

Frontiers

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DECEMBER 2012–JANUARY 2013 / Volume XI, Issue VIII



Wing of innovation

The story of the X-48 program is one of discovery—and ideas taking flight



THE BOEING 777. FLOWN BY THE WORLD'S ELITE AIRLINES.



The Boeing 777 has made itself indispensable to premier airlines around the world. Its outstanding range and unmatched efficiency enable carriers to profitably open new routes, while providing the award-winning comfort that has made it the preferred long-haul airplane of passengers everywhere.



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Ad watch

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

Inside cover:



This ad was developed to run in the Middle East, a key market for the Boeing 777 jetliner with more operating there than in any other region in the world.

Page 6:



Highlighting the combined capabilities of Boeing's Super Hornet and Growler military aircraft, this ad is running in U.S. trade and congressional publications.

Pages 10–11:



This is the first ad in a new campaign, "Partners Across Generations," celebrating the relationship between Boeing and China's aviation industry. Translation: The memorable glamour of [Shanghai's famous] Bund over time as a Boeing flies over. For over 40 years, Boeing has been supporting the development of the Chinese aviation industry. Boeing is proud of every achievement in this partnership, which transcends time.

Pages 14–15:



"Enduring Force," featuring the V-22 tilt-rotor aircraft, focuses on Boeing's military aircraft expertise. It is one of several ads in a Boeing Defense, Space & Security campaign highlighting the capabilities Boeing brings to its customers. The ads are running in print and online business, political and trade publications.

Back cover:



This is the first of two new ads featuring the "Endless Possibilities" theme, developed to celebrate a new high in the partnership between India and Boeing with the recent induction of the 787 Dreamliner into Air India's fleet.

Print and digital advertising ran during October in publications such as the *Times of India*, *Economic Times* and *India Today*.



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The right blend

On a dry lake bed in the high desert of California at NASA's Dryden Flight Research Center, Boeing and NASA are testing an unusual-looking aircraft. Called the Blended Wing Body, its design lies somewhere between a flying wing and a traditional tube-and-wing airplane. Although Boeing has no plans to develop a Blended Wing Body commercial airplane, valuable knowledge has been gained in more than 100 test flights of two different versions.

COVER IMAGE: SPECIAL LIGHTING HIGHLIGHTS THE X-48C TEST AIRCRAFT'S UNIQUE DESIGN IN THIS NIGHT SHOT AT NASA'S DRYDEN FLIGHT RESEARCH CENTER AT EDWARDS AIR FORCE BASE, CALIF. BOB FERGUSON/BOEING
PHOTO: SOON AFTER SUNRISE, THE X-48C TEAM PREPARES THE AIRCRAFT FOR ANOTHER TEST FLIGHT AT THE DRYDEN SITE. BOB FERGUSON/BOEING



Frontiers

Publisher: Tom Downey
Editorial director: Anne Toulouse

EDITORIAL TEAM

Executive editor:
Paul Proctor: 312-544-2938

Editor:
James Wallace: 312-544-2161

Managing editor:
Vineta Plume: 312-544-2954

Graphic designers:
Brandon Luong: 312-544-2118
Cass Weaver: 480-216-4539

Photo director:
Bob Ferguson: 312-544-2132

Commercial Airplanes editor:
Don Smith: 206-766-1329

Defense, Space & Security editor:
Diane Stratman: 562-797-1443

Engineering, Operations & Technology editor:
Junu Kim: 312-544-2939

Human Resources and Administration editor:
Geoff Potter: 312-544-2946

Shared Services Group editor:
Beriah Osorio: 425-577-4157

Staff writer:
Eric Feters-Walp: 425-266-5871

ONLINE PRODUCTION

Web manager:
Wendy Manning: 312-544-2936

Web designer:
Michael Craddock: 312-544-2931

Web developers:
Lynn Hesby: 312-544-2934
Keith Ward: 312-544-2935

Information technology consultant:
Tina Skelley: 312-544-2323

HOW TO CONTACT US:

E-mail:
boeingfrontiers@boeing.com

Mailing address:
Boeing Frontiers
MC: 5003-0983
100 N. Riverside Plaza
Chicago, IL 60606

Phone:
312-544-2954

Fax:
312-544-2078

Web address:
www.boeing.com/frontiers
Send all retiree address changes to
Boeing Frontiers, MC 3T-12
P.O. Box 3707
Seattle, WA 98124-2207

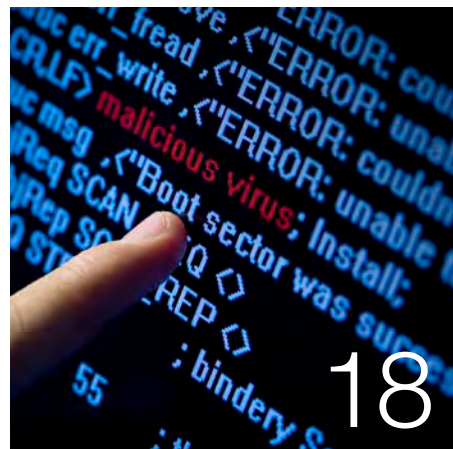
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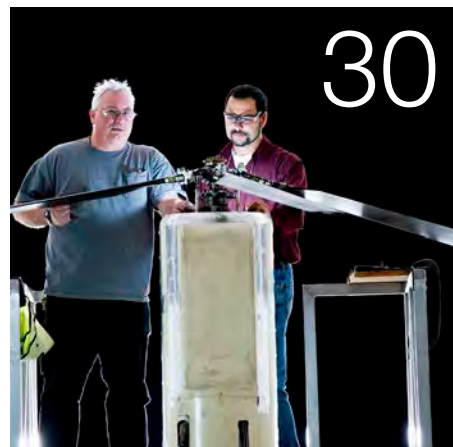
Historical Perspective

Harry S. Gann joined Boeing heritage company Douglas Aircraft in 1954 as an engineer, but he would become best-known for his aircraft photography. Gann's pictures of the U.S. Navy's Blue Angels and various Douglas-built aircraft can be found in countless aviation books and magazines. For taking such great aerial shots, Gann was named an honorary Blue Angel by the precision flying team. PHOTO: BOEING ARCHIVES



Cyber safe

At a newly opened lab in Huntington Beach, Calif., Boeing and its customers are running war-game scenarios to help develop defenses to a growing global threat—cyberattacks. It's the kind of innovation that's building a global reputation for Boeing's cutting-edge Information Security Solutions business. PHOTO: SHUTTERSTOCK



Testing the future

At Boeing in Philadelphia, work is under way on a new test stand for the site's large wind tunnel so it can test innovative rotorcraft blades. It's one of many examples of how Boeing Test & Evaluation laboratory test teams are called upon to prepare plans and equipment to test the next big thing—even if it doesn't exist yet. PHOTO: FRED TROILO/BOEING

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Fuel for growth

Boeing has built more than 1,000 commercial 767 jetliners at its Everett, Wash., plant. Now it's preparing for a new 767 version to move down the assembly line: the KC-46A tanker ordered by the U.S. Air Force. Commercial Airplanes and Defense, Space & Security employees have teamed as "One Boeing" to develop and build the tanker.

PHOTO: BOB FERGUSON/BOEING



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Great ideas enable innovation and bolster Boeing's competitiveness. But where do they come from? They come from engaged employees who work in a collaborative environment and are empowered to tackle technical challenges, says John Tracy, Boeing's chief technology officer and senior vice president, Engineering, Operations & Technology.

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Partners and friends

When President Richard Nixon landed in Beijing 40 years ago in Air Force One, a Boeing 707, the historic visit opened the door for Boeing in China. From a first order for 10 707 jetliners, the relationship has grown into an important partnership with the world's most populous nation and second-largest economy. PHOTO: YONG HE





A dominant pair, a dominant force.

Together, the E/A-18 Growler and the F/A-18 Super Hornet are a powerful force multiplier, providing unmatched capability to suppress enemy air defenses in even the most heavily defended areas. The Growler is the foremost advanced electronic attack aircraft while the Super Hornet remains the most adaptable, best strike fighter in the world today, capable of integrating advanced payloads today and beyond. Together, they guarantee an affordable and adaptable force structure to ensure dominance for decades to come.

EA-18G GROWLER



F/A-18E/F SUPER HORNET





Great ideas come from you

We're all involved in building a stronger and more competitive Boeing

John Tracy

*Chief technology officer
Senior vice president, Engineering, Operations & Technology*

Walk through our facilities and you'll see talented, dedicated people going about the business of researching, designing, building and testing the world's best airplanes, defense systems and spacecraft. Through their work, Boeing continues to efficiently produce high-quality, highly capable products. In fact, through the first three quarters of 2012, Boeing employees delivered 436 commercial airplanes along with 110 military aircraft of different types and nine satellites.

With all these aircraft and spacecraft around us, one might think the concept of powered flight has become mundane. But it never gets old. The thought of machines that fly still captivates the imagination of people even after more than 100 years of powered flight.

Products mentioned in this edition of *Frontiers*, such as the X-48C Blended Wing Body demonstrator aircraft, the 787 Dreamliner and the KC-46A refueling tanker, demonstrate how great ideas matter: Great ideas enable innovation because they demonstrate the vision, foresight and will to shape the future. By developing and executing on great ideas, we bolster Boeing's competitiveness, strengthen our stature as a leader in aerospace and technology, and continue to improve the lives of people worldwide.

Where do ideas come from? Great ideas come from engaged employees who work in a collaborative, inclusive environment and who are empowered to apply their own perspectives to

tackle technical challenges.

Thanks to the innovations we develop, which reflect our ability to find the intersection of technology breakthroughs and customer needs, our world is a better place. Our commercial airplanes continue to set standards in safety, capability, reliability, and economic and environmental performance. Our satellites support instantaneous communications across oceans and between continents. And our defense products enable warfighters to defend

“We all play a role in making Boeing a stronger, more competitive company, whose stellar future complements its storied past.”

freedom by giving them the tools to successfully execute their missions and return safely.

Great ideas lead to improvements in not only what we create but how we create it. So it's vitally important that we continue to take the initiative to streamline processes, reduce costs and cycle time, and improve quality. In “One Boeing” fashion, collaborate with the right

colleagues, teams and experts around the company to make the most of Boeing's collective knowledge and improve efficiency. As we work hard to replicate our successes and achievements across the enterprise, know that our teammates can use our company's know-how to do their work more efficiently.

