

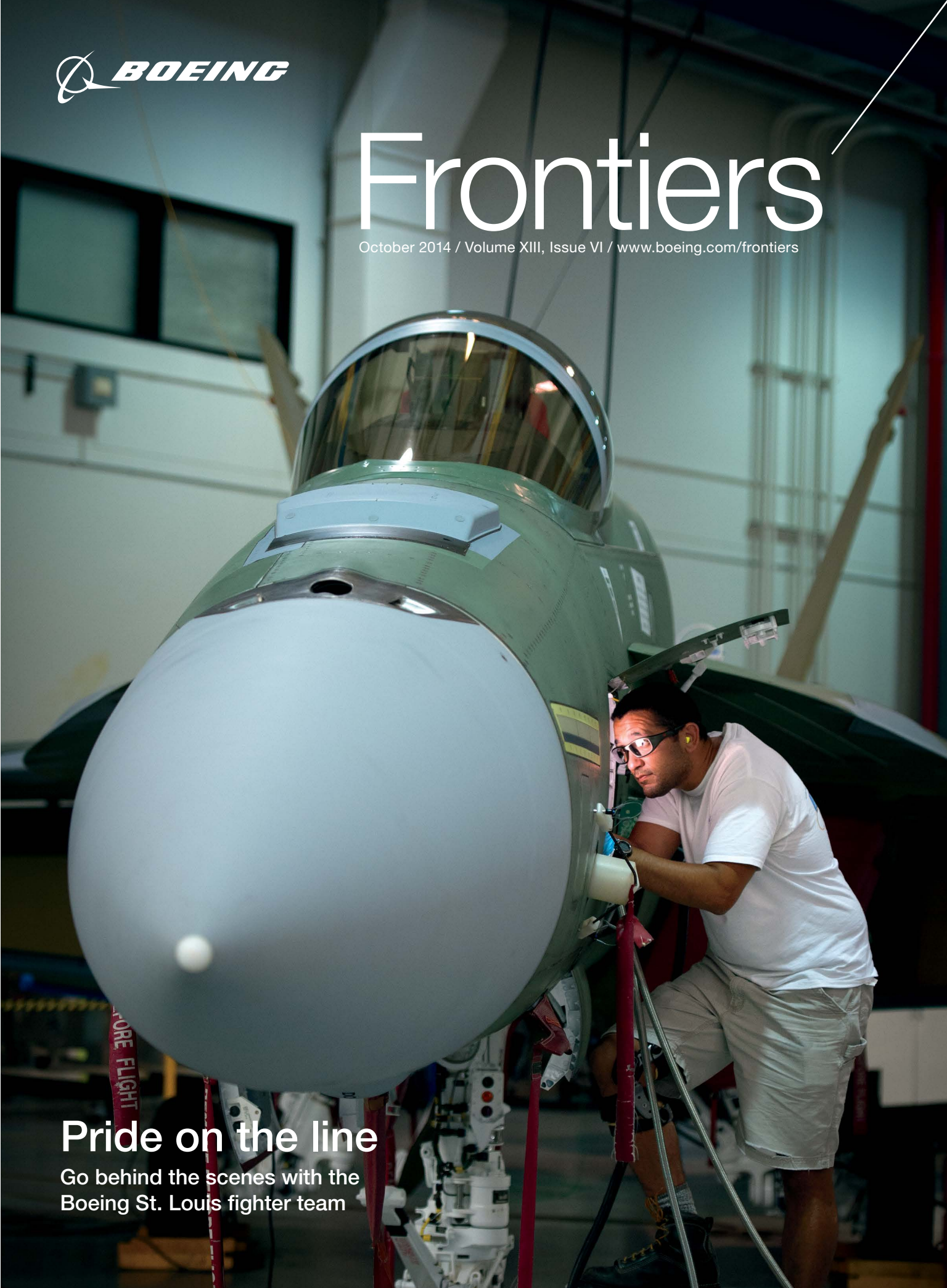


Frontiers

October 2014 / Volume XIII, Issue VI / www.boeing.com/frontiers

Pride on the line

Go behind the scenes with the Boeing St. Louis fighter team



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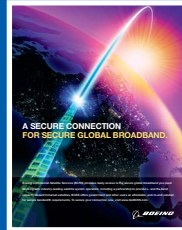
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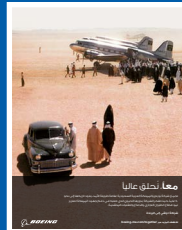
The stories behind the ads in this issue of *Frontiers*.

