



Frontiers

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Soaring ahead

Unmanned systems represent a fast-growing Boeing business



Whether performing reconnaissance in the ocean depths, helping soldiers and emergency responders safely investigate hazardous situations, or keeping watch over an unsuspecting enemy from high above, unmanned systems perform a variety of critical missions. Boeing is establishing itself as a major player in this fast-growing market, with a varied portfolio of products for use in the air, at sea or on land.

COVER IMAGE: THE SCANEAGLE, A HIGHLY SUCCESSFUL UNMANNED AERIAL VEHICLE (UAV) FROM BOEING SUBSIDIARY INSITU, WILL SOON HAVE A BIG BROTHER, THE INTEGRATOR, SHOWN HERE WITH INSITU EMPLOYEES. THE INTEGRATOR WAS DEVELOPED TO MEET MILITARY REQUIREMENTS FOR A UAV THAT CAN CARRY A HEAVIER PAYLOAD AND PERFORM A VARIETY OF MISSIONS. THE SCANEAGLE AND INTEGRATOR CAN BE OPERATED USING THE SAME GROUND EQUIPMENT. BOB FERGUSON/BOEING

PHOTO: INSITU'S KRISTOPHER FROELICH, LEAD AIR VEHICLE TECHNICIAN, AND JAKE ALLEN, ENGINEER, PERFORM SYSTEM CHECKS ON THE BOEING SUBSIDIARY'S NEW INTEGRATOR UNMANNED AERIAL VEHICLE WHILE MATTHEW GRUBB, MECHANICAL ENGINEER, INSPECTS THE CAPTURE HOOK AND WINGLET. BOB FERGUSON/BOEING



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Boeing is bringing next-generation capability to unmanned systems. From small tactical to high-altitude systems, Boeing is maximizing the performance envelope for remotely-piloted vehicles with greater payload flexibility, secure networked systems, autonomous operations and an open architecture design for built-in growth potential. At every altitude, Boeing is taking unmanned systems to new heights.



Phantom Ray



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Ad watch

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

Inside cover:



This Defense, Space & Security ad underscores how Boeing is leveraging its advanced capabilities to provide a wide range of uniquely capable Unmanned Airborne Systems to meet current and emerging customer requirements. The ad will appear in key trade publications.

Back cover:



"Science Museum" is part of a series of ads reinforcing Boeing's partnership with the United Kingdom, using images of well-known U.K. architecture. Boeing is the largest overseas customer of the U.K. aerospace industry and partners with more than 300 businesses and universities around the country. The ad is currently running in *The Sunday Times*, *Economist UK* and *House Magazine*, as well as four other U.K. publications.



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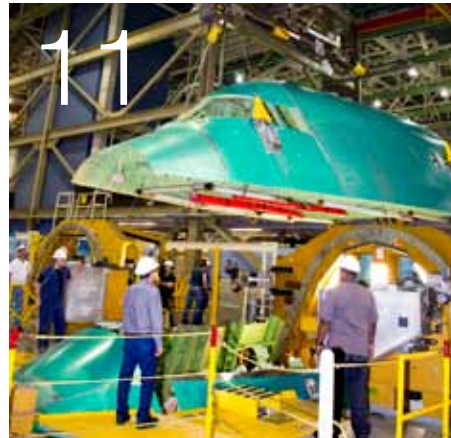
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PHOTO: JEREMIAH SCOTT/BOEING



14 Carrying the load

Whether hauling equipment and supplies to warfighters in Iraq and Afghanistan or using their huge cargo capacity for humanitarian missions, Boeing C-17s are always on the go at Joint Base Charleston in South Carolina. Nearly 60 of the U.S. Air Force Globemaster III airlifters are assigned to the airlift wing at Charleston, where about 150 Boeing employees help keep the planes ready for their critical missions.

PHOTO: BOB FERGUSON/BOEING



38 Office with a view

As a global company, Boeing has a substantial and active role in the European community and participates in discussions before the European Union when they involve aerospace, defense and the environment. Giving Boeing that important voice is its office in Brussels, which represents Boeing not only before the 27-nation EU but also at NATO headquarters. PHOTO: NATO



23 Fast forward

It lasted only 200 seconds, but the recent test flight of the X-51A WaveRider (in white), which reached speeds of around Mach 5, or five times the speed of sound, helped open the way for future hypersonic applications such as high-speed weapons and reconnaissance, as well as access to space. PHOTO: U.S. AIR FORCE

PHOTO: U.S. AIR FORCE



49 Historical Perspective

This month marks the 75th anniversary of one of Boeing's most recognized and storied airplanes, the rugged B-17 Flying Fortress. This four-engine bomber had a cast of thousands behind it, including the brave young airmen who flew it into combat and the thousands of women who helped build it during World War II and became known as "Rosie the Riveters."

PHOTO: BOEING ARCHIVES

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The world's aerospace industry gathers this month for the Farnborough International Airshow near London. If there's one word that reflects the growing sentiment within Boeing and the industry going into the show, it is "optimism," according to Shep Hill, president of Boeing International and senior vice president of Business Development and Strategy. One of the highlights of this year's show: a planned visit by Boeing's 787 Dreamliner.

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A show of optimism

Boeing and the aerospace industry head into the Farnborough Airshow with a growing sense of optimism

Shep Hill

President, Boeing International
Senior vice president, Business Development and Strategy

Optimism. One simple word that reflects the growing sentiment within Boeing and the aerospace industry. Midpoint through the year we can look back at the progress we have made—as well as look forward to where we are headed as a company.

So what is fueling the optimism within Boeing? We only have to look at the data points: the continuing recovery of the global economy, the World Trade Organization ruling that will establish rules for a level playing field for commercial airplane manufacturers, and the global demand for Boeing products.

The increasing sense of optimism is also evident across our industry. The biennial Farnborough International Airshow, the aerospace exhibition held in the United Kingdom July 19–25, is shaping up to be one of the busiest and biggest in recent memory. Global industry events such as this serve as international platforms for companies like Boeing to showcase advanced-technology products.

At this year's show, Boeing's presence will be dominated by the first appearance in Europe of the 787 Dreamliner—an event that is already creating huge excitement within the industry. And Boeing Defense, Space & Security will create more enthusiasm with a new concept—an Unmanned Systems Display. (See *Frontiers* story, Page 28.) Employees can follow the Farnborough Airshow coverage daily in Boeing News Now.

Of course, the air show is about more than just promoting our products and services; it is also about meeting with our customers, partners, government officials, the media—getting perspective on customer needs, maintaining and enhancing relationships, telling the story of what Boeing's employees are doing every day to ensure our competitive success. It also provides an opportunity for the general public to visit the Boeing exhibit, learn about the company, interact with employees and see firsthand the state-of-the-art Boeing products on display.

In 2009, 42 percent of our more than \$68 billion in revenues came from international sales. The international market represents opportunities well in excess of \$1 trillion over the next 10 years, and the company looks to international markets to support its growth in both commercial and defense businesses. Currently,



“Key to future success will be our relationships with partners around the world.”

the Boeing Commercial Airplanes backlog is roughly 80 percent international, while BDS plans to grow its international business from the current 16 percent to 20–25 percent of total revenue in the next five years.

Key to future success will be our relationships with partners around the world. Whether it is in Europe, the Middle East, Latin America, North America, Africa or Asia, we are building and strengthening our collaborative efforts with suppliers, customers and other important industry stakeholders who



shape and influence markets, bringing new work and career opportunities for Boeing employees.

This month's issue of *Frontiers* features our Boeing operation and employees in Brussels, who represent the company to the institutions of the European Union and NATO (Page 38). Boeing is committed to building constructive relationships with Europe's decision-makers to advance the interests of the aerospace industry in a way that benefits both European and American competitiveness and growth.

Even as we continue our efforts to ensure a fair and level playing field consistent with WTO rulings, we will strengthen our presence as a reliable, long-term, environmentally progressive partner to European governments and industry.

Our formula to grow globally is straightforward: Operate as one company, build strong local presence, leverage global intellectual, financial and industrial capabilities, and offer the customer the highest-quality products at the right price with the best service. Simple formula; proven results. ■

PHOTOS: (Clockwise, from top left) Shep Hill, president of Boeing International and senior vice president of Business Development and Strategy. BOB FERGUSON/BOEING The 787 Dreamliner is scheduled to make its first flight to Europe to be part of the air show. LEO DEJILLAS A full-scale Phantom Ray will be part of Boeing's Unmanned Systems Display at the Farnborough International Airshow. BOEING

First impressions

Making sure the critical first contact a visitor has with Boeing is a great one

By Catherine Fjeseth and photo by Paul Pinner



As a customer relations specialist with Boeing Defense, Space & Security, Yolanda Cueva supports Space & Intelligence Systems in El Segundo, Calif. In this *Frontiers* series that profiles employees talking about their jobs and the way their work fits into Boeing's goals, Cueva explains how she helps promote Boeing, its products and its leadership through superlative customer engagement.

HEAD OVER HEELS FOR BIOFUEL

A Boeing AH-64D Apache operated by the Royal Netherlands Air Force rolls inverted and releases flares over the Gilze-Rijen Air Base, home of the Dutch air force's combat rotorcraft. The maneuver was part of a demonstration flight using a 50/50 blend of sustainable bio-kerosene and standard aviation jet fuel. The 20-minute flight on June 16 was the first time any rotorcraft had flown with this blend.

BOEING

Whether it's a satellite launch, conference, trade show, VIP visit or executive meeting, there are no "do-overs." I am often the first encounter a customer or guest has with Boeing. As a customer relations specialist with Boeing Defense, Space & Security, I get one chance to make a good impression and I take that responsibility very seriously.

Planning meetings and events is just one aspect of what I do. I also provide support to the Geostationary Operational Environmental Satellites (GOES) program. In March, I had the opportunity to lead the customer relations team that supported the GOES-P launch at Cape Canaveral, Fla.

When I lead tours of the Satellite Development Center, it is gratifying to see the amazement in the customers' eyes at the factory and the satellites being built. I can see the pride the Boeing technicians have in their work.

One of the things I like about my job is that I get to interact with customers and executives. I get to hear what they have to say about the business. I learn from them and it better prepares me to answer questions other visitors might ask me.

My job has its challenges: I have to make sure the right support people are engaged, including employees from information technology, security, catering, creative services, export control, facilities and transportation. I am responsible for making sure every detail is taken care of, from logistics to the smaller but critical details such as

letting attendees know the meeting agenda, dress code, directions and where to park, or finding out if they have any special requests or dietary needs.

My biggest challenge is protocol. What are the special rules that apply to the visitors? What is the proper way to address them? What is the order when making introductions? Are there special rules for seating? What is the correct placement of the flags in the meeting room? As Boeing grows its international business, it is important for me to know the proper etiquette when dealing with different cultures and their customs.

Teamwork is the key to successful meetings and events. I am fortunate to have co-workers and colleagues who are incredible and so helpful. It is very rewarding when an activity is completed and everything has gone well—and visitors leave with a good impression. ■

catherine.fjeseth@boeing.com

Quotables

“Just like every other 787 flight that I've flown in the last several months—smooth, per plan and excellent.”

– Boeing test pilot Mike Bryan, who captained the first flight on June 16 of Dreamliner ZA005, the first of the flight-test planes with General Electric engines, as reported in *Puget Sound Business Journal*. The other four 787 test planes have Rolls-Royce engines. The sixth, and final, 787 to join the flight-test program is expected to fly by the end of this month.

“We could have in the future ... hypersonic weapons that fly 600 nautical miles [1,100 kilometers] in 10 minutes.”

– Charlie Brink, X-51A program manager with the Air Force Research Laboratory at Wright-Patterson Air Force Base in Ohio, during a June 1 teleconference to discuss the successful flight of the X-51A, also known as WaveRider. (See *Frontiers* story on Page 23.)

The Dream in 3-D

The 787 Dreamliner and its chief test pilot have starring roles in a new IMAX film

As chief test pilot for the 787, Mike Carriker is one of Boeing's "top guns," a former U.S. Navy flier with nearly three decades' experience in the cockpit. Now, Carriker and the 787 are stars of their own film, an IMAX 3-D movie that will be shown at museums around the world.

"When you're up on a screen that's six stories tall, in an IMAX movie theater, you wish you had sucked in your gut a little more!" he joked.

It's not likely anyone will notice that while watching the new IMAX film *Legends of Flight*. As in real life, Carriker the 3-D film star is portrayed as a pilot who loves and flies old airplanes to better develop and test new ones.

Legends of Flight, now playing at museums and other IMAX venues, uses Carriker and his vast aviation experience to frame and explore some important predecessors to the 787. Among them: the Boeing Stearman biplane, the Harrier vertical/short takeoff and landing "jump jet," and the propeller-driven Lockheed Super Constellation airliner.

"At the beginning of the movie, I'm remembering the first time I flew in an airplane," Carriker said. "I'm looking out the window, looking at those big engines start up. I remember just being mesmerized."

He's excited by the potential influence of *Legends*.