Of course, if an idea is great, the execution of it also has to be outstanding. The ability to apply technical expertise from anywhere and everywhere within Boeing ensures we will deliver the value inherent in our great ideas—and help Boeing grow and be more productive.

We all play a role in making Boeing a stronger, more competitive company, whose stellar future complements its storied past. Our future rests upon the ideas we collectively generate to improve the products and services we create, as well as the ways we create them, so that we continue to delight our customers. They will greatly appreciate it, and this will ensure our company's success for decades to come. ■

PHOTO: BOB FERGUSON/BOEING



DREAM LINE: Three 787s are shown on the production line in the Everett, Wash., factory last month. Boeing employees in Everett and in North Charleston, S.C., now are producing Dreamliners at a rate of five per month. The program is on track to achieve a planned 10-per-month rate by late 2013. PHOTO: GAIL HANUSA/BOEING

Quotables

“What I’ve seen so far is passionate people who want to deliver a jet to the warfighter.”

– Maj. Gen. John Thompson, Air Force Tanker Program executive officer and KC-46 program director. See story on Page 36 for more on Boeing’s 767 tanker program.

“It was a very quiet cabin. The quietness really stood out for me.”

– A passenger on the inaugural flight from Houston to Chicago of United Airline’s 787 Dreamliner. Chicago Tribune, Nov. 5.



Fair play

For this employee, the goal is helping foster an open and respectful workplace *By Geoff Potter*

Donniss McPhaul is a Global Diversity & Employee Rights specialist who conducts Equal Employment Opportunity investigations at various Boeing sites. In this Frontiers series that profiles employees discussing their jobs, McPhaul explains how Boeing provides safeguards for employees as it strives to create and maintain a fair and respectful workplace.

PHOTO: RON WILLIAMS/BOEING

Equal Employment Opportunity is all about fairness. That's what makes my job so rewarding—giving employees a way to help ensure the workplace atmosphere offers everyone at Boeing a chance to contribute their best without being distracted or impeded by harassment or discrimination.

Outside of work, I enjoy watching thrillers and detective movies. My Boeing job is a little like being a detective. I have to put all the pieces together to see the big picture.

Part of my role is to help employees understand that certain behaviors—harassment, for example, or even gossip when it's related to someone's gender, race, religion or age—are simply unacceptable in the Boeing workplace. We also want employees who believe they've been discriminated against or harassed to raise their hand and report it.

Here's how the investigation process works.

Imagine that someone is sending emails with racially derogatory jokes or making unwanted sexual advances to a co-worker. Our

office receives a complaint from the affected individual or a witness, manager, or HR or Ethics representative. If the behavior is a potential violation of our Equal Employment Opportunity policies, I conduct a confidential investigation as promptly as possible. That may involve interviewing witnesses, analyzing data, collecting forensic evidence and, finally, documenting the findings establishing whether the behavior violated our policies.

Less than half of complaints are substantiated. But when they are, corrective action or other appropriate steps are taken, such as requiring specific training for the person exhibiting inappropriate behavior. Our goal is to address that behavior and prevent it from happening again. I also follow up afterward to make sure the behavior has been corrected and there's been no retaliation.

Boeing has employed me for more than 32 years in a variety of jobs, most of them in Human Resources. I have a passion for learning. And I'm the type of individual who sets goals and works hard to achieve them. Through the Learning Together program, I've earned a Ph.D. in Organization and Management, with a specialization in HR Management.

I'm a big believer in responsibility. I believe everyone at Boeing is responsible for fostering a productive workplace and treating others with respect, dignity and trust. And I feel proud that the work I do helps advance that goal. ■

geoffrey.potter@boeing.com

BOEING
波音



The image is a composite of a city skyline and a sky scene. The skyline, occupying the lower two-thirds, shows the Bund in Shanghai with various skyscrapers, including the Oriental Pearl Tower on the right. The water of the Huangpu River is in the foreground with several boats. The sky, occupying the upper third, is a clear blue with light clouds and a Boeing 787 Dreamliner in flight, angled towards the right. The text '飞越时代的伙伴' is overlaid on the sky in white.

飞越时代的伙伴

外滩见证着历史的变迁，蓝天见证着航空业的发展。40年以来，波音一如既往地支持着现代化中国航空体系的建设。这一份跨越世代的合作，成就我们飞越时代的伙伴关系，带着不变的承诺，飞向未来。



DEPTH OF FIELD

Harry Gann joined Douglas as an engineer, but he gained fame for his aviation photos

By Pat McGinnis





“What better could you ask than to get paid for doing what you love?” – Harry Gann

PHOTOS: (Clockwise from far top left) Blue Angels flying the Delta formation. **HARRY GANN** Harry S. Gann. **BOEING ARCHIVES** Photo taken from the aft cockpit of Blue Angel No. 7, a two-seat TA-4J Skyhawk; two specially marked F-4J Phantoms—the aircraft in the foreground is shown in a special bicentennial paint scheme to celebrate the 200th birthday of the United States; Blue Angel A-4Fs taxiing out for an air show. **HARRY GANN**

Whether in the back seat of an A-4 Skyhawk flying inverted or standing on the tarmac at an air show, if there were aircraft around, Harry S. Gann was taking pictures.

Author, aviation historian and Douglas Aircraft engineer, Gann also was a master aerial photographer. He did it so well the U.S. Navy’s crack aerial demonstration team, the Blue Angels, made him an honorary member, and the U.S. Marines made him an honorary Marine aviator.

Along the way, Gann documented and helped preserve both Douglas and aviation history with his air-to-air photography and by collecting and preserving important documents, artifacts and data for this Boeing heritage company.

“What better could you ask than to get paid for doing what you love?” Gann once asked.

And he loved taking pictures—of airplanes.

Growing up in Phoenix, Gann spent weekends visiting local airports photographing aircraft. He began collecting and trading photographs, negatives, magazines, books and other aircraft data.

During World War II, he served in the U.S. Army and was badly wounded by a land mine during the Battle of the Bulge in Europe. Although his injuries required postwar rehabilitation, they did

not stop Gann from earning a degree in mechanical engineering from the University of Southern California.

In college he co-authored a book on air racing. It would not be his last book.

Gann worked for several small aviation companies before landing a job at North American Aviation. In 1954, he moved to Douglas Aircraft, in El Segundo, Calif., where he worked as a designer on control surfaces for the A4D Skyhawk, A3D Skywarrior, F4D Skyray and F5D Skylancer.

In 1964, after having worked for Douglas for 10 years as a designer, his career path took a new focus. Douglas management had discovered his interest in and knowledge of aviation history and photography, and Gann’s talents were put to another use. The company tasked him to research and provide intelligence on competitive products for Douglas sales groups, both military and commercial.

Gann’s personal collection of more than 15,000 photo negatives, design details, performance records and other aviation statistics led to the establishment of a formal Douglas archive. In 1989, he was named company historian.

In addition to his duties at Douglas, Gann had a long association with the Navy’s Blue Angels and became the team’s unofficial photographer. Many of his photos featured the Blue Angels

flying the highly maneuverable Douglas A-4 Skyhawk, which the team flew from 1974 until switching to Boeing’s F/A-18 Hornet in 1986.

In 1979, Gann was named an Honorary Blue Angel.

His pictures of the Blue Angels, as well as other Navy, Marine and Air Force aircraft, can be found in countless aviation books, magazines and periodicals.

Gann retired from what was then McDonnell Douglas in September 1992.

Five years later, Adm. Jay Johnson, then chief of U.S. Naval Operations, designated the famed photographer as Honorary Naval Aviator No. 24. Gann joined two Douglas colleagues, Ed Heinemann and R.G. Smith, who had been similarly honored by the Navy. Smith was a widely regarded aviation artist. Heinemann designed the A-4 and many other Douglas combat aircraft. (See stories in the October 2010 and January 2012 issues of *Frontiers*.)

Gann died in October 2000 at his home in Huntington Beach, Calif. Three Navy F/A-18s flew a missing-man formation over Riverside National Cemetery during his memorial service. ■

patricia.m.mcginis@boeing.com

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TODAY TOMORROW BEYOND

 **BOEING**

Splash of genius

Huntington Beach site finds ‘cool’ use for treated groundwater

By Patrick Summers and photos by Paul Pinner

An innovative use of treated groundwater to cool buildings at Boeing's Huntington Beach, Calif., site is helping the environment, saving the company money and earning praise from state officials for Boeing's remediation program.

"Water is a very valuable resource, especially in an arid, drought-prone region like ours," said Jennifer Wiley, geologist and remediation project manager in Environment, Health and Safety in Huntington Beach. "Being proactive and finding new ways to reuse water and conserve resources makes sense for the environment and our business."

Wiley and a team of engineers and remediation experts saw an opportunity to use treated groundwater from a site remediation project that otherwise would have been discharged into a storm drain. The plan to use the treated groundwater on-site started taking shape as project engineers were installing the remediation project infrastructure, which included digging trenches and installing pipe.

"Since a half-mile of trenches already was excavated and open," explained environmental engineer John Netherwood, "I thought for the cost of some extra pipe we could divert the treated water up to the cooling tower and the system that cools the buildings."

Site leadership approved the plan and the facility began using the treated water this fall. "Using the water here at

the facility is a double win for the environment," Netherwood said.

The cooling tower uses 90,000 gallons (340,700 liters) of water a day in warmer weather.

"That's a lot of water we no longer have to buy from the local utility," said Dean Hill, mechanical engineering project manager in Shared Services Group's Site Services organization. The water savings is equivalent to the average daily amount of water used by 225 families, he said.

Hill estimates the reused treated water could cut the site's use of municipal water by up to half.

"We're not just helping the company; we're also helping the local water district meet its conservation goals," said Steve Shestag, Boeing's remediation leader. "State officials are sharing our ideas on remediation and water use with other industries in the area as an example of how they can reduce their environmental footprint."

Groundwater contamination was discovered at the Huntington Beach site after the removal of an underground tank used in the past for storing industrial cleaning solvents and other chemicals. Test wells revealed that volatile organic compounds had seeped into groundwater in a limited section of the property and migrated a short distance beyond the site's southern boundary.

