategy for Boeing. Tapping that knowledge and environment supports Boeing's strategy of identifying and working with the brightest minds globally to develop solutions, he added.

Case in point: In early 2007, Boeing was one of four global aerospace leaders that signed a memorandum of understanding with the research institutes of A*STAR to drive innovation in aerospace research in that country.

The intent of this agreement is to boost the capabilities of local aerospace companies, which helps them move up the value chain, and to help the four aerospace companies involved in the MOU tackle technological challenges by tapping the expertise of Singapore firms.

The MOU calls for research in five areas:

- Inspection and nondestructive testing
- Manufacturing processes and automation
- Advanced materials
- Information and communication
- Computational modeling and dynamics

"Because there's multiple parties involved in contributing funding, you get a good critical mass in research funds for a common benefit," said Hoffman, adding that Boeing, like the other consortium members (EADS, Pratt & Whitney and Rolls-Royce), has an influence on the areas where research funds are allocated. "The more members you can bring in, the more money you have to perform research, and the more you can accomplish."

That MOU follows a 2005 agreement between Boeing and A*STAR that calls for collaboration on investigating and developing aerospace-related technology research projects of mutual interest. The areas covered range from advanced materials to computational science and wireless communications.

"Technology is moving so quickly these days that financing all of our technology development independently would be too costly," Hoffman said. "We're looking to share the burden of keeping up with rapidly moving technologies by finding partners that are very bright and are willing to coinvest with us. That's what draws us to places in the world like Singapore." ■

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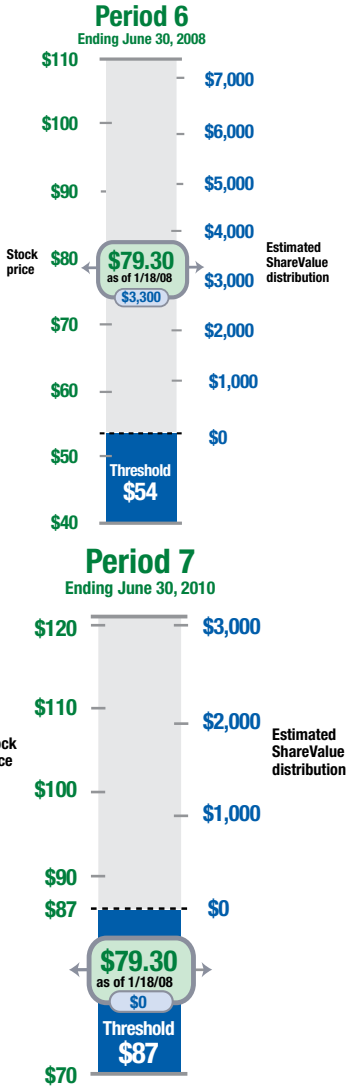
Boeing stock, ShareValue Trust performance

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 Periods 6 and 7.



The above graphs show an estimate of what a "full 4-year participant" ShareValue Trust distribution (pretax) would be for Periods 6 and 7 if the end-of-period average share prices were the same as the recent price shown.

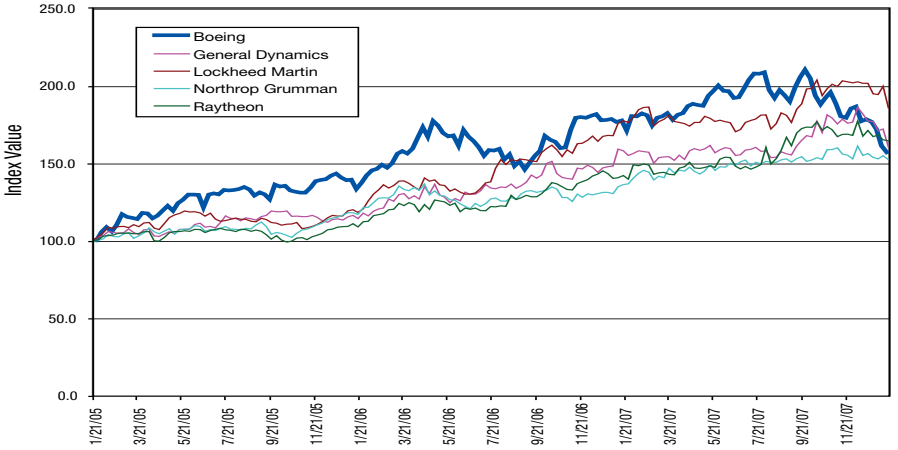
The share price shown is the average of the day's high and low New York Stock Exchange prices. Updates to participant/employment data will be made periodically.