"Now maybe we can have another generation of kids who can look out the window and be mesmerized by the concept of flying." ■



LEGENDS OF FLIGHT

Produced by The Stephen Low Co. in association with the Smithsonian National Air and Space Museum, the film opened in June at screens in Washington, D.C., Chicago, Seattle and other U.S. cities. This month it opens in London. The film will be showing in coming months at IMAX screens in dozens of other places, including St. Louis, Los Angeles, Sydney, Huntsville, Ala., and Myrtle Beach, S.C.

Visit the film's official website at www.legendsofflightfilm.com for more information.



THE IMAX 3-D CAMERA

- Single housing with two lenses and two spools of film
- Film frame size: 70mm x 48mm
- Film orientation: horizontal, with 15 spool perforations per frame
- Frame rate per second: typically 24, up to 36
- Film used per minute at 24 frames per second: 334 feet (102 meters)
- Weight of camera, lens and 1,000 feet (30 meters) of film: 215 pounds (97 kilograms)

Source: IMAX Corp.

PHOTOS: (Top) When the 787 landed at Boeing Field in Seattle after its first flight on Dec. 15, 2009, an IMAX 3-D camera, mounted on a crane, shot the scene for *Legends of Flight*. **STEPHEN LOW CO.** **(Above)** Mike Carriker, Boeing Test & Evaluation's chief test pilot for the 787, gets ready to shoot a scene in the cockpit of an AV-8B Harrier "jump jet." **STEPHEN LOW CO.**

Encore performance

Teams designing the 747-8 passenger plane used discipline, lessons learned—and a proven tool to keep the program on track

By Dawsalee Griffin

Sometimes what it takes to do a new job right is an old, simple idea: discipline.

Nyle Miyamoto, Anthony Slama and Steve Brown proved that after they joined the 747 program. Miyamoto and Brown came in February 2008 and Slama in January 2006. Design work on the initial freighter version was behind schedule. Morale was low. Overtime was mandatory.

And the follow-on 747-8 Intercontinental model—the re-envisioned passenger version of the venerable "Queen of the Skies"—could easily have fallen victim to many of the same problems.

Instead, the Intercontinental has met every weekly design deadline for more than a year and a half. Teams pitch in and help one another at any hint of trouble. Morale is high.

"There was a lot of churn on the 747-8 Freighter program," said Brian Thorpe, 747 airframe engineering manager, who defined churn as the extra work caused by late design changes and the lack of agreed-to standard processes. "We knew we needed to do the process differently for the Intercontinental."

Miyamoto and Brown came from



the original 767 Tanker program, where Brown had been developing standardized processes and templates that he brought with him to the 747-8. Executives from the 737 and P-8A programs brought lessons learned and a tool developed years ago by the Boeing site in Wichita, Kan., to keep design work on track and running smoothly—the non-recurring

product development tool. Called NRPD for short, the tool uses Excel-based tracking to provide milestone metrics and trend data.

Engineers and managers who had used the tool liked it and had taken NRPD with them as they moved on to new projects. From Wichita, it migrated to the P-8A, the 737-900ER (Extended Range)

PHOTO: Mechanics at the Everett, Wash., factory load the Section 41 cab into place for the first 747-8 Intercontinental. This is the area of the fuselage that houses the flight deck on the upper deck and the forward passenger cabin on the main deck.

JEREMIAH SCOTT/BOEING; GRAPHICS: DOUG YAMADA/BOEING



PHOTOS: (From left) Tony Slama, Kurt Madsen (center) and Steve Brown hang a wind sock signaling that the airframe design team met another weekly design goal. By the time the team finished its work in June, 76 wind socks lined the hallway—indicating the team had performed 100 percent on time since the beginning of the project. **ED TURNER/BOEING** Mechanics perform inspections before joining the cab to the rest of the 747-8 Intercontinental's Section 41 structure. **JEREMIAH SCOTT/BOEING** Some of the 747-8 engineering leads who helped keep the project on track (from left): Matt Wilson, Jim Wilkinson, Paul Koehler, Brian Gregg, Ashish Patel, Kurt Madsen and Dave Haworth. **ED TURNER/BOEING** 747 mechanics prepare to lift the cab into position to join it to the Section 41 bottom section. **JEREMIAH SCOTT/BOEING**

“We were able to build on the experiences from the freighter and do a better job of planning.” — Brian Gregg, 747 lead structures analyst

and the 747-8 development programs. Now it's being used by the 787-9 and NewGen Tanker projects.

The Intercontinental team not only adopted the tool but also expanded its use. NRPD was used to track the entire project.

“It allowed everyone to know exactly, day by day, step by step, what was supposed to happen, who the step owner was and what the status was, and to predict future performance,” said Slama, a lead in the 747 Program Planning & Control group at the time.

Miyamoto, then a 747 engineering manager, Brown, then a 747 engineering lead, and Slama proposed a framework for design efforts on the Intercontinental using a disciplined approach, an integrated plan and improved tools.

Their goals were straightforward—eliminate as much rework as possible, standardize processes and templates,

use better tools to track progress, and ensure effective communication among the worldwide design team.

“Everyone had to agree,” Miyamoto said. “We wanted a commitment from everyone—from the employees on the floor to the program leaders—that they would follow the plan and processes.”

The commonality of the two airplanes made it easier to define the basic requirements for the passenger version, which followed the freighter. The wing was essentially the same; the basic fuselage configuration required only minor changes for the passenger version; and the definition of the loads, or stresses the airplane needed to withstand, was complete.

“We focused upfront on defining the configuration,” said Brian Gregg, 747 lead structures analyst. “We were able to build on the experiences from the freighter and do a better job of planning what we needed to do.”

Layouts—electronic blueprints showing all systems interfaces in a specific section—were integral to defining the work that needed to be done.

“We used a more disciplined process to control the statement of work, including using layouts to develop the statement of work and discover potential problems,” said Dave Haworth, 747 design lead.

To stay on top of the schedule, as well as to provide metrics and status of each of the drawings, the team used the NRPD tool.

Standardizing processes also was a factor in successfully meeting the Intercontinental's aggressive design schedule. As a result, detailed design work done for the Intercontinental by Boeing Defense, Space & Security engineers in Long Beach, Calif., looked exactly like the work done by engineers in Everett, Wash. This made handoffs to other engineers

or to suppliers easier. Experienced people made a difference, too.

Because work was going more smoothly than it had on the freighter, the leads also had more time to match assignments and skill levels. “We still worked with a worldwide design team,” said Ashish Patel, 747 stress engineer, “but the work was better distributed with the more demanding work going to those who had the appropriate skills.”

The result? By the time the 747-8 Intercontinental airframe group had completed the design work in June, it had gone 76 weeks without missing a weekly deadline.

Today, employees from the Intercontinental design program are sharing their experiences on other programs throughout Boeing. “Moving people around is a way of sharing information and best practices dynamically,” said Mo Yahyavi, vice president and general manager of the 747 Program.

Indeed, Miyamoto now is a senior manager in product development. Brown and Slama are both working on the 787-9 design effort. And all three are still spreading the word, helping ensure Boeing programs everywhere capitalize on the Intercontinental success story—by design. ■

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Heavy

lifting

Flying humanitarian missions or ferrying supplies to warfighters, C-17s are on the go

By Eric Fetters-Walp and photos by Bob Ferguson



Interspersed between commercial jetliners taking off from the same runways, hulking Air Force–gray Boeing C-17 Globemaster III airlifters regularly take to the sky with a satisfying roar over North Charleston, S.C.

Fifty-six C-17s are assigned to Joint Base Charleston, where 145 employees with Boeing’s Global Services & Support, part of Defense, Space & Security, help make these critical airlifters ready for missions around the world.

Daily, C-17s from the 437th Airlift Wing at Charleston head to Afghanistan with newly built armored vehicles and supplies for warfighters. When needed, the C-17s also help with humanitarian missions. In the weeks after Haiti’s devastating earthquake in January, dozens of C-17s filled with relief supplies flew out of Charleston. The 437th Airlift Wing, which was the first operational C-17 wing in the U.S. Air Force, also is the primary cargo mover for the Denton Amendment program, which flies humanitarian aid on available missions to a dozen nations.

Since 1993, Global Services & Support

PHOTOS: (Left) A C-17 is directed into place on the ramp at Joint Base Charleston (S.C.), which is home to 56 of the Boeing-built airlifters. **(Insets, from left)** Staff Sgt. Nick Ivy (left) and Staff Sgt. Jason Head, 437th Aircraft Maintenance Squadron crew chiefs, inspect the brakes on a C-17; Ed Acevedo, Boeing product support technician lead, removes a panel on one of the C-17’s four Pratt & Whitney F117-PW-100 turbofan engines; Sgt. Nick Ivy (left) and Robert Baldwin, Boeing field service technician, inspect a C-17 air-conditioning “pack.”

has won contracts to support the Air Force's fleet of Boeing-built C-17s at bases worldwide under the C-17 Globemaster III Sustainment Partnership program. In Charleston, more than 100 Integrated Logistics employees work side by side with the U.S. Air Force to maintain the aircraft. A Boeing-run engine shop at the Charleston base is in charge of routing nonworking C-17 engines between the Air Force and a repair contractor, as well as providing spare engines at a moment's notice.

Another 40 Training Systems & Services employees at the base teach Air Force C-17 crews. Charleston is one of four U.S. bases with C-17 Weapon Systems Trainer simulators.

"It's an honor to be here at Joint Base Charleston, personally interacting with our customer daily," said John Cook, director of Boeing Field Services at the Charleston base. "I know that I have an opportunity every day to exceed customer expectations and support their mission success, so that we can be here supporting this great airlifter for years to come."

Assembled at Boeing's Long Beach, Calif., site, the C-17 is best known for its huge cargo hold, which is large enough to accommodate two large buses or three helicopters, according to the 437th Air Wing. It has an 85-ton (77-metric-ton) payload, and can transport one of the U.S. Army's main battle tanks, the M-1. The C-17 also can carry more than 100 paratroopers while handling a full load of cargo.

With in-flight refueling capability, its nonstop reach is global. ■

eric.c.fettters-walp@boeing.com

PHOTOS: (Right) C-17s assigned to Joint Base Charleston (S.C.) are in high demand, constantly returning from or leaving on missions around the world. **(Insets, from left)** Senior Airman Arbera Lindsey, 315th Aircraft Maintenance Squadron jet engine mechanic, opens an engine inspection panel; loading a Mine Resistant Ambush Protected vehicle onto a C-17; Master Sgt. Ronald Morris, 81st Aerial Port Squadron vehicle operator, provides hand signals to direct a vehicle being loaded onto a C-17; a crew chief signals to ensure proper wing clearance as a C-17 taxis out for takeoff; a C-17 co-pilot scans for ground traffic while taxiing for takeoff.



“Our domain has great potential for synergy and replication opportunities between the business units.”

— Howard Appelman, Manufacturing domain leader for Boeing Defense, Space & Security

PHOTO: Howard Appelman, Manufacturing domain leader for Boeing Defense, Space & Security (left), checks the quality of holes drilled by automated equipment on the F/A-18 line in St. Louis with Ray Baron, Materials, Process & Physics engineer.

RICHARD RAU/BOEING

The ‘productivity lever’

Boeing is developing and searching the world for technologies to meet current and future manufacturing needs

By Bill Seil

Boeing and other aerospace companies highly value titanium for its strength and resistance to expansion, contraction and corrosion.

Limits in the size of equipment at mills, however, have prevented fabrication of titanium parts larger than 4 feet by 12 feet (1.2 by 3.7 meters).

Recognizing an opportunity, Boeing researchers teamed with external partners to develop a breakthrough. Their efforts led to what’s believed to be the largest titanium sheet metal part ever made—a jet engine inlet 13 feet (4 meters) in diameter.

That teamwork is exactly what the Manufacturing technology domain is working to accomplish—helping facilitate connections across the company to ensure that production technologies, when appropriate, are replicated and leveraged companywide to improve quality and efficiency.

Mike Vander Wel, Manufacturing domain leader, described it as “pulling the productivity lever” on the Boeing business model.

“The Manufacturing domain strongly supports some of the company’s top business priorities,” he said. “The nature of the domain directly impacts the bottom

line in many areas. Our challenge is to align investments in the right way to have a maximum effect across the enterprise.”

There are eight domains, or technology focus areas, in Boeing’s Enterprise Technology Strategy. Through this strategy, technologists and business leaders across the company coordinate a “One Company” approach to technology development.

As with the other domains, Manufacturing works with Boeing business programs to ensure that technologies that ultimately support current and next-generation products are ready when needed.

This domain is among the most active in tapping research talent from around the world. It is engaged in collaborative efforts with partners in Australia, the United Kingdom, the Netherlands, Spain, Russia, Italy,

India, China and Germany. Projects touch on areas including composite processes, assembly and metals machining.

The domain’s diverse research projects fall into several categories, such as metals transformation—which involves taking sheets of aluminum, titanium and other metals and making parts as efficiently and economically as possible.

Creating parts from titanium is a challenge: The metal requires a special high-temperature cross-rolling process to convert it into sheets. That process has been the limiting factor in producing bigger parts.