As part of its commitment to clean up property affected by past operations,

Boeing environmental experts worked with state officials to design a remediation plan. Wiley said the site uses several remediation methods, depending on the chemicals being treated. State permits allow the treated groundwater to be discharged into storm drains or the municipal sanitary sewer.

Extraction wells along the property's southern boundary capture contaminated groundwater and pull it back on-site for treatment. Other extraction wells prevent further chemical migration and will shrink the contamination's footprint over time.

"This project is a unique solution to a complex problem," Shestag said. "It's an excellent demonstration of Boeing's commitment to environmental stewardship."

Teresa Howe, director of Environment, Health and Safety, noted that close collaboration among remediation, environmental and engineering teams was the key to the project's success.

"We had all of our knowledge and expertise working together on a common purpose," she said. "And wow, look at the result." ■

patrick.a.summers@boeing.com

PHOTOS: (Clockwise from top left)

Laboratory tests determine the presence and type of possible groundwater contamination; an on-site cooling tower uses treated groundwater to help cool the site's buildings; Jennifer Wiley, geologist and remediation project manager, leads the groundwater cleanup effort.



“Being proactive and finding new ways to reuse water and conserve resources makes sense for the environment and our business.”

– Jennifer Wiley, geologist and remediation project manager, Environment, Health and Safety, Huntington Beach, Calif.



GAME ON

Huntington Beach lab tests scenarios to help defend against cyberattacks

BY DAVE GARLICK

No one, other than top military commanders, knows much about the nondescript building surrounded only by yucca plants and cactuses in the middle of Utah's Great Basin Desert.

Guarding the concrete power-generating facility is, for the most part, uneventful. Cameras are everywhere: wide-angle wall cams; a robotic camera trundling along its programmed routes between gates and around buildings; scores of outside eyes monitoring the building's perimeter.

Then it happens. An explosion rocks the building. The sounds of gunfire echo off walls. Boots pound up the stairwell leading to the control room monitored by one armed guard. Static alerts crackle from his two-way radio. As alarms wail, the guard's eyes scan a bank of computers when he suddenly realizes what has happened. The cameras monitoring the east gate have been hacked, their electronic control systems and signal tampered with.

Luckily, there's the reset button. No buildings were blown up, no lives were lost.

This type of scenario is similar to dozens run every week at the newly opened Boeing Information Security Innovation Lab in Huntington Beach, Calif., where the town's mellow beach culture belies the full-scale computer-based battles playing out in the virtual world inside the lab.

The lab itself isn't much to look at: a room full of desktop computers connected to several racks of servers in a back area. But here, engineers can create realistic multiple-layer virtual networks in computer "cyberspace" to help them develop cyber operations. Customers run red team versus blue team, or attacker versus defender, scenarios to test their organization's network infrastructure and operator skills and to find ways to harden their networks and data centers against attack.

"We're providing solutions to help customers gain the advantage against the growing cyberthreat," said Per Beith, director of Information Security Solutions.

In the above-described scenario, the bad guys broke into the network, took control of several key cameras and inserted false video imagery. They used that opening to slip in under the defenses and raid the facility.



But the threat from cyberattacks is no game. It's happening on a global scale.

In a recent speech, U.S. Defense Secretary Leon Panetta warned that the country is increasingly vulnerable to computer hackers who could dismantle such infrastructure as power grids, transportation systems and financial institutions. He said the U.S. faced the possibility of a "cyber-Pearl Harbor."

"An aggressor nation or extremist group could use these kinds of cyber tools to gain control of critical switches," Panetta said. "They could derail passenger trains or, even more dangerous, derail passenger trains loaded with lethal chemicals. They could contaminate the water supply in major cities, or shut down the power grid across large parts of the country."

Other nations face a similar threat.

Providing customers with solutions to prevent cyberattacks is a top focus for Boeing. Its state-of-the-art Cyber Engagement Center in Maryland is already tackling these challenges, in partnership with Information Technology's Cyber Security Monitoring & Response team.

"The team at the Cyber Engagement Center is fighting this fight to protect the

Boeing network 24 hours a day, 365 days a year," said Kevin P. Meehan, vice president and chief information security officer.

The Huntington Beach team can provide real-time data about a customer's networks and alternatives during cyberattacks or other disasters, allowing the customer to practice fighting through them, explained Richard Wada, Boeing's Information Security Solutions chief engineer.

"After mastering the scenario, our customers are prepared to win real battles in the real world and find solutions to ever-increasing and sophisticated cybersecurity threats," Wada said.

Specialized equipment like Cyber-Range-In-A-Box (CRIAB), with its ability to re-create large-scale cyber warfare in a controlled environment, also plays a key role at the lab. This mini-refrigerator-sized rack of equipment can emulate hundreds of computers.

"We helped one of our customers simulate their own computer network in CRIAB so they could test it for vulnerabilities," said Randy Siegel, cyber test and evaluation lead for the lab. "They used a good-guy-bad-guy scenario to pinpoint, and ultimately resolve, weaknesses in their defensive systems."

Cyber innovation is quickly adding to Boeing's cutting-edge Information Security Solutions business. The Huntington Beach team won its first cyber contract in 2008 and has since added six new customers with more in the pipeline, including international customers.

"Many of Boeing's customers are cyber-savvy and see Boeing not as a vendor but as a partner to help them come up with the right solutions," Beith said.

"Boeing has the right resources, the right people and the right facilities, like the Information Security Innovation Lab, to help customers deal with one of their most serious challenges today—protecting their networks against attacks." ■

dave.garlick@boeing.com

PHOTO ILLUSTRATION: From far left, Rich Wada, Information Security Solutions' chief engineer, focuses on creating innovative cyber solutions for customers; Randy Siegel, cyber test and evaluation lead, creates operational scenarios to test people and systems; Per Beith, director of Information Security Solutions, guides the team in this expanding domestic and international business.

BRANDON LUONG/BOEING; WADA AND BEITH PHOTOS: PAUL PINNER/BOEING; SIEGEL PHOTO: FRED TROILO/BOEING



Shaping the future

A dedicated team advances development of the Blended Wing Body concept

By Bill Seil and photos by Bob Ferguson

Bob Liebeck has always been fascinated by wings.

His doctoral thesis was “Optimization of Airfoils for Maximum Lift.”

During the Cold War, he designed wings for secret high-altitude airplanes. As a consultant, he has designed wings that boosted performance for racing cars that won Indianapolis 500 and Formula 1 races. He even designed the keel section for the yacht that won the America’s Cup in 1991.

Since 1989, much of Liebeck’s time has been devoted to an innovative concept called the Blended Wing Body, an airplane design that lies somewhere between a traditional “tube-and-wing” airplane and a flying wing.

Boeing and NASA since 2007 have been conducting flight tests of two unmanned Blended Wing Body prototype airplane designs—the X-48B and X-48C—at NASA’s Dryden Flight Research Center at Edwards Air Force Base in California. The results of the research, undertaken to benefit the aerospace industry as a whole, have been widely disseminated.

While Boeing has no plans to develop a Blended Wing Body commercial airplane, knowledge gained from these tests will be used to evaluate the potential for future military aircraft.

Liebeck, a Senior Technical Fellow in Boeing Research & Technology, now is the company’s chief scientist for Blended Wing Body research. The veteran engineer has won a number of industry awards, including the General Charles E. Yeager Award for Aeronautical Innovation and the Daniel Guggenheim Medal. In addition to his work at Boeing, he is a professor at the Massachusetts Institute of Technology and the University of California at Irvine.

He noted that the X-48B made 92 test flights and produced invaluable data.

“The challenge was to test the flight mechanics of the Blended Wing Body concept and prove we could maintain stability and control,” Liebeck said. “We thoroughly addressed these issues with the X-48B and got excellent results.”

Testing of the X-48C, which began in August, already is off to a good start. While the X-48B had three engines mounted on top and to the rear of the airplane, the X-48C has two engines. The most critical change was removing winglets located on the tips of the wings and replacing them with inboard vertical structures near the engines. Tests of the X-48C will determine which configuration is best.

“We didn’t put the engines on top of the airplane to reduce noise; we had other



PHOTOS: (Above) Members of the X-48C team prepare the aircraft for a test flight from the dry lake bed at NASA’s Dryden Flight Research Center at Edwards Air Force Base, Calif. From left, Dave Weston, X-48C safety officer, Phantom Works; Jonathan Vass, X-48C test conductor, Boeing Research & Technology; and Ted Rothaupt, X-48C test director, Boeing Research & Technology. **(Insets, from left)** A decal commemorates the 50th flight, which occurred with the earlier X-48B model, in April 2009; the X-48C, ready for another test flight at the Dryden; one of the two X-48C engine nacelles. **BOB FERGUSON/BOEING**

ng



“Everybody wants to work on the newest, coolest thing. ... It’s a very small team doing some very, very extraordinary work.”

– Mike Kisska, X-48 project manager



“A lot of very smart people have improved on the design over the years. It’s been a diverse team of people who have openly exchanged ideas and challenged one another.”

– Blaine Rawdon, co-creator of the Blended Wing Body concept

reasons for doing that,” Liebeck said. “But when we tested it in this configuration, we found, lo and behold, it was quieter.”

Well over 100 employees have participated in the Blended Wing Body program since it began at Boeing heritage company McDonnell Douglas more than two decades ago. The team has ranged in size from 10 to 20 people over the years, though there have been times when as many as 40 people

have been closely associated with the program. Most engineers working on the Blended Wing Body are also involved in other projects.

Mike Kisska, who has served as Boeing project manager for both the X-48B and X-48C, is responsible for ensuring that flight tests at NASA Dryden and engineering work at Huntington Beach, Calif., all come together. Kisska, 42, is delighted by his role in the

program, having wanted to work on Blended Wing Body development since he was a graduate student at Virginia Tech. He said employees working on the program often have stepped forward to volunteer, since “everybody wants to work on the newest, coolest thing.”

Kisska said the Blended Wing Body team is highly dedicated, with a strong attachment to the program that keeps them fully engaged.



“It’s a very small team doing some very, very extraordinary work,” Kisska said. “Some of the people working on flight test at Dryden have been living out of hotel rooms for six or more years. You have to love what you’re doing to make that sort of personal sacrifice.”

Two X-48 airplanes, built by Cranfield Aerospace in the United Kingdom, will likely be the last unmanned prototypes flown. Liebeck is hopeful the next tests will be of a manned demonstrator military aircraft.