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

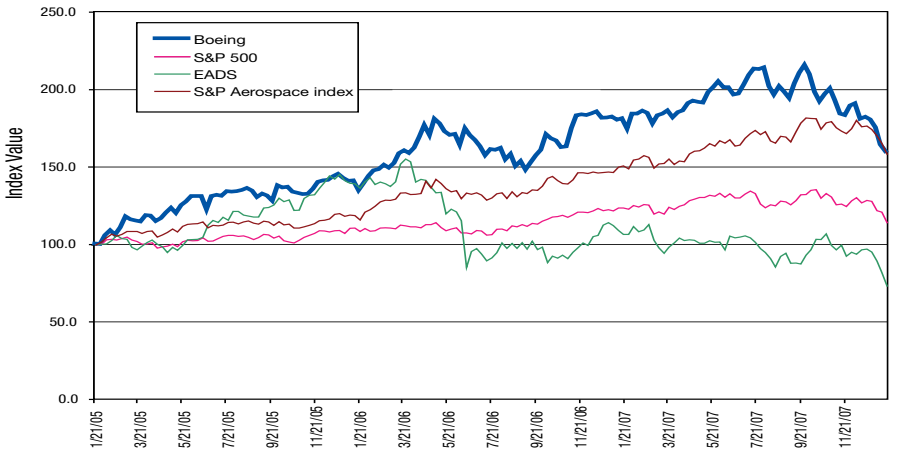
STOCK WATCH

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 Jan. 21, 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:

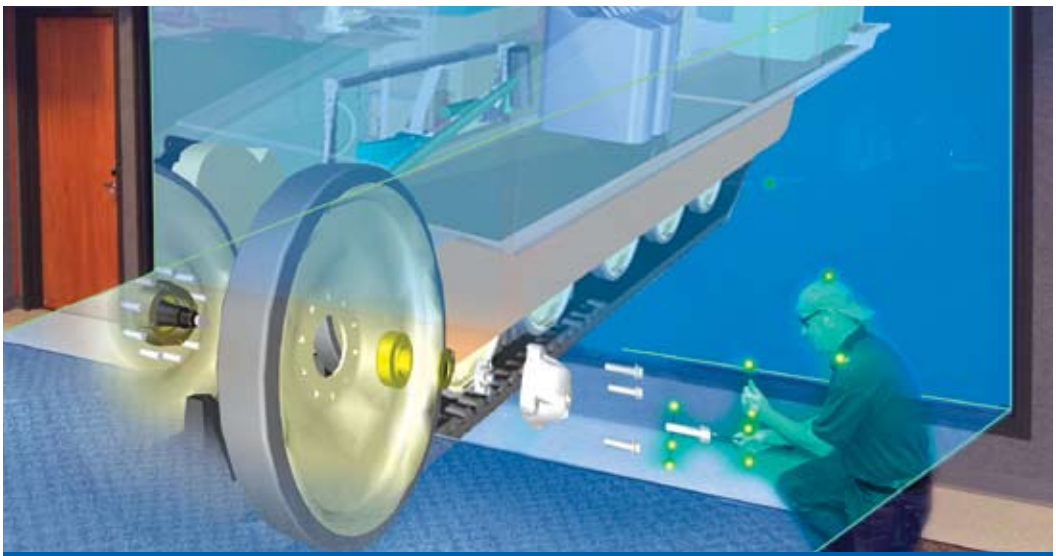
4-week, 52-week

	Price/value as of 1/18/08	Four-week comparison: Price/value as of 12/21/07	Four-week comparison: Percent change	52-week comparison: Price/value as of 1/19/07	52-week comparison: Percent change
BOEING	**78.40**	**89.07**	**-12.0%**	**89.55**	**-11.5%**
U.S. COMPETITORS					
General Dynamics	80.80	89.24	-9.5%	79.53	1.6%
Lockheed Martin	101.88	110.48	-7.8%	97.27	4.7%
Northrop Grumman	78.56	80.58	-2.5%	70.29	11.8%
Raytheon	60.56	63.00	-3.9%	52.30	15.8%
INT'L COMPETITORS					
EADS *	17.17	22.41	-23.4%	24.48	-29.9%
U.S. STOCK INDEXES					
S&P 500	1325.19	1484.46	-10.7%	1430.50	-7.4%
S&P 500 Aerospace and Defense Index	403.88	448.93	-10.0%	385.22	4.8%