To help generate ideas to overcome this limitation, researchers from Boeing Commercial Airplanes and Boeing Research & Technology worked with external partners. That collaboration eventually led to the

creation of the 13-foot jet engine inlet.

The end result was that researchers discovered how to apply a metalworking process called friction stir welding—long used by Boeing on aluminum—to titanium. In friction stir welding, a rotating pin tool moves along a metal surface to “plasticize” the metal and give it a gooey consistency. As the pin tool moves along the joint where two metals are butted together, it stirs the plasticized portions of the two pieces together, forming a strong bond.

“Applying this technology to titanium required the development of much-higher-temperature stirring pin tools and precision methods,” said Dan Sanders, a Senior Technical Fellow in Boeing Research & Technology.

Another of the domain’s focus areas

addresses the buildup process from parts to subassemblies to final product delivery. This area, known as integration and delivery, includes developments in robotics, or ways to use automated equipment for repetitive and arduous tasks. Commercial Airplanes' fabrication plant in Auburn, Wash., is using robotic equipment for drilling and riveting large titanium assemblies to drive productivity improvements in platform integration.

"Automation really started here in earnest around 2007," Sanders said. "Prior to that, we didn't have a robot in the factory. Now we have about 30 of them and more on the way. Anyone who's ever had to hand-drill titanium would definitely appreciate this development."

Howard Appelman, domain leader for Boeing Defense, Space & Security, said automated assembly equipment is also on the list of priorities for military programs. He noted that recently installed assembly automation equipment on the F/A-18 Super Hornet line in St. Louis is used to drill precision holes in wing trailing edge flaps.

"Our domain has great potential for synergy and replication opportunities between the business units," Appelman said.

Scott Cunningham, Manufacturing domain leader for Commercial Airplanes, said the domain is examining the needs of both current and future production programs.

"We're looking at automation, new materials, fabrication, inspection methods and assembly technology. Testing and investigation tells us what we can do right now. And with a little more effort, we can look ahead to 2015 and beyond," Cunningham said.

Don Mottaz, director of Assembly and Integration for Boeing Research & Technology and a member of the Manufacturing domain's leadership team, expects to see a lot more automation. "If you look at where robotics is going, the next 20 years should be just amazing," he said.

Developments will range from advanced hand-held tools to complex systems on the factory floor. Mottaz envisions GPS-based equipment—similar to today's navigation systems that guide cars—that tell robots in the factory where to find specific parts.

"I don't think there will ever be a time when these machines manage themselves," Mottaz said. "We'll need people to do that. But I think it will be more of a partnership than it has been in the past." ■

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"The Manufacturing domain strongly supports some of the company's top business priorities."

— Mike Vander Wel, Manufacturing domain leader

PHOTO: Mike Vander Wel, Manufacturing domain leader (right), and Dan Sanders, Senior Technical Fellow, Boeing Research & Technology, are shown with a prototype 13-foot- (4-meter-) diameter titanium nacelle lip skin. Developed and built at Boeing Fabrication Division's Auburn, Wash., site, it demonstrates recent advancements in manufacturing technologies. MARIAN LOCKHART/BOEING

GLOBALLY yours

As it aggressively expands its fleet, Turkish Airlines is poised to become a major global carrier *By Wilson Chow*



Turkey is a country where east meets west—literally. Divided by the Bosphorus waterway, the country is in both Europe and Asia, and is one of the fastest-growing economies in the world. Its largest city, Istanbul, the world's fourth-largest city, with a population of 12.8 million, has been a crucial location for international trade for thousands of years since its formation as Byzantium around 600 B.C.

That economic growth in Turkey is helping fuel the rapid expansion of its national flag carrier, Turkish Airlines, which recently celebrated its 77th birthday. Despite the global recession, which caused many airlines to reduce capacity, Turkish Airlines has continued to grow. In 2010, the airline aims to carry more than 30 million passengers—nearly triple the 10.4 million passengers it carried in 2003—and to generate revenues of \$5.7 billion.

"We have already grown to rapidly become the fourth-largest airline in Europe and our sights are firmly set on securing the No. 3 slot," said Temel Kotil, chief executive officer of Turkish Airlines. "We aim to create Europe's first five-star airline and offer a level of service and global network that are truly world-class."

Taking advantage of its Istanbul hub's central location, Turkish Airlines is building a major transit point for passengers as they travel between North America, Europe, Asia, the Middle East and Africa. The airline is opening new transatlantic and Asian routes, which will increase traffic through Istanbul by 40 percent.

"Turkish Airlines has long been an important Boeing customer. The strength

of the Turkish market and [the airline's] strategy will continue to enhance their position in the industry," said Aldo Basile, Boeing Commercial Airplanes vice president of Sales for Europe and Russia.

Turkish Airlines operates a mixed fleet of 142 airplanes. To accommodate growth and help build additional demand, it has ordered 12 777-300ER (Extended Range) and 69 Next-Generation 737 airplanes, the latest of which will have the new Boeing Sky Interior.

As the airline expands across the globe—Turkish now serves 161 destinations—it's aiming to take service to a new level. "Quality doesn't need a passport," Kotil said.

The effort is working. Recently, Skytrax (an airline research organization) recognized Turkish Airlines with two prestigious awards: Best Airline in Southern Europe and Best Onboard Catering—Economy Class.

"As Turkish Airlines continues to grow, we want to be there to support its business and future success with the most innovative, high-tech, capable jetliners in the world," Basile said. ■

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"Quality doesn't need a passport."

— Temel Kotil, chief executive officer of Turkish Airlines

PHOTO: TURKISH AIRLINES

PHOTO: (Above) The Boeing Next-Generation 737-800 model in the Turkish Airlines livery. TURKISH AIRLINES



Manual override

This Fabrication team improved efficiency and accuracy by automating operator instruction manuals for machines **By Dawsalee Griffin**

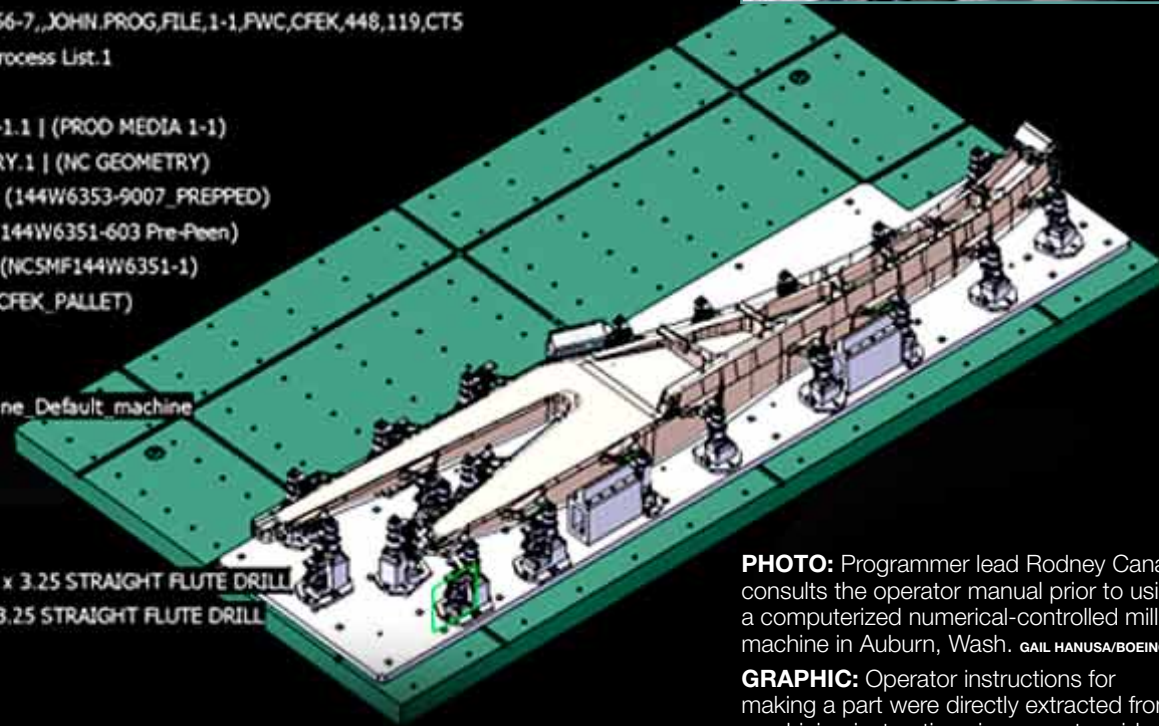
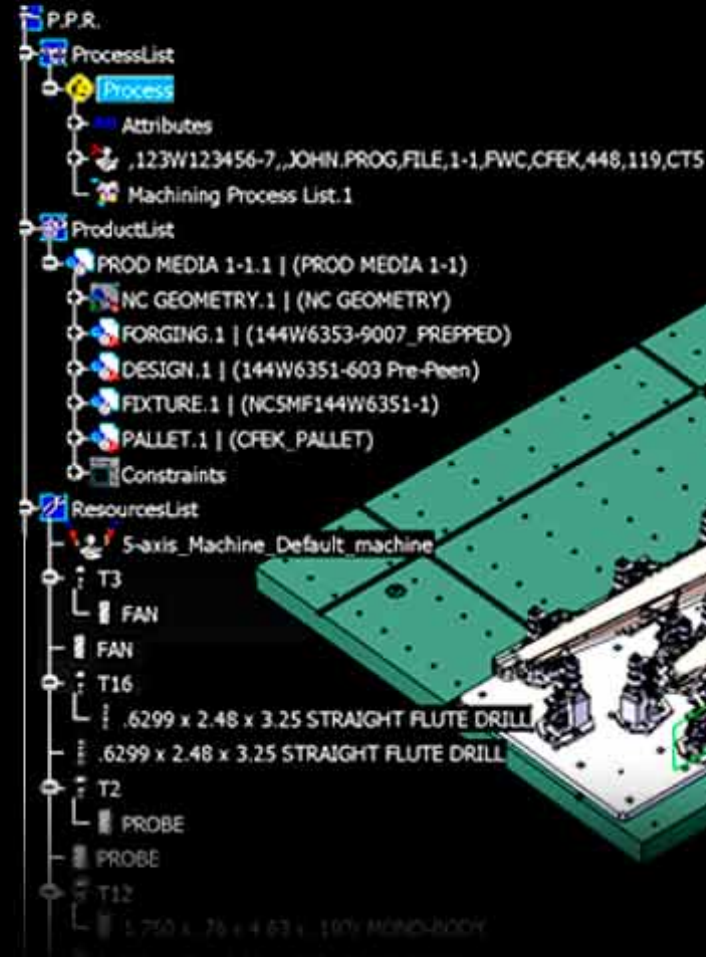


PHOTO: Programmer lead Rodney Canary consults the operator manual prior to using a computerized numerical-controlled milling machine in Auburn, Wash. **GAIL HANUSA/BOEING**

GRAPHIC: Operator instructions for making a part were directly extracted from machining instructions in computer-aided interactive three-dimensional applications, or CATIA, files like this one. **BOEING**

Rod Canary used to spend hours creating an operator instructions manual every time he wrote a new machined-part program.

Now, he and the other programmers for the computerized numerical-controlled machines at the Boeing Fabrication facility in Auburn, Wash., create the operator manual for each part in minutes.

What began last year as an effort within a programming group to automate operator instructions has proved so successful it may one day be incorporated into Boeing's best practices.

Until a year ago, operator instructions for the machines had to be manually created and updated as Word documents. Each time a programmer updated machine instructions, he or she had to make changes to the operator instructions.

This manual process risked keying errors and unclear directions. The documents also failed to capture the additional tips that machine operators had written on their copies of the documents.

Multiply this by up to 10 or more instructions per part for the thousands of parts Boeing Fabrication uses numerical-controlled machines to manufacture and the potential for error is huge.

"The operator has to know what he's going to do," said programming manager Corey Cassell, "and exactly what's going to happen when he presses the 'go' button."

The solution, according to Canary, programmer applications lead, was to automate production of the instructions manual. A team of programmers worked to set up a database and a program that would extract operator instructions directly

from the computer-aided interactive three-dimensional application, or CATIA, files that contain the machine instructions.

The new process did what the team expected. Besides improving the quality of operator instructions, it reduced the time needed to produce them by about 70 percent and increased their accuracy by about 90 percent.

Although the project began as an in-house process improvement, there is interest from other parts of Fabrication and Boeing organizations.

"Philadelphia is using the tool, with some improvements that we are looking to adopt," said Canary. "Boeing Portland has also expressed interest in the tool."

And the process of improvement continues. ■

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Speeding into the future

In a history-making flight, the X-51A showed the possibilities of hypersonic travel

By Christina Kelly

For Boeing engineer Mark Nugent and many other employees, nearly a decade of hard work and preparation all came down to a nail-biting 200 seconds.

That's how long it took the X-51A WaveRider to successfully complete the longest supersonic combustion (scramjet) powered flight in aviation history on May 26, reaching a speed of about Mach 5, or five times the speed of sound.

"It happened so fast," Nugent said. "The closer we got to first flight, we began counting down. First days, then hours, then tenths of seconds. It is still sinking in that we did it. We made history!"