Fay Collier, NASA’s project manager for the Environmentally Responsible Aviation Project, said NASA has long maintained an interest in the technology due to its promising potential—projecting ahead to technological advances by the

year 2025, a generation away, when such an airplane might be built.

Two of the challenges Boeing and NASA engineers addressed included developing low-speed flight controls for the airplane and finding a strong, lightweight material for its structure, Collier said. The flight controls issue was largely resolved during X-48B testing. For the airplane’s structure, researchers looked to a Boeing-developed composite manufacturing process called Pultruded Rod Stitched Efficient Unitized Structure, or PRSEUS.

“NASA and Boeing have maintained a very good relationship throughout this program,” Collier said. “We believe we have made some groundbreaking progress that will be broadly applicable

PHOTOS: (Clockwise from far left)

Ted Rothaupt, left, X-48C test director, and Jonathan Vass, X-48C test conductor, prepare the aircraft for a test flight at the Dryden Flight Research Center in California.

BOB FERGUSON/BOEING The X-48C takes off on its first flight, Aug. 7, 2012; the X-48B on an early test flight near the Dryden Flight Research Center. **NASA**





“One of the strengths of the program is the trust they have in people to do their job.”

– Jonathan Vass, X-48C test conductor, Boeing Research & Technology



in the industry.”

The idea of Blended Wing Body airplanes is an offshoot of a popular concept called the flying wing. Efforts to develop flying wing airplanes—or “tailless” airplanes—began in the 1920s and continued into World War II and beyond.

While flying wings and Blended Wing Body airplanes are similar in appearance, they have some important differences.

“Flying wings, whether they’re swept or unswept, look a lot like a big plank,” Liebeck said. But Blended Wing Body airplanes, he added, have a center similar to the fuselage of a traditional airplane.

“When we started researching this over 20 years ago, we made some comparisons to traditional tube-and-wing airplanes that were in service at that time,” Liebeck said. “We saw a potential for a significant reduction in fuel burn. So we decided that it was worth chasing.”

Liebeck and his team are still chasing that dream—and have high hopes for its future.

Their journey began in 1989, when NASA held an “aerodynamic renaissance” conference of aerospace professionals at its Langley Research Center in Hampton, Va. Its purpose was to explore whether there were effective alternatives to traditional tube-and-wing commercial airplanes.

Liebeck, then an employee of McDonnell Douglas, presented a paper at the conference that was on an embryonic Blended Wing Body commercial airplane. He didn’t realize when he presented it that it would change the course of his career.

Not long afterward, NASA offered a \$90,000 study contract to compare the Blended Wing Body concept to a tube-and-wing concept. “I gladly accepted the challenge,” Liebeck said.

Liebeck and two company engineering colleagues—Blaine Rawdon and Mark Page—got to work. Liebeck led the effort, with expertise in the areas of aerodynamics and wing design. Rawdon, who is still with the program, specialized in configuration and preparing conceptual drawings. Page, who has since left the company, had a strong background in flight mechanics, and stability and control.

Rawdon, now a Technical Fellow in Boeing Research & Technology’s Flight Sciences Technology group, said Liebeck was the driving force on the team. Their first job was to determine the basics of a Blended Wing Body airplane design.

“My job included real-time drafting on the computer, trying to sort out how all the pieces could fit together and satisfy the requirements,” Rawdon said. “From time to time, Bob and Mark would stand over my shoulder and we’d work various problems. It was all about figuring out what this thing would look like.”

At that time, the team didn’t realize the development program—which has received limited staffing and funding over the years—would still be going strong in 2012. But Rawdon said the long evolution of the program has had its benefits.

“Our present concept of a Blended Wing Body airplane didn’t pop up as a crystal-clear vision early on,” Rawdon said.

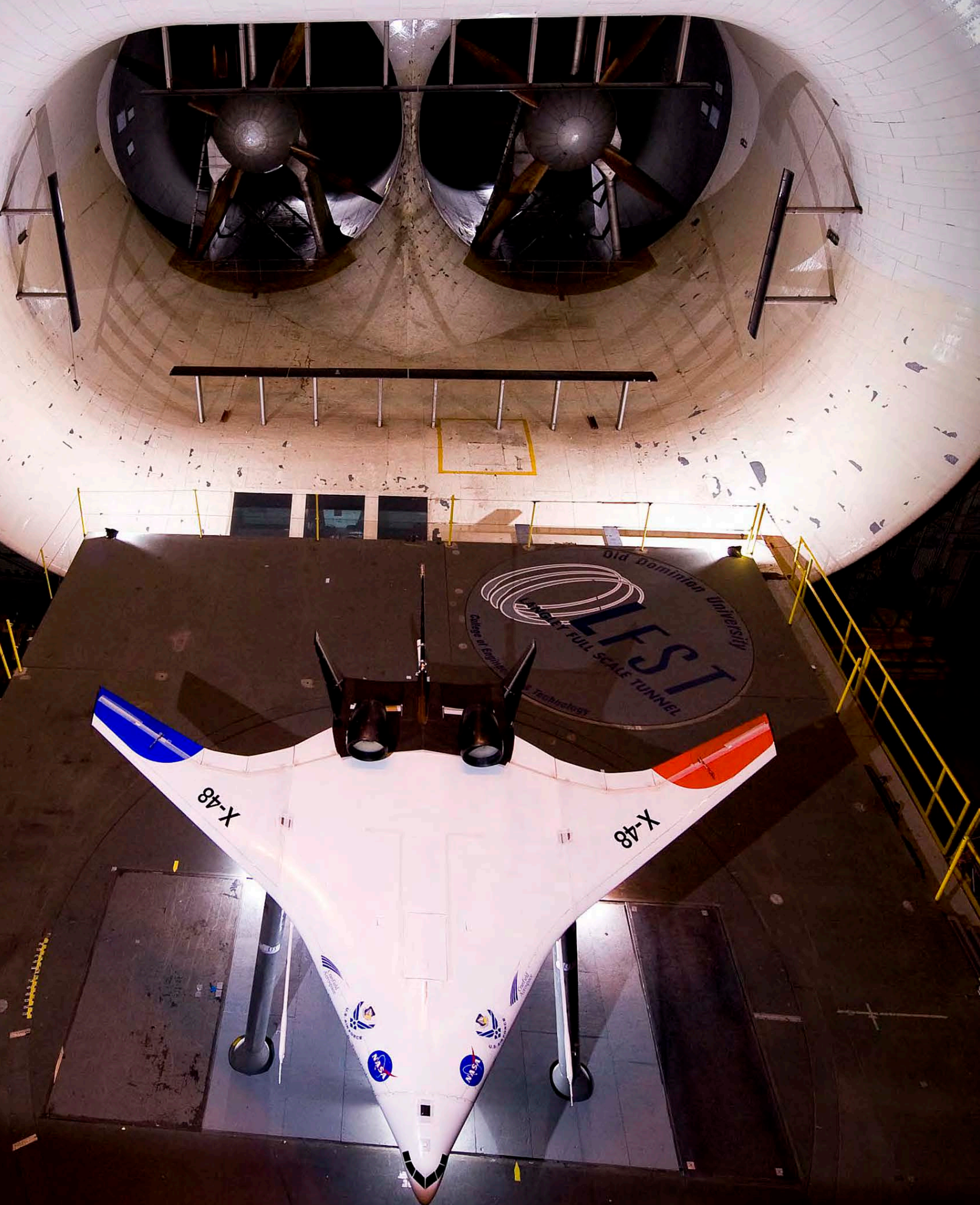
“A lot of very smart people have improved on the design over the years. It’s been a diverse team of people who have openly exchanged ideas and challenged one another. We’ve always had open, direct communication, and that makes it fun.”

At the end of the contract period they presented their results to NASA, noting they had found a strong potential for fuel savings. They were awarded a second \$90,000 contract to refine the concept. In 1994, NASA awarded McDonnell Douglas a \$3 million contract to study the technical and commercial feasibility of the concept.

Liebeck and his team partnered with NASA Langley Research Center, NASA Lewis Research Center (now the John H. Glenn Research Center), Stanford University, the University of Southern California, the University of Florida and Clark-Atlanta University.

One of the greatest challenges in designing a commercial Blended Wing Body airplane is cabin pressurization, Liebeck said. The circular fuselage of a

PHOTOS: (Opposite page) Bob Liebeck, left, chief scientist of the Blended Wing Body program, and Dave Weston of Phantom Works, the program’s safety officer. **(Above, from left)** An X-48C preflight briefing takes place in a hangar at NASA’s Dryden Flight Research Center; Ian Brooks, an instrumentation technician with Cranfield Aerospace, which built the X-48 aircraft, works next to one of the engine nacelles; two Boeing Research & Technology employees, John Sheen, left, flight controls engineer, and Ted Rothaupt, X-48C test director, download data from the X-48C following a test flight. **BOB FERGUSON/BOEING**



»»» *“The reason the Blended Wing Body program advanced to its current state is our 50-50 partnership with NASA.”*

– **Bob Liebeck, chief scientist, Blended Wing Body program**

PHOTOS: (Above) The X-48C undergoes wind tunnel testing at NASA’s Langley Research Center in Virginia in 2009.

(Insets, from left) Ian Brooks, instrumentation technician, left, and Alan Stevenson, systems engineer, both with Cranfield Aerospace, prepare the X-48C for a test flight at Dryden; David Klassman of NASA prepares the X-48C for engine start.

BOB FERGUSON/BOEING



tube-and-wing airplane naturally handles structural loads resulting from cabin pressurization, permitting efficient, light-weight skin structure. The flatter design of the Blended Wing Body fuselage, they thought, might need a stronger structure to accommodate pressure loads—and that could add weight.

“It was getting very complex,” Liebeck said. “Finally, I said, ‘Let’s assume we’ll be able to create a flat-sided pressure vessel and keep it at a relatively light weight.’ If you get cautious and constrain yourself too early in the design process, you’ll be haunted by that decision throughout the project.”

A solution to the cabin pressure problem was eventually found through the creation of PRSEUS, the innovative, lightweight composite material process.