* Price in Euros

AROUND BOEING

Kirk Postier, 23 Years
Randy Prosise, 21 Years
Michael Pucher, 38 Years
Patricia Ramirez, 30 Years
Harold Redd, 35 Years
Thelma Reilly, 23 Years
Carolina Rodriguez, 25 Years
Jerry Rogerson, 35 Years
Jesse Sanchez, 8 Years
Shirley Saxton, 10 Years
Phillip Scheuring, 21 Years
Michael Schmitt, 24 Years
John Sennikoff, 37 Years
John Seper, 29 Years
Raymond Shibata, 34 Years
Carolyn Smith, 28 Years
Larry Snyder, 21 Years
Emil Stevens, 30 Years
Charles Stump, 23 Years
Dennis Treece, 37 Years
Arun Trikha, 38 Years
Daniel Washburn, 27 Years
Louise Welch, 23 Years
Samuel Wiggins, 11 Years



JASON BARRAS PHOTO

George Tamasi, Boeing Design Visualization Technology specialist, explains how new capabilities of the Virtual Integration Center will appear to those using it. A full motion-capture system allows the analyst to interact with the models being investigated.

Mark Stinson, precision bench assembler; service date Jan. 21, 1981; died Dec. 8

John Townsend, quality engineer; service date May 1, 1972; died Dec. 2

Vicki Ursery, workforce specialist; service date Jan. 6, 1971; died Nov. 21

Irwin Vas, manager; service date Jan. 26, 1987; died Nov. 8

John Watson, coordinator; service date March 15, 1976; died Nov. 18

Patricia Werner, writer/editor; service date Sept. 24, 2007; died Nov. 21

Daniel Wybrant, courseware service consultant; service date Feb. 26, 2007; died Dec. 24

Jeffrey Zelna, project engineer; service date Dec. 9, 1990; died Nov. 15

MODELING, SIMULATION & ANALYSIS CENTER GOES VIRTUAL

With its recently completed $1.5 million computer-aided virtual-environment addition, the Modeling Simulation & Analysis Center at Rotorcraft Systems in Philadelphia now provides 3-D stereo viewing and motion-capture capability.

Opened in Philadelphia in 2005, the MSAC provides military customers with a state-of-the-art simulation environment supporting design and product-integration decisions. MSAC also offers the latest modeling and integration capabilities for Boeing programs, including the U.S. Army Future Combat Systems (FCS).

MSAC features a high-bay area capable of housing aircraft, vehicles and equipment, connecting the equipment to the viewing portal, simulations and enterprise, defense, and industry networks. MSAC also features dome simulators, exercise gaming and simulation, control and briefing rooms, and various internal laboratories.

All these features are linked together through a common communications area. A viewing portal capable of seating up to 50 supports engineering and testing interactions with several Boeing centers and the FCS Defense Research Engineering Network, a national government network providing simulation, integration and interaction capabilities.

The new addition, known as the Virtual Integration Center (VIC), "expands the MSAC's virtual capabilities into new areas and provides another dimension of integration and support to our customers and partners," said John Durkin, FCS engineer. "Now we can conduct real-time 3-D collaborative engineering in a virtual environment."

With this capability, engineers and customers in Philadelphia can observe and participate in virtual design reviews in Long Beach, Calif., or at partner locations in Minnesota and Detroit, while immersing engineers and customers in the 3-D design, Durkin said. Results can be sent to distributed network locations.

This new capability allows soldiers, equipped with instrumented motion-capture systems, to interact with 3-D models and perform maintenance tasks and procedures on virtual vehicles, providing early insights into areas of concern.

"VIC enables us to review all aspects of the design, engineering, human factors and supportability early in the program, before manufacturing. It allows us, our industry partners and military customers to host or participate in simultaneous integration reviews and exercises throughout the United States," Durkin said. "We're excited about the possibilities that the MSAC and new VIC provide, and this is just the beginning—the first step."