The journey from concept and design to the actual flight was a roller-coaster ride filled with delays and obstacles that often had little to do with the

test vehicle and more to do with other equipment and scheduling.

"It's been quite a ride," said Rick Marsh, Boeing's Integrated Product Team lead for the X-51A rocket booster. "In the aerospace industry you don't often get to see the project from design sketches to the actual flight. "There were a dozen times when I wondered if we'd ever get here."

So named because it is designed to ride its own hypersonic shock wave, WaveRider was built by Boeing Phantom Works for the U.S. Air Force Research Laboratory at Wright-Patterson Air Force Base, Ohio. The scramjet motor was developed by Pratt & Whitney Rocketdyne.

On the day of the test, WaveRider was carried under the wing of a U.S. Air Force B-52H bomber to an altitude



'Lighting a match in a hurricane'

Hypersonic technology is the ability of air-breathing vehicles to fly at speeds between Mach 4 and Mach 14 using a supersonic combustion (scramjet) powerplant. Air-breathing hypersonic vehicles offer the hope of low-cost, on-demand access to space. The idea has been around since the 1950s, but the technology didn't exist until recently.

X-51 program officials have compared the challenge of scramjet propulsion to "lighting a match in a hurricane and keeping it burning."

Previously, the longest hypersonic scramjet test flight was by the X-43, an unmanned air-launched vehicle conceived by NASA in 2004. Boeing Phantom Works was part of that team, but the flight lasted only about 10 seconds and the X-43 used hydrogen fuel. The X-51A engine uses JP-7 jet fuel, which is less costly and more efficient.

PHOTO ILLUSTRATION: The X-51A WaveRider began its history-making hypersonic flight after being released by a Boeing B-52 bomber at 50,000 feet (15,240 meters).

WAVERIDER GRAPHIC BY U.S. AIR FORCE; PHOTO ILLUSTRATION BY BRANDON LUONG/BOEING

of 50,000 feet (15,240 meters) off the Southern California Coast, over the Point Mugu Naval Air Warfare Center Sea Range.

Four seconds after WaveRider was released, a solid rocket booster accelerated it to about Mach 4.5 before it and a connecting interstage were jettisoned. For about 200 seconds WaveRider flew exactly as it was intended, reaching an altitude of about 70,000 feet (21,340 meters).

Somewhere in the span of those few minutes, Joe Vogel, Boeing's X-51A program manager, noticed the vehicle began to de-accelerate. In the control room, the buzz of excitement trailed off a bit. At about Mach 5, the control center lost telemetry, meaning no data

were being sent by WaveRider, and it was destroyed as planned.

"The vehicle did everything we wanted it to do, except go a little faster for a little longer," Vogel said. "Something occurred that we don't fully understand yet, but we have plenty of data to review. I have no doubt it is something we will be able to fix and that the next vehicle will go even faster."

Three more test vehicles were built, but no decision has been made about when WaveRider will fly again.

Even though WaveRider did not fly for 500 seconds as planned or reach a speed of Mach 6, the U.S. Air Force hailed the flight a success.

"We're ecstatic to have accomplished many of the X-51A test points during its

first hypersonic mission," said Charlie Brink, Air Force X-51A program manager with the Wright-Patterson research lab. "This gives us huge confidence."

Boeing's Vogel said the flight helped prepare the way for future applications of hypersonic technology.

"This is a new world record and sets the foundation for several hypersonic applications," Vogel said, "including access to space, reconnaissance, strike, global reach and commercial transportation." ■

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WaveRider flight brings moonwalk memories

On July 20, 1969, Joe Vogel watched as astronaut Neil Armstrong climbed down a ladder from the lunar lander Eagle and planted the first human footprints on the moon. The youngster turned to his dad and asked what kind of job would get him to the moon.

"My dad said, 'son, engineers made that happen,' and I knew from that

time on, I was going to be an engineer," recalled Vogel, who worked on the Space Shuttle *Endeavour* for NASA at the Johnson Space Center in Houston before coming to Boeing.

"I wanted to work on something that had never been done before," Vogel said, explaining why he joined Boeing.

Vogel got his wish with the X-51A WaveRider program, which he's managed since 2006.

Following the X-51A flight, a video from the F-18 chase plane was downloaded on the YouTube Internet videoclip sharing site. Within 48 hours, the video had nearly 200,000 visits.

After Vogel left Edwards Air Force Base, he took the YouTube video to his son Jeremy's third-grade classroom. In the

back of his mind was the childhood awe he felt after seeing men walk on the moon.

"The reaction from the kids was unbelievable," Vogel said. "They could not stop talking about it. Who knows? Perhaps 15 or 20 years down the road, we will see the next crop of engineers who will say it was the X-51A test flight in 2010 that jump-started their interest in aerospace."

— Christina Kelly

PHOTO: Skies call—the X-51A WaveRider vehicle and its B-52H launch aircraft are readied for the record-setting test flight.
U.S. AIR FORCE PHOTO

Safe passage

Transporting hazardous items safely around the world requires specialized knowledge—and ingenuity **By Kathrine Beck**

Mike Ouhl knows all about hazardous chemicals. And in the real world, it's not like the fluorescent green stuff of Hollywood.

"When you watch movies, hazardous chemicals are always oozing and fluorescent green," said Ouhl, Supply Chain Logistics coordinator at the Boeing Commercial Airplanes Spares Distribution Center near Seattle.

Commercial airplane parts are shipped from the facility to airline customers around the globe, and Ouhl and his Shared Services Group teammates are responsible for making sure potentially dangerous items are transported safely.

Some are parts that require special handling. These include oxygen generators that supply oxygen to overhead masks in

the cabin, fire extinguishing devices and squibs—small explosive devices that open emergency doors. Paints and sealers also can be potentially hazardous.

"We work with every spare part that Boeing sells," Ouhl said. "There are nine classes of hazardous materials, and we move all nine."

The classifications are based on characteristics such as flammability, explosiveness and whether chemicals are in solid, liquid or gaseous form. The shipment of these hazardous chemicals involves a vast body of regulations and requirements from the U.S. Transportation Department, the International Civil Aviation Organization, the International Air Transport Association, governments, airlines, and cargo carriers such as FedEx and UPS.

Some items can't travel on passenger aircraft. Others can't be imported into certain countries. Recently, oxygen generators were needed in the Cape Verde islands off the west coast of Africa. No scheduled carriers could legally fly them there, so the parts went to Lisbon, Portugal, and were transferred to a boat for delivery.

"There have been rare occasions," Ouhl said, "that we couldn't find a way to move something to a specific city and country, so we've had to find a common location where the airplane was going to be in maintenance and where we could send the parts."

Often, there's a rush, especially if the situation involves what's known as an AOG, or airplane on ground. But

Supply Chain Logistics can't cut corners.

At the Boeing spares and distribution facility, Ouhl works closely with Commercial Airplanes packaging specialists Dean Ramert and Jim Russell. First they determine the exact nature of the item and research the applicable regulations.

"Once we have all the information, we develop the package," Russell explained. They use a variety of materials including cardboard boxes, fire retardant foam, lumber and reinforcing metal bands to build the packaging.

"The regulations don't tell us how, but they tell us what standards it has to meet," Russell said.

Sample packages are tested in the team's Package Testing Lab. Actual hazardous materials aren't used for the

testing; Russell and Ramert use safe materials with the same characteristics, such as weight and viscosity. Boxes go into an environmental chamber set at various temperatures and humidity levels for 24 hours to simulate sitting on the tarmac or in a warehouse in any climate. A machine test-drops boxes—from 48 inches (1.2 meters)—onto corners, tops, bottoms and sides.

To simulate how packaging performs on trucks, boxes spend time on a vibration table and are then checked for damage and leaks. Boxes are also stacked to see how the weight of other freight can affect the packaging. Flammability tests also may be performed to determine at what temperature the packaging ignites.

And every two years, packaging

has to be retested and recertified.

Jere Schumacher is chairman of the companywide Dangerous Goods Technical Team that oversees hazardous materials compliance issues. "If we aren't compliant," he noted, "there can be fines, as well as civil and criminal penalties. But most of all, when we put products into the public realm—by air, sea or surface—we have to make sure the public is safe." ■

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PHOTO: Mike Ouhl, Supply Chain Logistics coordinator, manages compliance and paperwork for nine classes of hazardous materials. **MARIAN LOCKHART/BOEING**

Unmanned and unlimited

Growing demand for unmanned systems is driving Boeing's business, and ingenuity, in new markets—and the sky is not the limit **By Jay Spenser**

When Somali pirates held an American cargo ship captain hostage in April 2009, they didn't count on a spy in the sky. A ScanEagle launched by a U.S. Navy destroyer circled above the pirates' vessel during the five-day standoff near the Horn of Africa. Too small and quiet to be noticed, the unmanned craft provided real-time video surveillance that contributed to a successful rescue operation.

Built by Insitu, a Boeing subsidiary in Bingen, Wash., ScanEagles have logged more than 320,000 flight hours assisting coalition forces in Iraq and Afghanistan, according to Bill Clark, vice president of Emerging Programs at Insitu. They also perform many other surveillance missions, from helping scientists track polar bears and monitor ice floes to examining volcano calderas and flood plains.

The success that ScanEagle has had since entering service in 2002 underscores the global demand for unmanned aircraft—and unmanned systems in general.

Over the past decade, there has been a dramatic shift toward unmanned systems, according to Darryl Davis, president of Boeing Phantom Works, which has a number of unmanned programs in the works, including Phantom Ray, a fighter-sized technology demonstrator scheduled to make its first flight at the end of this year. Phantom Ray builds on Boeing's success with the X-45A unmanned vehicle.

"Our customers have recognized the value of unmanned systems taking on the dull, dirty and dangerous missions that are ill-suited for manned platforms," Davis said. "Unmanned systems fill a niche when the optimum design of an aircraft is limited by the human element. Taking people out of the cockpit allows designers to reduce the size of an aircraft, eliminate many of the environmental controls and increase the range or overall flight time. More important, they also take our most important resource—people—out of harm's way."

The company's talent and vision, however, are not just focused on the sky.

Boeing has teamed with manufacturer iRobot Corp. to develop the Small Unmanned Ground Vehicle (SUGV) 310, a lightweight robot designed to give soldiers and emergency responders real-time awareness of critical situations.

The SUGV 310 weighs 29 pounds (13 kilograms) with no payload and can climb steep grades, go up and down stairs, and investigate potentially hazardous environments through the use of a variety

UNMANNED SYSTEMS ON DISPLAY AT AIR SHOW

Boeing's unmanned systems will be a featured attraction at this year's Farnborough International Airshow, which takes place July 19–25. This biennial aerospace industry gathering near London is one of the world's premier aviation trade shows.

More than a dozen large-scale models of Boeing unmanned systems, including a full-scale Phantom Ray with a 50-foot

(15-meter) wingspan, will be featured in the Boeing Unmanned Systems Display. Touch screens will provide information about the various products, and videos will describe Boeing's "sea-to-space" market coverage.

"The display is impressive because it highlights the breadth and depth of unmanned systems and projects across the Boeing enterprise," said Darryl Davis, president of Boeing Phantom Works, which is developing both Phantom Ray and

Phantom Eye unmanned airborne vehicles. Vic Sweberg, director of Unmanned Airborne Systems for Boeing Defense, Space & Security, noted that the unmanned systems business is as "robust internationally" as it is domestically. "Farnborough offers us a very exciting opportunity to showcase our unmanned solutions before a broad set of customers from around the world," Sweberg said.

Davis and Sweberg will conduct media briefings during the air show.



PHOTO: Insitu's Kristopher Froehlich, lead air vehicle technician, downloads telemetry files from the Boeing subsidiary's new Integrator unmanned aerial vehicle, which can carry a heavier payload than Insitu's successful ScanEagle. **BOB FERGUSON/BOEING**

of sensors and a manipulator arm. It also can traverse 6 inches (15 centimeters) of water.

Boeing's Echo Ranger, on the other hand, can explore ocean depths of 10,000 feet (3,000 meters). It is a large, autonomous unmanned underwater vehicle, or UUV, capable of performing commercial surveys, as well as intelligence, surveillance and reconnaissance missions for the military.

But it is the unmanned aerial vehicles that are getting most of the attention these days.

"Boeing has a varied portfolio of unmanned systems designed to meet the rapidly evolving needs of the warfighter," said Chris Chadwick, president of Boeing Military Aircraft. "Our customers have always looked to us for best-of-industry solutions, and the unmanned systems market is no different."

The fast-growing market for unmanned aerial vehicles (UAVs) saw sales surpassing \$4 billion last year and is forecast to more than double over the next decade. Some 50 companies around the world today offer about 300 UAVs of all sizes and descriptions.

"A multitude of new mission capabilities and concepts of operation is emerging right now for UAVs that people never imagined," said Vic Sweberg, director of Boeing's Unmanned Airborne Systems. "That is what's driving growth on the military side today, and it will spur similar growth in commercial markets down the line."

Boeing currently markets more than a half-dozen unmanned aerial vehicles. "This product line benefits from our structures, control system, aerodynamics and other strengths as a developer of manned aircraft," Sweberg added.