In July 1997, the test team flew a remotely piloted subscale Blended Wing Body airplane at El Mirage Dry Lake in California. That aircraft, which had a 17-foot (5-meter) wingspan, was designed and built by Stanford University. The test took place just days before the merger of Boeing and McDonnell Douglas.

While Boeing Commercial Airplanes had other plans for the next generation of commercial jetliners, it continued to fund Blended Wing Body research. From 1997 to 2003, the program explored various concepts for a Blended Wing Body airplane, which ranged in size from 200 to 500 passengers. The studies were limited mainly to computer simulations and wind tunnel tests, and no flying models were built. NASA remained a dependable partner during this period and beyond.

“The reason the Blended Wing Body

program advanced to its current state is our 50-50 partnership with NASA,” Liebeck said. “They didn’t limit their support to sending checks. They provided wind tunnels for testing, along with a lot of technical support by NASA engineers.”

While the Blended Wing Body program had the potential to produce better results, research into the new design was far from complete when Boeing Commercial Airplanes decided to begin a new airplane program. It was considered not a viable option at that time, said Kouroush Hadi, director, Airplane Product Development, Commercial Airplanes.

Commercial Airplanes considered several alternatives for the next generation of jetliners—including the Sonic Cruiser—before finally deciding on the 787 Dreamliner, Hadi said. Extensive market research involving both airline customers and passengers clearly pointed toward an advanced tube-and-wing design. The 787 concept, with extensive use of composites, a new wing and technologically advanced new engines, produced major efficiency and environmental improvements, while also introducing significant passenger experience improvements. It was the right choice for a competitive market, Hadi said.

As Commercial Airplanes prepared to offer the 787 Dreamliner to airlines in 2003, it transferred funding responsibility for Blended Wing Body research to what was then Boeing Phantom Works—now Boeing Research & Technology—to focus on its unresolved issues as a commercial transport. Financial assistance also was provided by Boeing Integrated Defense



Systems (now Boeing Defense, Space & Security). NASA also continued to fund the program.

In 2006, Boeing signed a contract with the U.S. Air Force Research Laboratory at Wright-Patterson Air Force Base in Dayton, Ohio. With the support of NASA, it funded research to apply Blended Wing Body technology to military transports, tankers and bombers.

In September 2005, a cooperative agreement was signed involving Boeing, NASA and the Air Force Research Laboratory to conduct the X-48B flight-test program. The following year, the two 21-foot (6.5-meter) wingspan prototype X-48B test vehicles were built. The Air Force gave the program the “X” designation based on its interest in designing a flexible, long-range, high-capacity military aircraft using Blended Wing Body technology.

The X-48B flew for the first time on July 20, 2007, and went on to complete the 92 successful test flights. At the conclusion of this program it was converted to the X-48C configuration. The X-48C flew for the first time Aug. 7.

Jonathan Vass, a 32-year-old engineer, has served as test conductor for both the X-48B and X-48C test programs. He joined Boeing in 2005 after getting his master’s degree from the University of California, Irvine, where he took classes from Liebeck and later served

as his teaching assistant.

Vass has found the program to be an exciting opportunity to broaden his skills and experience. After starting the program running computer code, he was given an opportunity to participate in wind tunnel testing at NASA Langley—and then processing some of the wind tunnel data. He then moved on to becoming a flight-test ground control system manager at NASA Dryden. This opened an opportunity for him to serve as a test conductor, where he coordinates multiple activities during flight test.

“One of the strengths of the program is the trust they have in people to do their job,” Vass said. “It’s been very challenging, because each of the jobs I’ve taken on has required a new skill set. Flight test is particularly rewarding, because it’s fast-paced and you have the responsibility to get the plane home safely. You’re also getting good data that will be used by teammates to advance the program.”

The Blended Wing Body research aircraft recently completed the 100th flight since the X-48B model lifted off the dry lake bed for the first time at the NASA Dryden center in California’s high desert that July day in 2007. The Boeing-NASA team expected to fly the X-48C approximately 20 more times through the end of this year.

For Liebeck, it is the continuation of a journey that began some 20 years ago, when he presented that conference paper on what was then just an idea, a concept, that perhaps there are alternatives to the traditional tube-and-wing airplanes.

“Boeing and NASA for more than two decades have been steadfast in exploring this technology,” Liebeck said. “It will be exciting to see how it develops over the next 20 years.” ■

william.j.seil@boeing.com

To learn what it’s like to remotely “pilot” the X-48C, view a video at: www.boeing.com/Features/2012/12/corp_x48ctestpilot_12_07_12.html



“We believe we have made some groundbreaking progress that will be broadly applicable in the industry.”

– Fay Collier, NASA project manager for the Environmentally Responsible Aviation Project

PHOTOS: (Above) Members of the X-48C team remove the aircraft from its transport trailer to prepare it for a flight test from the lake bed at NASA’s Dryden Flight Research Center. **(Insets, from left)** The X-48C ground control station plays a critical role during test flights; the X-48C is housed in a hangar at Dryden; Rod Wyatt, left, crew chief, Boeing Research & Technology, and Ian Brooks, instrumentation technician, Cranfield Aerospace, weigh the X-48C for post-flight data analysis.

BOB FERGUSON/BOEING

Test of imagination

Boeing teams must be ready to test what doesn't yet exist

By Jennifer Hawton



In a small office in Albuquerque, N.M., Jeff Waitkus, a Boeing Test & Evaluation engineer, is busy planning tests—for a product that doesn't yet exist.

Over the past several years, Directed Energy Systems and the Boeing Test & Evaluation team in Albuquerque have been collaborating to test and enhance new kinds of lasers powered by solid-state materials instead of caustic chemicals. This has significantly reduced the size of a laser needed to create the same power. The chemical-powered Airborne Laser, for example, was carried on a 747. Now, the new laser concepts are intended to be flown on small jet fighters or even attached to gun mounts on ships.

And these new lasers need to be tested—efficiently, precisely and reliably.

"I may not know what's coming down the pipeline, but I know we have to be prepared to accurately test and evaluate whatever our program partners dream up," Waitkus said. "That's why it's important for us to be close with our partners. What they dream, we must test. And before we test it, we need to test the test."

Laboratory test teams with Boeing Test & Evaluation are often required to anticipate and prepare equipment and plans to test the next new thing. Devising tests early speeds the process of developing new products and validates the quality of the innovations in them.

Take the work that's being done at the Material Measurements Lab in St. Louis, which characterizes the interaction of electromagnetic signals with various materials. Because many of Boeing's products use materials that are exposed to electromagnetic signals, the lab must develop tests to understand how certain materials dampen, amplify or otherwise affect these signals.

Lydell Frasch, a Technical Fellow in electromagnetics at the lab, said one of the latest test innovations from the team there involves a new approach to measuring changes to electromagnetic signals that interact with materials in high-temperature environments, such as those on the control surfaces of a wing during very high-speed flight.

The lab's challenge, he explained, was akin to making a call from a mobile phone in an airplane and measuring how the electromagnetic energy changes as it interacts with the cellphone case, the seats and many other things the electromagnetic waves must pass through. Now imagine

trying to test that at 2,000 degrees Fahrenheit (1,100 Celsius), Frasch said.

The standard fixtures used for these tests were deforming and oxidizing at the high temperatures, according to Frasch. So the team had to find new materials to re-create real-world conditions. Metallic alloys capable of withstanding higher temperatures, such as stainless steel, were used to fabricate new fixtures. New measurement procedures were adopted to reduce test times, which reduced the exposure of the test fixture to higher temperatures.

For this St. Louis test team, and others with Boeing Test & Evaluation, good communication with product development teams is essential.

In Philadelphia, for example, work is under way on a new test stand for the large Boeing wind tunnel there—which will be used to test new and innovative rotorcraft blades.

"About three years ago, we started seeing a significant increase in requests for proposals and contracts for improving rotor-blade performance," said Bill Grauer, senior manager of the wind tunnel. "We knew our current test stand wouldn't be up to the job."

Grauer talked with Rich Bussom, Associate Technical Fellow and program manager for Advanced Mobility Systems in Boeing Defense, Space & Security, and together their teams started to focus on future rotorcraft blades.

Rotor-blade technology has reached the limit of what can be done with fixed shapes, Bussom said. So the team developed

"What they dream, we must test. And before we test it, we need to test the test."

— Jeff Waitkus, Boeing Test & Evaluation engineer

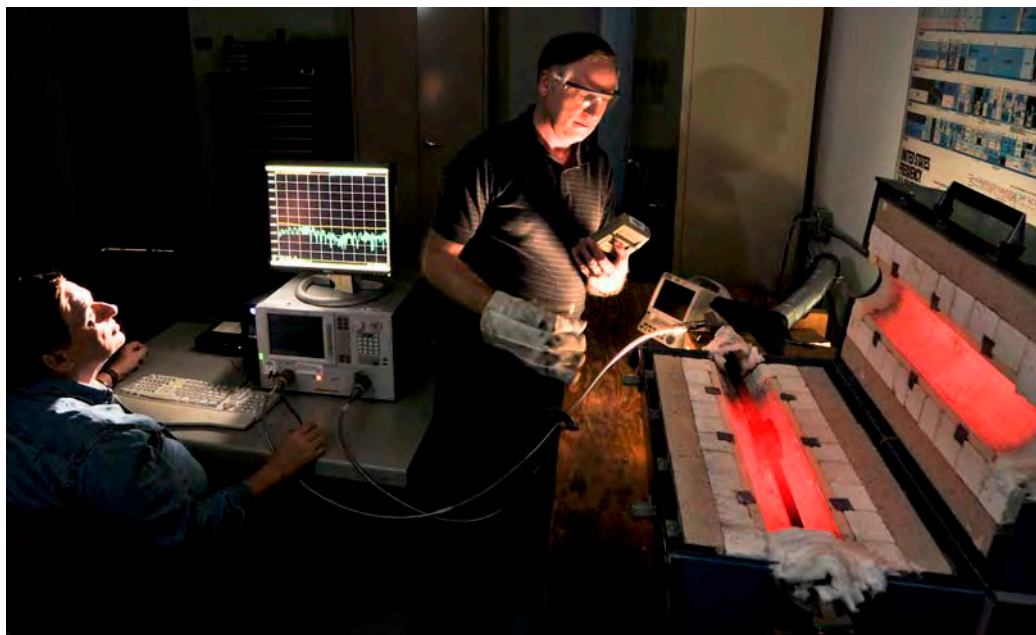
powered rotor blades whose shape can morph and adjust to dynamic conditions.