—Donna McGinley

GAIL HANUSA PHOTO

Everett, Wash., Propulsion Systems team

In early January, our value stream team moved its buildup and integration operations from south Seattle and restarted production in the 40-54 building in Everett. We prioritized our new beginnings so that we could live up to our legacy of delivering quality products on time. And sure enough, a few days later, we delivered our first widebody jet engines to the 747, 767 and 777 programs.

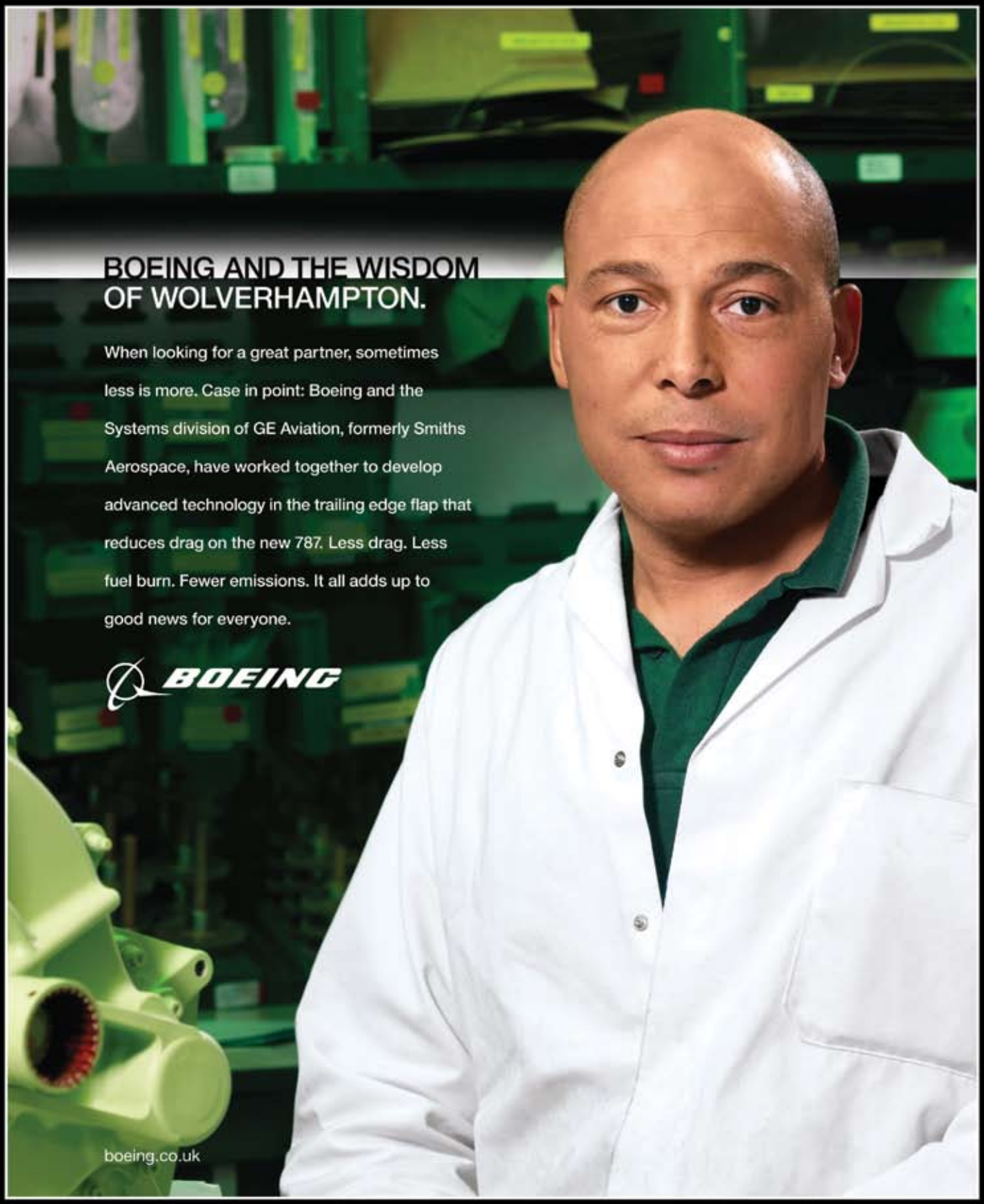
We made the move to Everett as part of Propulsion Systems' journey of continuous improvement. This move, which is similar to the move some of our Propulsion Systems teammates made to Renton, Wash., in late 2006, means that we're fully integrated with our most immediate customer: Final Assembly.