Strategic acquisitions such as Insitu have further strengthened the Boeing Defense, Space & Security portfolio of unmanned capabilities.

Insitu's latest product is the Integrator, a UAV that meets military needs for a larger, more robust stablemate to ScanEagle. In addition to its standard sensor array, Integrator can carry 25 pounds (11 kilograms) of payload for 15 hours or, like ScanEagle, be configured for 24-hour missions.

"Integrator's name reflects our driving focus on seamless payload integration to rapidly support our customer's missions and intelligence, surveillance and reconnaissance needs," said Insitu's Clark.

Intelligence, surveillance and reconnaissance is the primary role of UAVs, the others being mobility, strike applications and communications relay. Within these categories, the list of current or possible UAV applications is large and growing fast.

Take Boeing's A160T Hummingbird, an unmanned rotorcraft. In March, in a demonstration for the U.S. Marines, a Hummingbird flew two 150-nautical-mile (278-kilometer) round trips to shuttle 2,500 pounds (1,134 kilograms) of cargo from one simulated forward operating base to another—in less than five hours.

"In military service, Hummingbirds could potentially save lives in war zones by substituting for trucks vulnerable to roadside [bombs]," Sweberg said. "Down the line, this type might play a wide variety of civil roles. With its performance, I can even imagine it retrieving injured climbers from the world's highest peaks."

Earlier this year, Boeing put the nearly all-composite A160T into production in Mesa, Ariz. Paulina Bryant is a veteran composite fabrication expert there, helping to build the A160T. "Boeing has had top talent on this project from the beginning," Bryant said. "We are all excited to see the Hummingbird in production at Boeing Mesa and view unmanned systems as the wave of the future."

Boeing has built and delivered unmanned aerial vehicles

"Boeing has a varied portfolio of unmanned systems designed to meet the rapidly evolving needs of the warfighter."

— Chris Chadwick, president of Boeing Military Aircraft

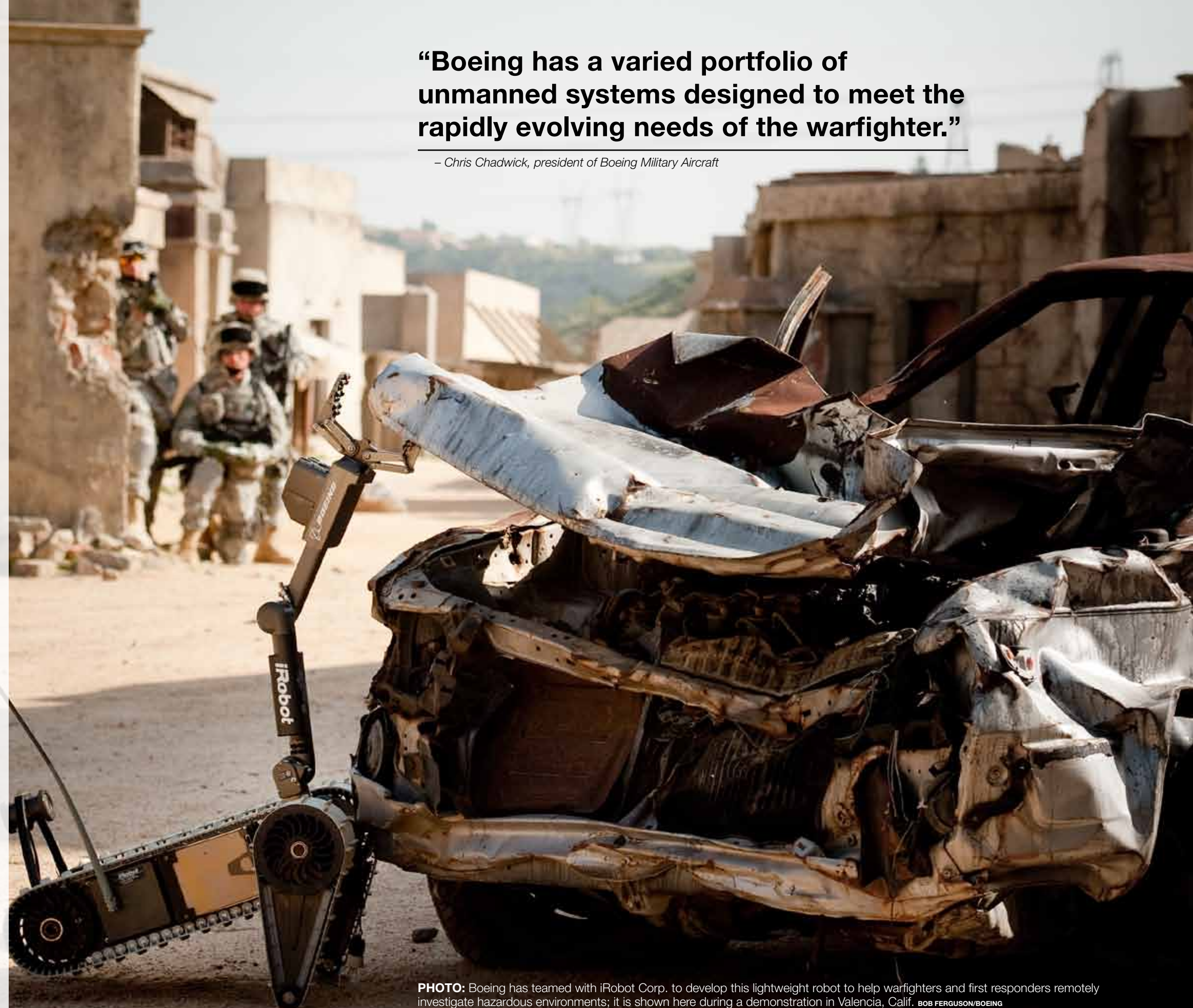


PHOTO: Boeing has teamed with iRobot Corp. to develop this lightweight robot to help warfighters and first responders remotely investigate hazardous environments; it is shown here during a demonstration in Valencia, Calif. BOB FERGUSON/BOEING



“Boeing’s UAV focus is on autonomy.”

— Ron Perkins, director of Advanced Unmanned Airborne Systems for Phantom Works

PHOTO: Lead mechanic Ray Rich secures a cargo sling to a Boeing A160T Hummingbird rotorcraft during testing in Victorville, Calif., earlier this year.

KEITH SKELTON/BOEING

and spacecraft over many decades, but today’s products are fundamentally different.

“Boeing’s UAV focus is on autonomy,” said Ron Perkins, director of Advanced Unmanned Airborne Systems for Phantom Works. “Our UAVs literally fly themselves. We don’t have remote pilots at the controls. We use sophisticated software that allows us to ‘fly by mouse,’ which reduces the number of people required to perform a mission and provides combat commanders more flexibility.”

Bob Feldmann, vice president and general manager of Airborne Battle Management, agreed. “We’re working with our military customers to help incorporate UAVs into their integrated battle-management environments, where they can enhance situational awareness and otherwise contribute to achieving military objectives,” he said. “In this information-rich environment, manned/unmanned interoperability is a key capability.”

A Boeing 737 Wedgetail, an Airborne Early Warning & Control aircraft, has already demonstrated during a test in Australia that it can control three ScanEagles in flight. In the near future, according to Feldman, UAVs will improve the ability of the Navy’s new P-8A Poseidon, a modified 737, to find and track subs and surface vessels.

UAVs can be more economical and better for the environment than manned aircraft. They can also stay aloft longer—about 2,000 days in the case of the SolarEagle, which will have a wingspan twice that of a 747.

SolarEagle’s performance comes from a combination of non-hydrocarbon fuels, nontraditional power systems and very lightweight, flexible structures. “The result is satellite-like capabilities with lower cost and greater flexibility,” said Pat O’Neil, Boeing’s program manager for SolarEagle.

The ultra High Altitude Long Endurance (HALE) aircraft will be able to provide continuous observation in roles such as border surveillance, port security, environmental monitoring and hurricane tracking. It can also provide vital communications relay for disaster relief.

Another HALE aircraft currently under way with Phantom Works is the Phantom Eye demonstrator. Like SolarEagle, Phantom Eye, a propeller-driven aircraft with a 150-foot (46-meter) wingspan and powered by two modified hydrogen engines, will fly at 65,000 feet (19,800 meters). However, instead of staying aloft for five years, Phantom Eye is designed to stay on station for up to four days to perform missions similar to SolarEagle.

What does the future hold? UAVs may someday share the same sky with aircraft that carry people. “This will happen once further advancements in autonomy, sense-and-avoid and air traffic management technologies combine with an updated regulatory framework to ensure safe operations,” Sweberg said.

Last month, the Federal Aviation Administration announced that Insitu will provide it with a ScanEagle system for research leading to recommendations for integrating unmanned aircraft into the U.S. airspace system.

“We create platforms with capabilities that are highly desired by several key customers,” said Davis, Phantom Works president. “It’s an exciting time because we are creating the future of unmanned aircraft, and the future is now.” ■

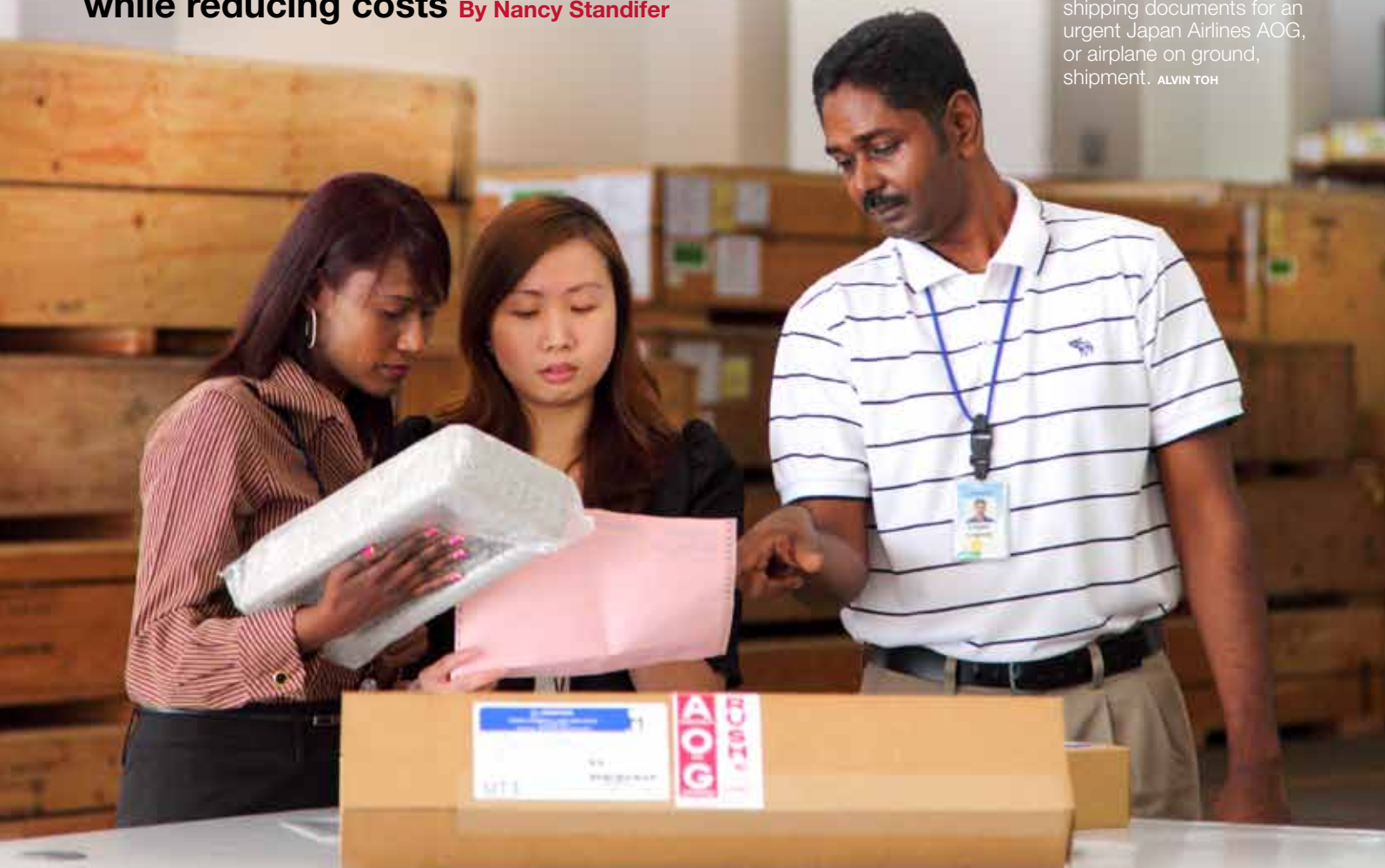
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To learn more about ScanEagle and Boeing’s Unmanned Airborne Systems, see the story beginning on Page 14 in the July 2009 issue of Frontiers.

Parts of the solution

This Boeing service manages an airline's spares inventory, improving availability while reducing costs **By Nancy Standifer**

PHOTO: Jaya Veeramani (from left), Eunice Ng and Logan Logaraj, material planners, review the shipping documents for an urgent Japan Airlines AOG, or airplane on ground, shipment. **ALVIN TOH**



It's Monday morning at the Boeing Asia Regional Center in Singapore, and Logan Logaraj has a challenge.