The Boeing Test & Evaluation team now is racing to get the new rotor test stand created, built and tested before the advanced rotor team is ready to test their first product in June.

"The new test stand," Grauer said, "has more power, more data ports and adaptability so it can support the next generations of rotors that Rich's team dreams up." ■

jennifer.d.hawton@boeing.com

PHOTOS: (Left) Marty Lecloux, left, wind tunnel mechanic, and Jim Corrado, wind tunnel instrumentation engineer, perform preflight inspection of a rotor test stand. **FRED TROILO/BOEING (Below)** Lead technician Ray Rose, left, and Technical Fellow Lydell Frasch developed the X-Band waveguide test fixture, shown in the St. Louis Material Measurements Lab, to measure electromagnetic signals in high-temperature environments. **RON BOOKOUT/BOEING**





FOR ACCESS ONLY
SUPPORT DOOR AT
CLOSE WITH EXTENSION

KEEP HANDS
OFF DOOR
WHICH MOVES
DOOR CLOSED

DOOR

老朋友

‘Old friends’

Boeing and China have forged a strong relationship that goes back 40 years *By Eric Fettaers-Walp*

Aerospace technicians in Shanghai are maintaining and repairing Boeing 777s, while far to the west, workers are building composite rudders for the 787 and wing components for the 747-8. In Beijing, sales representatives meet with potential customers in Boeing China’s headquarters.

In a typical day, more than 6,000 people are working for Boeing, its joint ventures and subsidiaries across China, a growing presence in a nation that represents the world’s second-largest aviation market. It’s also something not envisioned two generations ago.

The historic visit of a U.S. president 40 years ago, and the subsequent initial order for 10 Boeing 707 jetliners from China’s aviation authority, opened the door between Boeing and the Chinese government. Since then, Chinese airlines have ordered more than 1,000 Boeing jetliners and are projected to need more than 5,200 new airplanes in the next 20 years. China’s population is four times that of the United States, but Chinese airlines still have only one-fourth as many commercial jetliners as U.S. airlines.

“It’s the world’s most populous nation, it’s the second-largest economy and the fourth-largest nation in area,” said Shep Hill, president of Boeing International and senior vice president of Business Development and Strategy.

“It’s an incredibly important market to Boeing, and one we’ve had a large share in.”

As a market for Boeing’s airplanes, China’s potential isn’t difficult to see. Not as visible is the growth of Boeing services in China—and the company’s numerous relationships with suppliers and partner companies there.

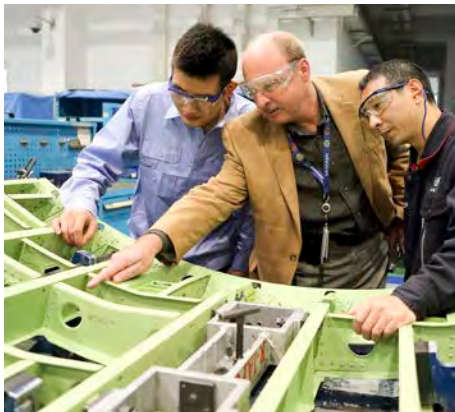
China’s role as a supplier for Boeing and its heritage companies started shortly after Boeing sold its first airplanes to Air China. More than 6,000 Boeing jetliners—about 60 percent of those operating around the globe—include significant structural components from Chinese manufacturers. That makes Boeing the largest foreign-based buyer of aerospace equipment and components from China. Among the jetliners for which Chinese aerospace firms are producing parts are the 787 Dreamliner and 747-8.

Additionally, Boeing has a stake in several joint ventures that produce such components, including Boeing Tianjin Composites Co., which makes structures and interior parts used in all Boeing commercial airplanes.

Other joint ventures also are on the rise, including TAECO in Xiamen, which plays a large role in converting used 747 passenger planes into freighters. In October 2009, Boeing Shanghai Aviation Services, a joint venture with Shanghai

GRAPHIC: (Above) Chinese calligraphy for “old friends.”
PHOTOS: (Left) A 767 undergoes a heavy maintenance check at Boeing Shanghai Aviation Services. (Right) Performing an end-of-lease 737 check and interior upgrade at Boeing Shanghai. YONG HE





“It’s fair to say Boeing’s an old friend to China. That matters. Boeing’s respected here and the airplanes are admired.”

– Marc Allen, president of Boeing China

Airport Authority and China Eastern Airlines, opened hangar doors to support modification, maintenance, repair and overhaul services at Shanghai’s Pudong International Airport. Also in Shanghai, Boeing recently expanded its Flight Services business, adding an advanced 787 Dreamliner training suite and a 747-400 full-flight simulator to the training campus’ 757/767 full-flight simulator.

“Our presence in China has really taken a robust shape the past 10 years,” said Marc Allen, president of Boeing China. “It’s fair to say Boeing’s an old friend to China. That matters. Boeing’s respected here and the airplanes are admired.”

It all began with a high-profile Boeing aircraft touching down in Beijing in February 1972. U.S. President Richard Nixon traveled there aboard Air Force One—and then a Boeing 707—and became the first president to visit since the People’s Republic of China was established in 1949. Because it was the first Boeing jetliner to land in the country, Chinese workers had to specially build a compatible portable stairway. During that visit, Nixon met with Chairman Mao Zedong and Premier Zhou Enlai and issued a joint agreement to improve diplomacy between the two countries.

Within months, China ordered 10 707s for its airlines, opening the market for Boeing. Air China took delivery of the first 707 to arrive in China. The airline has since ordered more than 100 jetliners from Boeing, including 777-300ERs (Extended Range), 787s and the 747-8.

“Such a fleet expansion will definitely

inject new power into Air China,” said the airline’s chairman, Wang Changshun, noting that Boeing models now constitute 60 percent of Air China’s fleet.

Liu Shaoyong, chairman of China Eastern Airlines, added that Boeing’s influence on improving aviation safety in China through its training of Chinese aerospace workers can’t be underestimated, either.

“Boeing has done a lot of work regarding China’s air traffic management, executive development and training for services,” said Liu, whose China Eastern Airlines flies Boeing 737s and has ordered 20 777-300ERs. “We step to the global arena with the help of Boeing.”

China and Boeing similarly are moving forward with the establishment of Boeing Research & Technology–China, collaboration with the Chinese Academy of Sciences and other Chinese universities, and a new joint Boeing-COMAC Aviation Energy Conservation and Emissions Reductions Technology Center in Beijing, which will research aviation biofuels.

To inspire the next generation in China, Boeing sponsors the Soaring with Your Dream aerospace education project, which has involved more than 45,000 elementary school students since 2009. This summer, Boeing helped introduce the FIRST—For Inspiration and Recognition of Science and Technology—robotics contest to high school students in Beijing.

Because many people in China experienced their first flight on a Boeing jetliner, the company’s name carries

with it fond feelings among many, said Boeing’s Hssane Mounir, vice president of Sales and Marketing for Northeast Asia, Commercial Airplanes.

But building on that name means Boeing needs to continue building relations and keeping promises to customers in China, he said.

“The best opportunities we have are to continue to partner with the airlines and satisfy their growth demands going forward,” Mounir said. “We have the best products, we work closely with them and the government agencies, and we continue to look for better ways to work with them.” ■

eric.c.fetters-walp@boeing.com

PHOTOS: (Above left) Barry Livingston, center, Boeing Asia Supplier Quality team leader, works with Chengdu Commercial Aircraft Company (CCAC) mechanics mentoring and reviewing workmanship on 737 doors. **(Above center)** Boeing’s Russ Whitten, left, Manufacturing Integration Center Satellite Supplier Quality representative, reviews workmanship of a 747 spoiler with CCAC mechanic Gong Yu Lin, center, and Boeing CCAC site leader David Crane. **YANG WEIHUA (Above right)** Engine inspection at Boeing Shanghai. **YONG HE (Opposite page, from left)** Boeing’s Ivan Kwok, Mina Chen and Chao “Joseph” Zhou. **LIU ZHIJIAN**



Amazing growth

Once, Chinese workers in search of better opportunities moved across the ocean to the United States. That's what Ivan Kwok's family did generations ago.

But today, Kwok, who was born and raised in the United States, is helping Boeing build on its experience to prepare for the future in China. The transformation of that nation's aviation industry is evident just in the six years he's lived there, Kwok said.

"Saying there are boundless opportunities in China would be an understatement," said Kwok, operations engineering chief for Boeing Tianjin Composite and a China field operations site leader. He said Boeing is well-respected in China, and the government's efforts to promote aerospace and aviation infrastructure has given the industry a particular prestige.

Kwok joined Boeing 15 years ago and served on several assignments throughout Asia before settling in China. In addition to realizing the opportunities for Boeing, Kwok said his time spent in China has given him insight into his family's heritage.

"You might think I would understand China better than most, but truthfully, I didn't fully understand my parents until I started working here," he said. "The perspective I had has completely changed, as I am beginning to learn and appreciate everything around me."

Taking flight

Mina Chen remembers a time not so long ago when most people she knew only dreamed about flying in airplanes.

That's all changed. Beijing is planning to build another airport designed to handle the same number of passengers as New York City's John F. Kennedy International Airport and London's Heathrow Airport—combined.

"As the economy is developing, nowadays it's very common to travel by air," said Chen, who joined Boeing Research & Technology last year. "And we can find more and more Boeing airplanes in China."

Chen works with researchers from universities and institutes in developing biofuels for aviation. She performed similar research while earning her master's degree at the Chinese Academy of Sciences before she joined Boeing.

"As an environment researcher, I really hope I can have some effect on alternative fuel research," Chen said. "And Boeing-China provides the platform for me."

Chen is also excited about other Boeing research projects in China, such as in the field of aerospace materials and cabin design. And she is proud of Boeing's corporate citizenship work there. On the company's Global Day of Service this past summer, she joined Boeing employees around the world who volunteered for community service.

An enduring reputation

When Chao "Joseph" Zhou joined Boeing's Beijing-based office in 1998, he stood out among the field service representatives. He was the first locally hired employee, the only one born and raised in China.

Zhou was well-prepared for the role. His early interest in aviation led him to study engineering and flight control at the Beijing University of Aeronautics and Astronautics. After graduation, he worked for the Aviation Industry Corporation of China and pursued a master's degree in engineering.