Our move wasn't easy. There's more than 160 of us, along with our computing stations, as well as about 100 trailers full of equipment, tooling and production hardware. But now we're just a short forklift drive away from each of Commercial Airplanes' widebody final-assembly lines. And we expect to help reduce flow times and improve quality even more than before—especially since we've basically transformed an empty warehouse into a living, breathing engine-buildup facility. It's a place where we can improve our existing production processes and incorporate new ideas into our workspace.

We feel great about how our move to Everett turned out, because we didn't create a hiccup in quality, delivery or safety. It was a huge effort that took us two years to plan, but it was worth it.

Even though we in Everett make up one of three Propulsion Systems teams across the Puget Sound area, it's our goal to keep our culture—one that's committed as "one team, with one plan, and one future."

Team leader Peter Maloney (below right) ensures the safety of mechanics Randy Thompson and Corey Verburg (top of engine, from left) as the members of the Propulsion Systems widebody value stream team perform buildup on the first post-move 777 engine. When completed, it will be delivered to Everett final assembly—now just a short forklift drive away from Propulsion Systems' new operations.



This is the eleventh in a series of new ads created to build awareness of Boeing and its many partnerships in the United Kingdom. Boeing, the largest overseas customer of the UK aerospace industry, currently partners with more than 300 businesses and universities around the country. The advertising campaign has appeared in The Sunday Times, The Economist, Spectator Magazine *and other UK publications, and complements current Boeing business and communications activities in that nation.*

WHAT CAN YOU SEE from the vantage point of the world's largest satellite builder? The deepest reaches of space and the smallest changes in climate. At Boeing, you'll help develop the powerful, innovative satellites that give us new ways to explore the world we inhabit and the universe it's in. That's why we're here. The job categories below reflect skills we are seeking for various positions in Alabama, Arizona, California, Colorado, Florida, Kansas, Maryland, Missouri, Oklahoma, Pennsylvania, Texas, Virginia and Washington. To view the available jobs at each location and to apply, visit: boeing.com/careers

- AVIONICS – FLIGHT TEST
- COMMUNICATION SYSTEMS – MILSATCOM/ NETWORK/SATELLITE/WIRELESS
- ELECTRICAL ENGINEERING – COMPONENTS
- ELECTRONIC WARFARE
- FINANCE/ACCOUNTING/PLANNING/SCHEDULING/ ESTIMATING/PRICING/EVMS/TAX
- FLIGHT CONTROL LAW ENGINEERING
- GIS/IMAGERY
- GROUND MISSILE DEFENSE/GROUND-BASED MISSILES
- INFORMATION TECHNOLOGY
- MECHANICAL ENGINEERING – EM/STRUCTURAL/DYNAMIC/ THERMAL/STRESS
- MODELING & SIMULATION
- NETWORK ARCHITECT/NETWORK SECURITY
- NETWORKING/EMBEDDED/WEB/ARCHITECTURE
- OPERATIONAL CONCEPT ANALYSIS
- PAYLOAD SYSTEMS – SPACECRAFT/SATELLITE/AIRCRAFT
- PRODUCT REVIEW ENGINEER (LIAISON/MRB ENGINEER)
- QUALITY ENGINEERING
- RADAR DESIGN/ANALYSIS
- SIGNAL PROCESSING – SONAR/RADAR/ DSP/SIGINT SYSTEMS
- SOFTWARE ENGINEERING – REAL-TIME
- SYSTEMS ENGINEERING

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BOEING

Boeing is an equal opportunity employer supporting diversity in the workplace.

This image, from the "Epic" recruitment advertising campaign, is part of Boeing's efforts to attract a talented, diverse group of college and experienced professionals, and encourage them to explore a career with Boeing. The skill sets listed demonstrate the breadth and depth of Boeing opportunities. The ad directs candidates to view detailed job descriptions and apply online at: boeing.com/careers.