Japan Airlines (JAL) has issued an order for its 767 fleet—a flap-bearing inspection. The work on the 11 767s in the Tokyo-based airline's fleet is to be handled during regular maintenance over the next 10 months. Boeing's Integrated Materials Management on-site team at JAL has asked the regional center to coordinate with suppliers so the work can be accomplished on schedule without unnecessary costs.

That's Logaraj's task. A material planner at the Singapore Distribution Center at Changi Airport, he knows some parts required for the job have long lead times for delivery; some are in short supply. He must ensure the 28 parts needed for the flap-bearing inspection are available as each jetliner comes in for maintenance.

Material Management Services employees work closely with customers to maintain and manage airlines' spare-parts inventories. They are part of Commercial Airplanes' Seattle-based Commercial Aviation Services, which supports customers around the world. The team manages supplier-owned inventory at airline

maintenance locations. That helps ensure parts are available, costs are as low as possible and pricing is predictable.

"Boeing has completely satisfied us by meeting our demand dates even when the schedule for an inspection is very tight," said Nobuyuki Okamura of JAL's Haneda Material & Component Management Department.

"We are proud to offer services that help our customers operate their business more efficiently," said Scott Rasmussen, director of the Integrated Materials Management, Asia Regional Center.

For JAL, the mandated flap-bearing inspections were completed on time and as part of scheduled maintenance.

"The program has the potential to save customers 20 percent in inventory purchases, holding cost and supporting infrastructure over the life of an agreement," said Larry Grulich, a material planner. "Ultimately, that saves millions of dollars even as it improves the service level to the airline mechanic."

It's also a great example, he added, of "One Boeing"—employees in Seattle and Asia working together to help customers. ■

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THE GO TEAM

The aim of these Boeing investigators is to make flying even safer than it already is **By Sandy Angers**

PHOTO: Boeing air safety investigator Rick Mayfield (kneeling) examines runway marks with investigators from the National Transportation Safety Board and Federal Aviation Administration during a 2007 investigation. **NATIONAL TRANSPORTATION SAFETY BOARD**

As an air safety investigator, Rick Howes knows he could get a call in the middle of the night that could send him packing for some remote region of the world.

Howes is a part of a specialized team of Boeing investigators who assist government agencies in determining the cause of airplane accidents. These investigators—six of whom are based in Washington state and two in California—must be ready to go anywhere an accident has occurred within hours of the event.

Approximately 6 million people fly safely to their destinations every day, making flying one of the safest modes of transportation. Howes' job—and that of the Boeing investigative team—is to help keep it that way.

Although the aviation industry focuses on preventing airplane accidents in the first place, tremendous effort goes into investigating them. The goal is to learn from any accident.

"That's our charter—to determine the cause so we can prevent it from happening again," Howes said.

International protocol, defined by the International Civil Aviation Organization treaty, establishes that a government with jurisdiction over an accident site leads an investigation. Accredited representatives from the countries of the airplane's manufacturer, designer, operator and registry are invited to join the investigative team. For international accidents involving Boeing airplanes, the accredited representative is the U.S. National Transportation Safety Board. The NTSB leads all domestic investigations.

Boeing's role is to support the NTSB as technical adviser.

Because accidents typically result from a chain of events, investigating and determining probable cause can be complex.

"First impressions are not usually correct. We don't rely on speculation; evidence determines what really occurred," said Tom Dodt, chief engineer of Boeing Air Safety Investigation.

That's why investigative teams follow a disciplined process that includes data gathering and analysis.

During the initial hours after an accident, Boeing mobilizes a "go team" to join the NTSB. These investigators usually lead a small, preselected field team that can include experts on structures,



PHOTOS: (Clockwise, from top left) Boeing investigator Rick Howes helps determine the bank angle of an airplane that hit trees in a Peruvian swamp. **NTSB** Boeing investigator Simon Lie, on a Taiwanese Coast Guard boat, uses a receiver to locate "pinger" signals from the flight data recorder and cockpit voice recorder of an aircraft in a 2005 accident. **TAIWAN AVIATION SAFETY COUNCIL** Boeing investigator Lori Anglin (left) examines an airplane that sustained fire damage during a major incident in which no one was injured. **NTSB** Boeing investigator Bill Steelhammer examines a wingtip of an MD-80 from a 2007 accident in Turkey. **PRATT & WHITNEY, NTSB** Boeing investigator Richard Andersons matches a damaged interior panel to an oxygen cylinder while examining a decompression incident. **KEN HICKS/BOEING, NTSB, AUSTRALIAN TRANSPORT SAFETY BUREAU** Boeing investigator Mark Smith documents a 2007 accident site in an Amazon jungle. **NTSB**

“First impressions are not usually correct. We don’t rely on speculation; evidence determines what really occurred.”

– Tom Dodt, chief engineer of Boeing Air Safety Investigation



systems, performance and human factors, as well as a pilot.

At the scene, the investigator in charge gathers NTSB and other members of the investigative team, including Boeing personnel, to establish what’s known and set initial priorities for the investigation. Among the first of these is to retrieve the flight data and cockpit voice recorders, known as black boxes. These can quickly provide the investigation with some focus and help corroborate other factual information collected in the field. Still, all parties of the investigation must resist the temptation to draw early conclusions.

“That’s challenging because as engineers, we want to resolve things. But part of our training as investigators requires us

to let the data speak for itself in the days, weeks or months to come,” Howes said.

A “go team” can be in the field for several weeks, depending on the location and condition of the site. Generally, accidents over an ocean can lengthen the field phase, but not always.

Even on land, an accident site can be difficult to find or access. Sometimes, roads have to be built to the site, or teams have to hike through jungles or use helicopters to reach a mountaintop.

Once work in the field concludes, the team returns home for the analysis phase, work that can often take a year or more to complete.

“We have data and information at this point, but we have to go about turning

that data into knowledge, which can be used to prevent future accidents,” Dodt said.

Data from the black boxes are analyzed. Recovered airplane components are examined and tested as required. At the request of investigative authorities, Boeing frequently provides analytical tools and capabilities as well as access to company test labs and flight simulators.

From 20 to 100 Boeing employees can be involved in supporting this phase, depending on the amount of available data. Based on their knowledge of the airplane, Boeing specialists can determine whether a particular part sustained damage prior to or as a result of the accident.

Once analysis is complete, the

investigative authority draws conclusions and publishes a final report, which typically includes safety recommendations that may be directed to a regulator such as the U.S. Federal Aviation Administration, as well as to the airplane operator, air traffic control or manufacturers.

These recommendations may be implemented before the investigation is complete. For example, in the case of the January 2008 crash landing of a 777 at Heathrow Airport, in which all passengers and crew were safely evacuated from the jet, a team led by the UK Air Accident Investigation Branch discovered the reason both engines lost thrust as the airplane approached the airport.

The team learned that on long-range

flights during winter, where fuel temperatures can be below freezing for extended periods, ice from water that is naturally present in fuel can accumulate inside the fuel feed system. On rare occasions, ice can release and collect at the engine heat exchanger, restricting fuel flow to the engine.

Boeing quickly worked with regulators and operators to implement temporary flight-crew procedures while the engine manufacturer redesigned the engine heat exchanger. The redesigned component was certified and installation was mandated last year.

“By the time the final report came out earlier this year, there were no additional recommendations in that specific area,

because corrective action was already under way,” said Mark Smith, a Boeing air safety investigator. ■

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For more information about Boeing’s efforts to advance aviation safety, visit www.boeing.com/commercial/safety/index.html

Constructive relationships

Boeing has a long and important history with Europe, and a strong voice in Brussels, home of NATO and the EU **By Bill Seil**

Europe is a major market for The Boeing Company. It is also the home of important partners and suppliers, and a leading source of advanced technology.

The European Union, headquartered in Brussels, is Europe's primary regulatory body. It represents 27 member countries and nearly 500 million people. Decisions made by the European Union—many of which affect aviation, defense and environmental issues—have both regional and global implications.

"It's essential that we get involved in discussions before the EU when they involve issues that affect our industry," said Shep Hill, president, Boeing International, and senior vice president, Business Development and Strategy. "But we need to understand

those issues from a European perspective. That adds to our ability to educate and inform, and to work in concert with those whose decisions impact our business."

The Boeing Brussels office represents the company before the EU as well as the Brussels-based North Atlantic Treaty Organization. Its role is similar to that of the company's office in Washington, D.C. Employees in the U.S. capital are a short distance from Congress, federal executive offices and the Pentagon. The company's Brussels office is less than 15 minutes away from both the EU institutions and NATO headquarters.

Antonio De Palmas, Boeing president of European Union and NATO relations, said it's vital for Boeing to be part of the European community and be a player

in European decision-making. "As a function of our being a global company, it is not sufficient in today's business environment to simply establish a sales presence," he said.

The Boeing Brussels office is unique among the company's European locations. It focuses on governmental issues and is not directly involved in sales. Boeing business operations for the country of Belgium are handled out of the company's Northern Europe office, located in Amsterdam.

Brussels draws many advocates from various European and global interests, so the competition for attention and access within EU institutions is intense, De Palmas noted. Organizations that succeed are often those with an ability to build broad-based coalitions and establish constructive

relationships with policymakers.

"We are here because we are committed to building constructive relationships with EU decision-makers," De Palmas said. "We are an integral part of the European aerospace community, with customers, suppliers and employees throughout the region. In addition to protecting our own interests, we want to work within the EU to advance solutions that strengthen the success, safety and environmental performance of our industry and ultimately make our customers stronger."

The Brussels office works closely with the company's business units and its individual country offices throughout Europe. The Brussels team is focused on gathering information, driving advocacy

and positioning the company within the political environment.

"Our engagement and alignment with the business units and the company's Washington, D.C., office is of the essence," De Palmas said. "Washington and Brussels are important regulatory capitals, and they produce most of the rules and policies that are followed around the globe. They have a number of joint activities and parallel agendas that shape a variety of critical issues like the environment, air safety, air traffic management, defense and security."

Boeing is actively involved in issues

PHOTO: Antonio De Palmas, president of Boeing European Union and North Atlantic Treaty Organization relations, represents the company to EU and NATO decision-makers. ASSOCIATED PRESS

EU at a glance

BY THE NUMBERS

- **Countries:** 27
- **Population:** About 492 million (July 2009 estimate)
- **Area:** About 1.7 million square miles (more than 4.3 million square kilometers)
- **GDP:** \$14.51 trillion (2009 estimate)
- **Official languages:** 23

Source: Europa

EU members

Austria	Latvia
Belgium	Lithuania
Bulgaria	Luxembourg
Cyprus	Malta
Czech Republic	Netherlands
Denmark	Poland
Estonia	Portugal
Finland	Romania
France	Slovakia
Germany	Slovenia
Greece	Spain
Hungary	Sweden
Ireland	United Kingdom
Italy	

such as market liberalization and trade, and the company also contributes to research and development activities promoted by the European Union to support technological innovation.

"I think environmental issues are currently among the most complex and strategic of those we're following," De Palmas said.

High on the list of the company's environmental priorities is reducing airplane emissions, including carbon dioxide and nitrogen oxide, and helping to advance the commercialization of sustainable aviation biofuels.

The other primary responsibility of the Boeing Brussels office is representing the company at NATO headquarters. While NATO has been a cornerstone of international security for more than 60 years, its role has changed significantly since the Cold War. Today, the defense alliance is more involved in peacekeeping operations and includes a number of Central and Eastern European nations. While NATO itself makes few purchases of military hardware, it does set standards for member nations that wish to participate in NATO operations.

NATO's largest commonly funded project is a fleet of 17 Boeing Airborne Warning and Control System E-3A radar aircraft and three training and cargo planes. In 2009, Boeing delivered three C-17 airlifters to the Strategic Airlift Capability consortium, comprising 12 NATO and Partnership for Peace nations.

Like NATO, the European Union has changed over the years. The EU's foundation was formed in the late 1950s when, as a first step, leaders of six countries (Belgium, France, Italy, Luxembourg, the Netherlands and West Germany) founded the European Coal and Steel Community. But its influence grew dramatically with the creation in the late 1980s of the European Single Market, an integrated area with common rules for the free circulation of goods, services, people and capital. Today the EU is Europe's primary regulatory body, deciding a substantial majority of social and economic matters affecting its member countries, which makes Brussels and the EU critical to the business community.

De Palmas said one might have the misconception that Boeing has an adversarial relationship with the EU because



"We are an integral part of the European aerospace community, with customers, suppliers and employees throughout the region."

— Antonio De Palmas, Boeing president of European Union and NATO relations

Europe is the home of the company's competitor, Airbus, and its parent, EADS. But Brussels is a complex ecosystem and diverse views are often needed to deliver effective and meaningful policies. The EU has welcomed Boeing as an industry participant, he said. More often than not, the company has joined forces with its aerospace competitors to push for policies that strengthen commercial aviation and the success of customer airlines, he added.