When he was hired at Boeing, the company was just beginning to step up its presence and partnership with Chinese firms. Now, with scores of locally hired employees in China and a greatly expanded business there, he sees many more opportunities.

"There are many things I enjoy about my job," he said. "But if I had to pick one, I would say it's the fun of working with different people and teams within Boeing—the best teams of professionals you could ever work with in this industry."

Boeing's reputation, Zhou said, has continued to grow in his country as China's airlines have stepped up their airplane orders. "Boeing carries a big name in China," he said.

TANKER

Next year is critical for the new Air Force tanker, but 'One Boeing' teams are fueled and ready

By **Kymerly Vandlac**

At first glance, it seems to be an ark or some other kind of wooden boat taking shape behind the walls of an inconspicuous building a few blocks from the Everett, Wash., factory where Boeing assembles its twin-aisle commercial jetliners.

The enormity of what are soon recognized as sections of a full-sized 767 airplane is remarkable. Even more so are the materials from which this mock-up is made.

It's a paper, wood, plastic and foam airplane, with a foam cockpit, wood switches and paper monitors, and it's strong enough for a person to stand in.

As the countdown continues toward assembly of the first KC-46A tanker for the U.S. Air Force—a next-generation tanker based on the 767—the mock-ups in the Tanker Validation Center are crucial first steps toward streamlining the assembly process for when production begins next summer. The tanker, known in the factory as the 767-2C, will be built on the same line in the Everett plant as the rest of the 767 family.

"Modern computer simulations serve a purpose, but it is also important to see, feel and understand all of the

ergonomic and assembly line challenges upfront," said Allan Kremenich, 767 manufacturing engineer. "That way you can walk through changes prior to putting them on the assembly line."

Engineers on the tanker program are using the models to explore and understand everything from wiring and designs to ergonomics and safety, and how to best integrate the tanker into the 767 production floor.

"The large-scale models have played a big part in helping the team identify the best possible build for our U.S. military customer," Kremenich said.

Work being performed at the Tanker Validation Center is but one element of the "One Boeing" approach on the all-important tanker program. Utilizing the resources and people of the entire company working together toward a common goal was key to Boeing beating EADS, the parent of Airbus, to win the Air Force tanker competition in 2011. Boeing will build 179 tankers as replacements for aging KC-135 tankers operated by the Air Force, which now average about 50 years old.

Boeing must deliver the first 18 combat-ready tankers to the Air Force by the

"We have put processes in place to ensure quality and accuracy the first time—we are ready and excited to begin."

— *Richard Duncan, 767 airframe team lead*



PHOTOS: (Left) Full-scale models at the Tanker Validation Center are used to help streamline the planned assembly process when KC-46A tanker production begins next summer. **(Right)** Looking up at the aft fuselage of a 767 commercial jetliner on the Everett, Wash, assembly line.

BOB FERGUSON/BOEING

POWER





“Men and women in uniform deserve the very best. They are counting on us. No matter how big or small our job, each of us plays an important part.”

— Tom Fisher, 767 wing mechanic

end of 2017. The One Boeing way of doing business that helped win the tanker competition will be critical to the company's success in meeting this and other important deadlines along the way, including a key program review in 2013.

Boeing has merged hundreds of employees from Commercial Airplanes and Defense, Space & Security—at dozens of sites across the United States—to develop and build the tanker, which will be a variant of the 767-200ER (Extended Range) commercial jet.

Even though the tanker is a BDS program, about 60 percent of the employees assigned to the program are from Commercial Airplanes, which has built and delivered more than 1,000 767 passenger planes and freighters over the past 30 years.

“What I've seen so far is passionate people who want to deliver a jet to the warfighter and want that jet to be as inexpensive as possible, as quality-oriented as possible and as robust as possible,” said Maj. Gen. John Thompson, Air Force Tanker Program executive officer and KC-46 program director. “We're on a really good track.”

Maureen Dougherty, Boeing KC-46 vice president and program manager, said the team is on schedule for the next major Air Force contract milestone, the Critical Design Review, set for next summer.

This review will determine whether the design of the KC-46A is mature and ready to proceed to the manufacturing phase. When it does, the program will be able to draw on the experience of hundreds of 767 factory employees.

Richard Duncan, 767 airframe team lead with 20 years' experience, is preparing his team now for the start of the production process.

“My team literally crafts the starting point for the airplane build. We must be very precise in everything we do,” Duncan said. “We have put processes in place to ensure quality and accuracy the first time—we are ready and excited to begin.”

Tom Fisher, 767 wing mechanic, who relocated from Long Beach, Calif., to Everett, brings experience and skills as a team leader on the C-17 military transport.

“Men and women in uniform deserve the very best,” Fisher said. “They are counting on us. No matter how big or small our job, each of us plays an important part.”

That sense of pride is shared by many others, including Rob Fink, a 767 manager and U.S. Army veteran who recently transferred to the 767 program.

“Working on the tanker,” Fink said, “gives me the opportunity to be a part of something bigger—to contribute to the men and women in the military today.”

Pulling together so many people from across the company was not without challenges. The KC-46 tanker team working at an assembly center in the Seattle suburb of Tukwila is a good example. They build the refueling booms.

When it was announced last January that Boeing's site in Wichita, Kan., would close, the team started the move to Seattle within a few months.

“Getting the assembly center up and running quickly was no small task,” said Jerry Lazar, manager of the KC-46 Tanker Finishing Center.

“For me, after 29 years in Wichita, it was tough to balance the personal decision to relocate to Puget Sound and also guide impacted employees.”

The facility opened on schedule in October. Testing of the first boom is scheduled to begin in the third quarter of 2013 at a System Integration Laboratory. Five laboratories supporting integration and testing of various military systems on the tanker—four at Boeing Field, a fifth in Everett—are scheduled to be operational by the end of 2013.

“The greatest reward,” Lazar said of getting the facility up and running, “was witnessing the collaboration and commitment of the team, all the while maintaining focus on the common goal—exceed customer expectations and produce the highest-quality boom.”

After assembly of each tanker in Everett, the planes will be flown to Boeing Field, where the refueling booms will be attached along with other military equipment.

But much work remains until that first tanker is ready to roll out of the Everett plant.

“The priorities for the coming year are significant—completing a successful critical design review,” said Thompson, the Air Force general in charge of the program.

“I have every confidence that we'll get there.” ■

kymberly.y.vandlac@boeing.com

GRAPHIC: (Top) The KC-46A tanker will feature advanced technology including a digital flight deck with Boeing 787 Dreamliner electronic pilot displays and a state-of-the-art air refueling operator station. **BOEING**

PHOTOS: (Far left) Jaydee Dyess, 767 Tanker Validation Center, inspects an actual-size mock-up of the wing center fuel tank. **BOB FERGUSON/BOEING**
(Left) Brad Storey, boom assembly mechanic, begins work on the first refueling boom being built at Boeing Field in Seattle. **JIM ANDERSON/BOEING**

Excellence without borders

Regional teams help navigate the complexities of operating internationally

By Bill Seil

Boeing has more than 9,000 employees based in 70 countries outside the United States, and each day they face new challenges involving the laws, regulations and customs of individual countries and jurisdictions.

"If you're going to put an employee or inventory into an overseas location, that inevitably triggers a number of compliance requirements with local laws and regulations," said Paul Kinscherff, chief financial officer for Boeing International.

John Demers, Boeing International's general counsel, added, "We need to conform to local rules, while efficiently pursuing our business objectives. This can be challenging, considering the number of jurisdictions in which we do business."

But operating internationally recently became easier than ever for Boeing—and for employees.

Five newly created regional teams, representing the functions on the Boeing International leadership team, are prepared to help with a wide range of issues, large and small. It could be providing assistance with legal and financial matters, global staffing support, information technology setup or furnishing new facilities. In the Middle East, for example, the group has begun to tackle visa issues in a systematic fashion to make it easier for Boeing to move people in and out of region.

Whatever the need, the purpose of these Boeing teams is to serve as "one-stop shops" to support the local Boeing International and business unit leaders.

"We have designed an elegant and effective solution to address our global challenges and opportunities," said Shep Hill, president, Boeing International, and senior vice president, Business Development and Strategy. "It gives our business units an important new tool to operate internationally and projects a unified 'One Boeing' presence in the countries where we do business."

The teams are called Regional Functional



“The creation of these regional councils is a great idea.”

– Al Bryant, managing director, Boeing Research & Technology–Brazil

Councils, and they cover five geographic regions:

- Europe, Turkey, Russia and Israel
- The Americas, outside the United States
- The Middle East, India and Africa
- Southeast Asia and Australia
- Northeast Asia, including Japan, Korea and China

Hill said the new structure creates an efficient way to get expert assistance when navigating the complexities of foreign laws and regulations. It also creates a system for sharing best practices, and making sure that mistakes made in one country aren't duplicated in another.

The five regional councils were launched by Boeing International earlier this year. Each has a core team of representatives from Shared Services Group, Human Resources, Finance, Law, Information Technology, Global Trade Controls, Ethics and Communications.

Daniella Turner is the Shared Services representative to the Regional Functional Council for Europe, Turkey, Russia and Israel.

“It's very much in its infancy, but we're all excited by its potential and committed to making it work,” she said. As an example of how well the new structure is working, Turner explained that the regional council she is on has already reviewed requirements for the 787 Dreamliner's entry into service in the region, with the “goal of ensuring full and coordinated functional support.”