One area of conflict has been the recently decided case before the World Trade Organization (WTO) regarding European government launch aid to Airbus. In this case, the European Union and the United States government were engaged in a lengthy legal contest. The complaint, filed by the U.S. Trade Representative, charged

that these subsidies are illegal. Boeing strongly supported the U.S. government taking this case to the world's ruling body on trade issues, noting that European governments paid the development costs of early Airbus products. Although the ruling has not yet been made public, people familiar with the details have said the WTO agreed Airbus launch aid is improper.

In response to the U.S. case, European officials filed a counter-complaint that alleges Boeing has also received illegal subsidies over the years, mostly related to government research and development spending. A WTO ruling on that case is still pending.

Despite the intensity of this debate on both sides of the Atlantic, Hill said the working relationship between Boeing and

the EU remains strong and positive.

"There are always going to be areas of disagreement and dispute," Hill said. "But there are also many areas of commonality where Boeing, the EU and Airbus are working together to address matters of mutual concern. We've signed collaborative agreements on air safety, air traffic management and airplane emissions, and that work continues."

Boeing has a long history with Europe, with many established customer relationships and business alliances, Hill noted. As a global company, Boeing also has a strong business presence in the region.

"Having our team in Brussels gives Boeing a voice in a governmental center that affects our company in many ways," Hill said. "That presence sends a clear

message that Boeing is not just a distant corporation. We are part of the fabric of Europe and have been for a long time." ■

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PHOTOS: (Clockwise, from top left) Lab technicians from Honeywell's UOP conduct fuel testing on camelina biofuel. Boeing is working with UOP and others to research, test and commercialize sustainable plant sources that can help government and military customers lessen dependency on fossil fuels. **UOP** One of NATO's 17 Boeing Airborne Warning and Control System aircraft in flight. **BOEING** The European Parliament building in Brussels. **SHUTTERSTOCK.COM** An artist's concept of a Boeing 787 in the livery of LOT Polish Airlines, which will be a 787 operator based in Europe. **BOEING** A Boeing 777 model graces a conference room table at Boeing's Brussels office. **BOEING**

EU

10 historic steps

1951 The European Coal and Steel Community is established by the six founding members

1957 The Treaty of Rome establishes the European Economic Community, or EEC

1973 The Community expands to nine member states and develops common policies

1979 The first direct elections to the European Parliament

1981 The first Mediterranean enlargement

1993 Completion of the single market

The Treaty of Maastricht establishes the European Union

1995 The EU expands to 15 members

2002 Euro notes and coins are introduced

2004 Enlargement on an unprecedented scale—10 more countries join the Union

Source: Europa



EU

in practice



The European Union is a unique economic and political partnership between 27 democratic European countries.

How does it work?

Three primary institutions produce the policies and laws that are enforced widely throughout Europe:

- The European Parliament represents the people of Europe.
- The Council of the European Union represents national governments.
- The European Commission represents the common interests of the union and proposes legislation.

Source: Europa
Photo: Shutterstock.com

Environment for change

Boeing, the EU and the aerospace industry are working together to improve environmental performance

The European Union, Boeing and the aerospace industry share a deep concern for the environment. The challenge comes in developing technologies, standards and regulations that best address a range of complex issues.

Boeing is in contact with European Union officials, as well as European governments, and commercial and military customers, to support finding global solutions to aerospace environmental concerns, according to Mary Armstrong, Boeing vice president for Environment, Health and Safety.

“Our overall environmental strategy fits well with priorities expressed by Europe and other regions throughout the world,” Armstrong said. “We take a life-cycle approach that includes environmental planning from the time our products are designed to the point where they are recycled at the end of their useful life.”

About one-third of the company’s commercial airplane customers are based in Europe, and many others use European airports. In addition, a number of European companies are part of Boeing’s supply chain. Environmental regulations set by the European Union can have a major impact.

“Given the global nature of our industry, our goal is to have commercial airplane emissions policies harmonized around

the world,” said Bill Glover, managing director of Environmental Strategy for Boeing Commercial Airplanes. “We want to avoid having a patchwork of different regulations.”

Glover noted the aerospace industry is working to aggressively improve its environmental performance, with the aim to achieve carbon neutral growth across the industry by 2020. The industry has called for global guidelines setting high fuel efficiency standards for new airplanes, improvements in the global air traffic control system to reduce air-travel-related carbon dioxide emissions and continued efforts to commercialize sustainable biofuels.

Boeing has made significant progress in reducing emissions in its own products. Its newest jetliners, the 787 Dreamliner and the 747-8, are designed for significantly greater fuel efficiency and reduced emissions. The company is also reducing emissions on its existing models.

One long-term approach to reducing airplane emissions is through the development of sustainable biofuels. EU policies, such as the Renewable Energy Directive, can dramatically impact the development and commercialization of aviation biofuels. Boeing is taking an active role in discussions, directly and through industry groups, as these policies are being written.

Brought together by Boeing in 2008, the Sustainable Aviation Fuel Users Group (SAFUG) believes carbon neutrality is achievable. “But we need the support of many parties, including governments,” said Willemijn van der Werf, corporate manager of Environmental Strategy for KLM Royal Dutch Airlines, and KLM representative to SAFUG. “Through the European chapter of SAFUG, members are working together to help educate regulators and influence EU legislation to stimulate the creation of a viable sustainable aviation biofuel market.”

Boeing’s Glover said EU policies are very important to the company and Boeing is addressing their concerns. “But ultimately we all need to take a global perspective to find solutions that serve a worldwide market.”

— Bill Seil

PHOTOS: (Above) A KLM Boeing 747-400 in November flew a sustainable biofuel demonstration flight with one engine fueled by a 50/50 mixture of camelina-based biofuel and traditional kerosene. KLM is a founding member of the Sustainable Aviation Fuel Users Group. **(Right)** Controllers work in the air traffic control tower of Amsterdam Airport Schiphol, where Boeing advanced air traffic management concepts were tested.

AIR TRAFFIC CONTROL-LVNL

One Europe, one sky

Improving Europe’s air traffic management system is a priority

The European Union, with the support of Boeing and the commercial aviation industry, is working intently to address the challenge of fragmentation of its air traffic control network.

While the U.S. Federal Aviation Administration has the advantage of controlling air traffic within the boundaries of one geographically large nation, Europe is divided into many nations that have independent air traffic control systems.

The European Union’s Single European Sky initiative has been working to transform the air traffic control system. Boeing and Airbus are jointly supporting the timely implementation of global interoperability in air traffic management (ATM).

The European Commission created a program called SESAR, short for Single European Sky ATM Research. “SESAR’s goal—like that of our FAA counterpart, NextGen—is to develop air traffic control systems that establish a homogenous air traffic system, with the technology and systems needed to increase safety and efficiency,” said Patrick Ky, executive director of the SESAR Joint Undertaking.

In addition to building a more efficient commercial air system, the network is being designed to allow NATO and other military training exercises to operate more

safely in restricted airspace, away from commercial flight paths.

“It’s really important for our customers that SESAR succeed,” said Neil Planzer, vice president, ATM Transformation, Boeing Commercial Airplanes. “We need an interoperable system between the U.S. and Europe. If we can cover these two regions—roughly 80 percent of the world’s air traffic—we’re on our way to interoperability worldwide.”

Mike Lewis, director of Aviation Infrastructure for Commercial Airplanes, said Boeing has been a strong advocate for bringing continuity to air traffic management systems.

Growth of the airline industry to accommodate greater traffic depends on the implementation of global interoperability. Improvements in air traffic management also represent the best short-term opportunity to reduce carbon dioxide emissions by jetliners.

Paco Escarti, managing director of Boeing Research & Technology, Europe, said the company’s research facility in Madrid is working on aircraft guidance technologies to allow continuous descent landing approaches at highly congested airports.

“This is a project we’re very excited about, because of its possibilities for enhancing airport operations,” Escarti said.

— Bill Seil



NATO

at a glance

FAST FACTS

- **Members:** 28 countries
- **Military personnel engaged in NATO missions:** About 70,000
- **Current operations:** Afghanistan, Kosovo, Iraq, the Mediterranean, off the Horn of Africa and in Somalia

KEY MILESTONES

- **1949:** The North Atlantic Treaty is signed in Washington, D.C.
- **1950:** General Dwight D. Eisenhower is appointed the first supreme allied commander of Europe.
- **1967:** New NATO Headquarters is opened in Brussels.
- **1995:** NATO launches its first military operation, to end violence in Bosnia and Herzegovina.
- **2003:** NATO leads security efforts in Kabul, Afghanistan, in its first mission beyond the Euro-Atlantic area.

Source: NATO

NATO members

Albania	Latvia
Belgium	Lithuania
Bulgaria	Luxembourg
Canada	Netherlands
Croatia	Norway
Czech Republic	Poland
Denmark	Portugal
Estonia	Romania
France	Slovakia
Germany	Slovenia
Greece	Spain
Hungary	Turkey
Iceland	United Kingdom
Italy	United States

A model defense

New approaches to European defense are creating opportunities for Boeing

The NATO alliance was created during the Cold War to provide military defense to Western Europe and enhance international security. Today, it is involved in humanitarian and peace-keeping missions, including a presence in Afghanistan.

Antonio De Palmas, Boeing president of European Union and NATO relations, said NATO, the organization, is important because it sets the standards for individual countries to participate in NATO missions and can influence the defense spending of its member countries. In addition to NATO, the European Defence Agency, he added, is set to play an increasingly important role in helping member states develop their military capabilities.

"To be successful, you really have to understand the political dynamics and build relationships," De Palmas said.

And that's just what Boeing has been doing.

Take the innovative sale to NATO of three Boeing C-17s, which were delivered in 2009 to Pápa Air Base in Hungary. The 12-nation Strategic Airlift Capability (SAC) consortium was formed to jointly purchase the cargo planes on what can be thought of as a "time share" basis. Each of the 10 NATO countries and two Partnership for

Peace nations in the consortium can use the C-17s for national and allied missions.

"The SAC approach to shared use of the strategic airlifter is viewed as a model for future acquisition and management of defense capabilities," said Tommy Duneheew, vice president, Business Development, C-17 Program. "The same model could be applied for other international defense and Boeing programs."

Gunnar Borch, general manager of the NATO Airlift Management Agency, said the SAC purchase of the C-17s succeeded, while similar efforts in the past ran into obstacles.

"Pulling this program off in such a short time was a fantastic achievement for the participating nations," Borch said. "It demonstrates that not all NATO nations need to be involved to start a successful program. It also opens the door to growth as other member nations see its benefits."

Discussions are also taking place to apply the concept to helicopters and other military platforms.

NATO's largest aircraft project is its fleet of 17 Boeing Airborne Warning and Control System (AWACS) aircraft. In 2008, a team led by Boeing completed a major upgrade for the NATO planes. It was

completed on schedule by the European Aeronautic Defense and Space Company, or EADS, as an industry partner and subcontractor to Boeing.

Beyond the AWACS modernization program, there is a potential market for upgrading existing NATO equipment as well as providing logistics and training services, according to Mark Kronenberg, vice president, International Business Development, Boeing Defense, Space & Security.

"I think the European market for military products is evolving from where it was 15 years ago," Kronenberg said. "That market was very platform-centric. While opportunities still exist for the sale of military platforms like CH-47 Chinook helicopters and C-17s and Super Hornet fighters, we're seeing a growing trend toward providing logistic services, training and upgrades to provide future growth."

— Bill Seil

PHOTOS: Multinational crews of the Strategic Airlift Consortium's Heavy Airlift Wing are shown in formation at Pápa Air Base, Hungary. The consortium's 12 participating nations operate three shared Boeing C-17s out of Pápa. JERRY DRELLING/BOEING

One Boeing, in any language

A diverse team with an international assignment

The Boeing Brussels office has evolved in recent years from a regional sales headquarters to a governmental affairs office focused on the European Union and NATO.

Today, the office is staffed by a team of 18 people—about one-third the size it was five years ago when it hosted Boeing Commercial Airplanes' European sales office. The sales operation moved to London in 2005.

Since then, its primary mission has been to serve as the company's voice before the EU and NATO.

Linda Seber, Boeing's director of Human Resources for Europe, the Middle East and Africa, joined the Brussels office in 2001. She said the staff is among the most diverse in the company, with nationalities including Belgian, Italian, British, Turkish, Chinese, Hungarian and citizens of the United States.

"Discussions are always very interesting, because people have so many perspectives," Seber said.

In addition to Boeing International employees, the Brussels team includes representatives from Shared Services Group, Information Technology, Human Resources and International Corporate Communications. It also hosts other

Boeing personnel, including Commercial Airplanes' Field Service and Supplier Quality representatives.

Although the team's working language is English, individual conversations often take place in a variety of languages. Belgium has three official languages: French, Dutch and German.

Along with the EU and NATO, Brussels is home to the regional headquarters of a number of other multinational companies, including FedEx, Toyota and General Electric. "Living and working in such a cosmopolitan, yet small country centrally located at the heart of the EU," Seber said, "fosters an outward-looking state of mind and provides for a diverse professional and social life."

— Bill Seil

PHOTO: Boeing employees in the Brussels office (standing, from left): Eszter Ungar, Sarah Clerens, Yuhang Zheng, Gary Van de Ven, David Packer, Antonio de Palmas, Sabine de Brauwer, Linda Seber and Alison Chapman; (sitting, from left) Nathalie Gille, Peter Van Pellicom, Fabienne Jacob, Annalisa Monaco and Thao Nguyen. Not pictured: Nathalie Van Damme.

PIERRE WATCHOLDER

'Helo' again

Learning to fly the Apache Longbow helicopter begins in a Boeing-developed simulator

By Alison Sheridan and photos by Bob Ferguson

Boeing Mesa employee David Hosea was itching to get back into the cockpit of an Apache, the Boeing-built helicopter he had once flown in the U.S. Army as an instructor pilot.

So he lost nearly 60 pounds (30 kilograms). He had a bum knee repaired. And now he's completing the very Apache Longbow simulator training he has been supporting as a Boeing employee.

"Those first two hours were pretty sad," Hosea, a field engineer in Mesa, Ariz., said of his first time in the D-model Apache simulator. "I was very rusty. But the second time I got in, what had taken me 45 minutes the first time only took me 15. This is a huge advantage because you aren't burning up valuable blade time in an actual aircraft."

Hosea had helped develop the simulator after he joined Boeing 12 years ago. He previously spent nine years in the U.S. Army flying the AH-64 A-model Apache, but he received a medical discharge due to a knee injury. He decided the next best thing to flying the Apache was working with the helicopter, so he went to work for Boeing in Mesa and eventually transferred to St. Louis. There, as a member of Training Systems & Services, he worked on the original Apache Longbow Crew Trainer program.

He spent time in Iraq with Boeing, as an operational maintenance manager for the Longbow Crew Trainer, and eventually returned to Mesa, where his job in the Field Engineering organization is to coordinate the resolution of field issues involving the Apache.

But he wanted to fly the Apache again, so he re-enlisted in the Arizona Army National Guard and, to make sure he met the active-duty pilot qualifications, went through his own personal training program. Getting his knee repaired proved pretty easy. But he also took Boeing's online health assessment and researched tips on diet and exercise on the Boeing Wellness website. Hosea changed his diet, started bicycling until he was riding up to 35 miles (55 kilometers) a day—and lost 58 pounds (26 kilograms).

He also began another kind of training program—in the Longbow Crew Trainer he had helped bring into existence. It simulates the helicopter's fully integrated avionics and weapons, including a modem that transmits real-time, secure, digitized battlefield information to air and ground forces.

The Longbow simulator, Hosea noted, "allows you to go through the maneuvers and 'freeze' the trainer at any point in time. The instructors can get up from their station and walk over to you and provide instant feedback."

Boeing has delivered 29 of the Longbow trainers worldwide, including to locations in Iraq and Afghanistan. The trainers, which can be linked together in a network, allow pilots ample opportunity to meet training requirements and to rehearse missions.

"I love the Apache and I've seen the LCT save lives—for instance, you can't practice landing in 'brownout' or dust-obscured visibility conditions in an aircraft to the same level as you can in the trainer," Hosea said. "When I think about how I get to work with the Apache and get to fly it, I realize, dang—I'm a lucky guy!" ■

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"I get to work with the Apache and get to fly it ... dang—I'm a lucky guy!"

— David Hosea, Boeing field engineer, Mesa, Ariz.



Cable vision

Expertise developed to support space shuttle operations could help other Boeing programs take flight **By Tabatha Thompson**

Seven million pounds of thrust from its three main engines and two solid rockets produces a whole lot of shaking when a space shuttle blasts off. More than a year before each mission, a Boeing team in Houston begins mapping out the complex system of cabling and brackets that keeps the electrical wiring stable and connected for powering, controlling and monitoring the shuttle's valuable onboard cargo.

The process has become even more effective and efficient as a result of the avionics integration team engineers' taking part in a Lean+ pilot project to test a new modeling program, called Capital Harness Systems.

With the shuttle program winding down, the team hopes to apply that capability to other Boeing programs.

Capital Harness Systems involves the use of 3-D tools to map out the most logical path for electrical cables. It also provides a list of all materials the team needs to tackle each job.

Manager Jack O'Neill said the Boeing team shaved about 50 percent off labor costs after switching to the new system. Engineers in the Mission Engineering

Room at Johnson Space Center also can refer to Capital Harness Systems—generated drawings to troubleshoot glitches during flight.

"They're good electrical engineers and use tools for problem-solving on a daily basis," said Mariella Hartgerink with United Space Alliance, the joint venture by Boeing and Lockheed Martin and space shuttle operations contractor. She has worked with O'Neill's team for 12 years.

"We had a failure on one of our pieces of hardware, called the remotely operated electrical unit, in 2008 when the orbiter was in space," Hartgerink said. "I worked with the Boeing Houston guys, Jack O'Neill's group. We found out what the problem was and we fixed it."

The shuttle program is set to end at the close of the year or in early 2011, but O'Neill and his team want to keep critical capabilities they learned on the program available to colleagues throughout the company.

"Wire harness design tools exist in all Boeing design facilities, O'Neill said. "They're used in helicopters, aircraft, spacecraft and satellites." Boeing engineer Samer Hasbani said the

system has worked great for the shuttle program and he is excited about the possibility of other applications within Boeing. "It has a much higher capability," he said. "It could be used for anything being started from scratch, any vehicle using different components that need to connect to each other." ■

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PHOTO: At the Houston Product Support Center, avionics engineers Samer Hasbani (foreground) and David Stinson decide whether a cable destined for the space shuttle measures up. ELIZABETH MORRELL/BOEING

88-year-old former airman writes to Boeing:

'Thank you for making such a good airplane'

This month marks the 75th anniversary of Boeing's B-17 bomber, the "Flying Fortress" that proved its mettle in World War II. On the next four pages, Boeing historian Mike Lombardi writes about one of Boeing's most famous airplanes, and of the young airmen who flew those B-17 bombing missions.

One of those airmen was Irvin Klanecky of Bellevue, Neb. Last month, Klanecky wrote The Boeing Company a letter. It began: "I would like to thank you for making such a good airplane, the B-17. I have been meaning to write for many years, but always put it off. I am 88 years old."

He went on to describe a mission to Magdeburg, Germany, on Aug. 5, 1944. He was co-pilot, and his B-17 was on the right wing of the lead plane. What follows is some of what Klanecky wrote:

The bomb run was straight, with no evasive movements. The flak was really coming at us. A plane in the squadron ahead of us must have

gotten a hit in the bomb bay; it looked like confetti coming down.

A few seconds later, we got hit. The No. 2 engine started to over-rev and retarding the throttle didn't slow it down. We decided to shut it down and feather [streamline] the prop. The No. 1 engine also lost power.

With the No. 2 engine dead and the No. 1 engine not putting out much power, we couldn't keep up with the squadron. There also was a big hole in the gas tanks.

We headed out to the North Sea to get away from enemy fighter planes. Our radio operator got in touch with the British sea patrol so we could be picked up if we had to ditch our plane in the water.

We made it home to Sudbury, England. Because of flak damage, the landing gear wouldn't come down; we had to crank it down by hand. Then the flaps, which give the wings extra lift so the plane can land at a slower speed, would not work; so we had to land at a higher speed than normal. When we hit the ground, the brakes did not work. We ran off the end of the runway into the mud before we stopped. We were very happy to get home

without anyone in our plane getting hurt.

Afterward, the ground crew told us there were 179 holes in the plane and the No. 1 engine had a small hole in one of the cylinders, which is why it wouldn't put out much power.

Thank you for making such a good airplane. To make it back to England from Germany with 179 flak holes and only two engines being able to put out high power, I am glad to be alive. ■

EDITOR'S NOTE: Klanecky enlisted in the U.S. Army Air Corps in July 1942. He received his pilot training in Boeing Stearmans and was initially assigned to the 8th Army Air Force flying B-24 bombers. He switched to B-17s after his 24th mission and flew a total of 33 combat missions over Europe—six in "lead" airplanes, which had a high loss rate. He was discharged in September 1945. For his service he was awarded the Distinguished Flying Cross.

PHOTO: Fresh from the plant in South Seattle, a Boeing B-17F makes a test flight over Washington state. Nearly 13,000 of the bombers were built by Boeing, Douglas and Lockheed. BOEING ARCHIVES



A legend turns 75

Boeing's B-17 bomber has a storied history, but behind the Flying Fortress was a cast of thousands **By Mike Lombardi**

Seventy-five years ago this month, on July 28, a four-engine plane took off from Boeing Field in South Seattle on its first flight.

Rolling out of the Boeing hangar, it was simply known as the Model 299. *Seattle Times* reporter Richard Smith dubbed the new plane, with its many machine-gun mounts, the "Flying Fortress," a name that Boeing quickly adopted and copyrighted.

The U.S. Army Air Corps designated the plane as the B-17. And during the Second World War, individual planes carried names that reflected the affection of crews: *Memphis Belle*, *Homesick Angel* and *Lucky Lady*, to name a few.

Along with its many names, the Flying Fortress was also a plane of many people. The list begins with Boeing Chairman Claire Egtvedt, the "father" of the B-17, who set Boeing on a new course to build "big" airplanes, rather than the smaller models popular at the time. Along with Boeing designers C.N. "Monty" Monteith, Robert Minshall, E.G. Emery and a young Ed Wells, they had the vision of interpreting the U.S. Army's request for a multi-engine bomber to be one with four engines rather than the standard two-engine design—a decision that saved the 299 from being a footnote to aviation history.

Another on that long list was Boeing test pilot Les Tower, who took the 299 for its first flight that July day and later made a record-breaking flight from Seattle to Wright Field in Dayton, Ohio, where the airplane was to fly against its competition, the Douglas DB-1 (B-18). He died from injuries sustained when the Model 299 crashed.

There were also tens of thousands of employees at Boeing, Douglas and Lockheed-Vega who contributed to

PHOTO: Rollout of the prototype for the B-17, the Boeing Model 299, on July 16, 1935. BOEING ARCHIVES





PHOTO: The B-17 flight line at Boeing Field with “5 Grand,” the 5,000 built at Boeing since the U.S. entry into the war. The airplane was signed by all employees who had a hand in building it. **BOEING ARCHIVES**

the war effort by building 12,731 Flying Fortresses for the “Arsenal of Democracy.” They included thousands of women who joined the war effort working at non-traditional jobs who collectively became known as “Rosie the Riveters.”

Assuredly the most important people in the B-17 story are the young men who flew them in combat. The success of the daylight bombing campaign over Germany hung on their courage—and the ruggedness of the Flying Fortress. There are volumes of stories of shot-up B-17s that returned crews safely to their bases, some so badly damaged they never flew again.

The effort and sacrifice of all of the people behind the B-17—and those who

flew in them—is perhaps best summed up by General Carl Spaatz, the American air commander in Europe, who said: “Without the B-17 we may have lost the war.”

Extensively used during the war, the Flying Fortress became an icon of American air power and helped establish Boeing’s global reputation.

The B-17 story is also one about the partnership between Boeing and the Seattle community, whose support and generosity ensured that Boeing built Plant 2, the “Fortress Factory” at Boeing Field in South Seattle. It was a team effort that involved employees, unions and the local community that made it possible for Boeing to produce 6,981 B-17s at that Seattle plant.

Finally, a big part of the success of the B-17 was the working-together relationship between Boeing and the U.S. military that resulted in the bomber earning a reputation for performing missions with precision and success—a tradition of quality and excellence that has continued with each new generation of Boeing planes for the warfighter.

After 75 years, the few B-17s that remain are greeted at air shows and museums with a kind of reverence—an enduring tribute for those who designed, built and maintained the Flying Fortress, for those young airmen who flew it in combat, and especially for those who gave their lives defending freedom. ■

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PHOTO: The flight and ground crew of the B-17 “Hells Angels.” Miniature bombs painted on the nose indicate the number of combat missions completed. **BOEING ARCHIVES**



PHOTO: This B-17G was hit by an 88mm shell that nearly cut the plane in two and trapped a ball turret gunner. The crew elected not to parachute out but to stay with the plane because of the trapped gunner. After flying 2.5 hours, it landed safely. **BOEING ARCHIVES**

B-17 production by the numbers

B-17 production:	Boeing	Douglas	Lockheed	Total
Model 299	1			1
YB-17/Y1B-17	13			13
Y1B-17A	1			1
B-17B	39			39
B-17C	38			38
B-17D	42			42
B-17E	512			512
B-17F	2,300	605	500	3,405
B-17G	4,035	2,395	2,250	8,680
Total	6,981	3,000	2,750	12,731

EAGLE-EYE VIEW

A Boeing F-15E Strike Eagle patrols the airspace near Kennedy Space Center, Fla., shortly after launch of the Space Shuttle *Atlantis* on May 14 on a mission to the International Space Station. The space shuttles are being retired, and the STS-132 mission was the final scheduled flight of *Atlantis* and the 34th shuttle flight dedicated to station assembly and maintenance. Boeing is a major subcontractor to United Space Alliance, the shuttle's operations contractor.

PHOTO: U.S. AIR FORCE





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