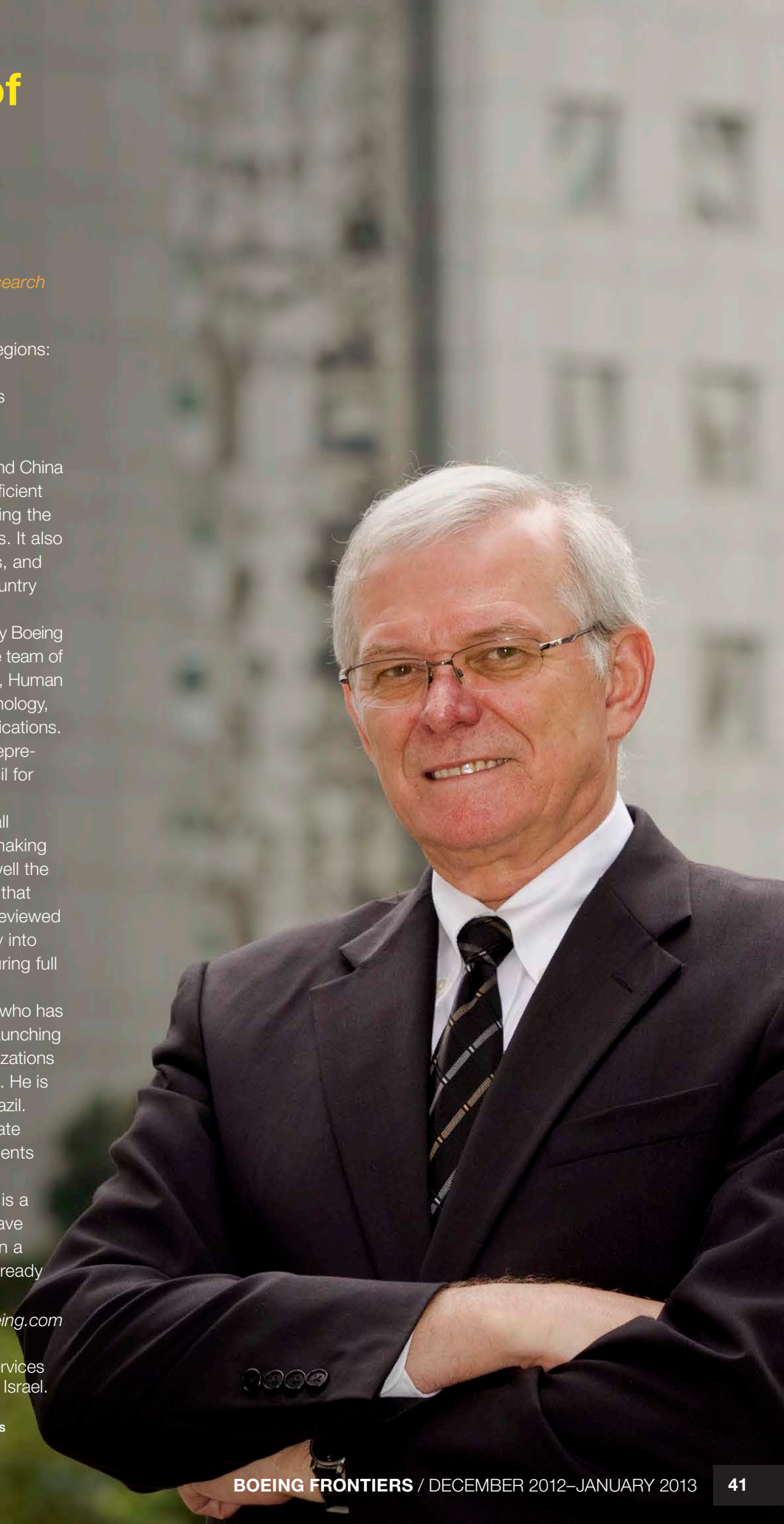
That enthusiasm is echoed by Al Bryant, who has had the responsibility—and challenge—of launching three Boeing Research & Technology organizations in Australia, China and, most recently, Brazil. He is currently managing director of the one in Brazil.

In each case, Bryant said he had to create “mini-teams” to tackle the special requirements of each unique operation.

“The creation of these regional councils is a great idea,” Bryant said. “My mini-teams have gotten the job done, but it would have been a real timesaver to have one regional team already in place each time I started a project.” ■

william.j.seil@boeing.com

PHOTOS: (Left) Daniella Turner, Shared Services Group regional director, Europe, Turkey and Israel. **(Right)** Al Bryant, managing director, Boeing Research & Technology–Brazil. **ASSOCIATED PRESS**



All the right moves

When it comes to aircraft financing, Boeing Capital Corp. charts the course

By John Kvasnosky

When major Boeing customer Southwest Airlines decided in 2012 to exit early from its significant Boeing-leased 717 fleet at its AirTran subsidiary to become an all-737 operator, the outcome could have had a significant financial impact on Boeing.

But the company's aircraft financing and leasing unit, Boeing Capital Corp., working with Commercial Airplanes Sales, Finance and Commercial Aviation Services, crafted an innovative "One Boeing" solution that enabled a deal between Southwest and Delta Air Lines.

Delta would sublease all of AirTran 717s.

"We found a way to let Southwest honor its obligation but do what they must, and give Delta, a good customer, a better solution than a competitor's new airplanes," said Mike Cave, president of Boeing Capital.

"Together we solved it in a 'win-win-win' fashion," Cave added.

For Boeing Capital and its team of 160 employees, finding solutions to customer requests starts with some "must do's," according to Cave.

"Our stated goal is that Boeing loses no campaign as a matter of customers being disadvantaged in financing, and

that no delivery will be missed due to financing," Cave said, adding that Boeing Capital's close collaboration with Commercial Airplanes on meeting customer expectations continues to yield impressive results for the company.

Dave Edgerton, Boeing Capital's vice president for risk management, said strategic actions taken with the unit's sizable aircraft portfolio such as the Southwest-Delta deal, as well as selling some older airplanes and placing available 717s at three operators during 2012, delivered solid results for Boeing.

"Making the right portfolio moves yields multiple benefits, including generating cash and earnings for Boeing, so we can deliver



on our financial commitments—and it reduces our risks as we move ahead to help us stay healthy,” Edgerton said.

Cave added that one of Boeing Capital’s highest-yielding investments is its people—and a workplace culture that is based on teamwork and values.

“We don’t have a handful of people in a smoke-filled room who define what good business is,” Cave said. “Ours is an inclusive process. We deliberate as a team and, as a result, we get better solutions and implementation is also smoother. If we focus on values, we do a better job. They’re a competitive advantage.”

That approach successfully guided Boeing Capital through a challenging 2012, he said, and will continue to do so in 2013.

“Our job is to look out a couple years and work with financiers to develop funding sources for Boeing commercial airplane deliveries,” Cave said. “We’re charting the course through our annual aircraft financing forecast. We do it in our customer support role and in our leadership role for industry. We set the tone.”

Airlines picking up new Boeing jets have been less challenged than others in borrowing funds, and Cave credited this to the attractiveness of those airplane assets. Also, jetliner production continues to increase in response to demand.

To keep sufficient financing available for Boeing aircraft deliveries, Boeing Capital works to energize financiers about aircraft investment through an aggressive schedule of global events for bankers, investors—even the appraisers who set airplane values. These sessions experienced record attendance in 2012, said Tim Myers, who leads Boeing Capital’s financial stakeholder efforts as vice president and general manager of Aircraft Financial Services.

“Our role is to be out there, whether it’s working with the financiers, the rating agencies that rate customers’ deals or the institutional investors,” Myers said. “Our job is to influence how they feel, and inspire them to want to invest in our products.” ■

john.kvasnosky@boeing.com

PHOTO: Tail fins and winglets of Southwest Airlines and AirTran 737s. SOUTHWEST AIRLINES



A LOT OF HISTORY

National airline of Poland continues to make aviation ‘firsts’ with Boeing

By Fiona O’Farrell



In 1989, Poland’s national airline, LOT, became the first carrier in Eastern Europe to operate Western aircraft.

That plane, a Boeing 767-200, began the airline’s fleet renewal program.

Last month, LOT Polish Airlines made history with Boeing again, when it became the first European carrier to take delivery of the 787 Dreamliner. The airline has seven more 787-8s on order.

LOT Chief Executive Officer Marcin Pirog led a delegation that included Polish political representatives and Polish media to Seattle to take part in celebrations surrounding that 787 “first.”

When the delivery flight arrived at Warsaw’s Chopin Airport, the arrival celebrations were attended by 1,500 people, including senior political figures, airline customers and LOT employees.

“I know that the 787 Dreamliner

product we are offering our passengers will exceed all of their expectations,” Pirog said. “Being the first European airline to operate this wonderful machine makes everyone at LOT extremely proud.”

Established in 1929, LOT is one of the world’s oldest airlines still in operation. It began international service in August 1929 with a route from Warsaw to Vienna, and was accepted into the International Air Transport Association in 1930. The association represents most of the world’s international airlines, which must meet stringent criteria for admission.

Today, LOT operates routes to more than 60 destinations in Europe, North America, Africa and Asia, with a fleet of 39 aircraft. In addition to the 787, LOT’s Boeing fleet includes 737s, 757s and the 767-300ER (Extended Range). The airline also operates passenger jets from

Brazilian airplane-maker Embraer.

“LOT is a great customer to work with—its heritage is part of the company’s DNA—and everyone at Boeing is so proud to do so,” said Marc Chere, the Boeing Sales director responsible for the airline. “LOT has a special place in the heart of the Polish nation, and it was truly an honor to be part of the huge celebrations when the 787 joined LOT’s fleet.”

After a series of short flights within Europe in December, LOT’s first 787 will begin long-haul service in January. It will replace the 767 on the airline’s route from Warsaw to Chicago, which has a special place in the heart of the Polish nation. Chicago is home to the largest population of Poles outside Poland. ■

fiona.ofarrell@boeing.com



PHOTOS: (Above left and right) Archival photos from LOT Polish Airlines. **LOT ARCHIVES**
(Above center and below) Marcin Pirog, CEO of LOT, in front of a 787 Dreamliner engine; the first 787 for LOT. **GAIL HANUSA/BOEING**

SPEED TO BURN

With engines in full afterburner, two Boeing F-15C Eagles from the Oregon Air National Guard's 142nd Fighter Wing fly above the Oregon Coast during a night training mission in September. The fighter wing performs the Air Sovereignty Alert missions to safeguard the Pacific Northwest. Afterburners provide an increase in engine thrust, usually for takeoff or combat situations. The pattern in the engine exhaust is referred to as shock diamonds or Mach disks. PHOTO: JIM HASELTINE/HIGH-G PRODUCTIONS







**ONE PARTNERSHIP.
ENDLESS POSSIBILITIES.**

The 787 Dreamliner's debut for Air India celebrates a historic moment in the 70-year partnership that Boeing shares with India. It heralds a new technologically advanced era for Indian civil aviation. As this partnership continues to soar, the possibilities of what more it will achieve are, indeed, endless.