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This new ad features Boeing Commercial Satellite Services, a full-service provider of global broadband connectivity. It appears in trade publications.

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Part of Boeing's Middle East "Together" campaign, this ad highlights Boeing's history in Saudi Arabia. Translated the text reads: Together we soar. The relationship between Saudi Arabia and Boeing goes back nearly 70 years when President Franklin Roosevelt presented a DC-3 Dakota to King Abdulaziz Al-Saud. Since then, Boeing has played a significant role in supporting Saudi Arabia's phenomenal growth in commercial aviation, defense and technology.

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FSC LOGO



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 **BOEING**

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Regardless of where they work or what they do, Boeing employees can take pride in the innovative and technologically leading products that are built in the company's factories, from satellites and commercial jetliners to rotorcraft and jet fighters. In this *Frontiers* photo essay, that pride can be seen on the faces of the men and women on the fighter production lines in St. Louis, where they build the F/A-18E/F Super Hornet, the EA-18G Growler and the Advanced F-15 that are protecting freedom around the world.

COVER: Oscar Harrell, flight ramp mechanic, completes a door close-up inspection on an F/A-18E Super Hornet.

BOB FERGUSON/BOEING

PHOTO: Larry Echele, sheet metal assembler riveter for the Super Hornet and Growler programs, inspects an aircraft for foreign object debris.

BOB FERGUSON/BOEING



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North American Aviation's F-86 Sabre became famous as America's first swept-wing jet fighter. But it had a lesser-known twin, the Fury (shown), that took a much different development course. PHOTO: BOEING ARCHIVES



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Learn about some of the employee-driven inventions that are being replicated throughout Boeing and helping make the company stronger and more competitive. PHOTO: MARIAN LOCKHART/BOEING



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Boeing's first 747 is looking like new after a restoration project that saw the iconic jet repainted in almost the exact color scheme as when Boeing rolled it out to the world in 1968. PHOTO: TED HUETTER/MUSEUM OF FLIGHT



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Saudi Arabia is a strong market for Boeing products, but the company's growing presence there includes support for education, research and development, and health and human services. PHOTO: HOPE FOR EXCEPTIONAL NEEDS

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Correction: The XB-70 Valkyrie could fly at Mach 3, but that is not a hypersonic speed as stated in a story in the September issue of Frontiers.

LEADERSHIP MESSAGE

John Tracy

Chief technology officer, Boeing

Senior vice president, Engineering, Operations & Technology

ENGINEERING

Ensuring Boeing's future requires sharp focus on engineering excellence

In this Q&A with *Frontiers*, John Tracy discusses the future of engineering and technology at Boeing.

How would you assess the state of innovation at Boeing today?

Innovation at Boeing is alive and well. We have more product and technology development underway today than at any time in nearly a half-century. At Commercial Airplanes, we're developing the 787-10, the 777-8X and -9X, and the 737 MAX 7, 8, 9 and 200—all of which embody huge advances in efficiency and value for our customers.

In Defense, Space & Security, we're developing derivative aircraft, such as the KC-46A tanker, the AH-6i, the Saudi F-15, and new platforms like the Long Range Strike bomber program, Unmanned Carrier-Launched Airborne Surveillance and Strike, Phantom Eye, Phantom Swift, and the Phoenix small satellite. And the CST-100, or Crew Space Transportation, win joins with the Space Launch System to put us back in the lead in manned space exploration.

From an advanced technology standpoint, we're more strategic and focused than we've ever been. Our Enterprise Technology Strategy is making a big difference in our key

domains. We see glimpses of that with exciting new ideas like the Subsonic Ultra-Green Aircraft Research, or SUGAR, airplane concept study, advanced biofuels, and the technologies we're putting on the ecoDemonstrator.

Do we have the engineering and technical workforce to see these efforts through successfully?

Our engineering and technical capabilities across the enterprise are exceptional. I think they are the best in the world. This year Boeing was named the No. 1 innovator in aerospace and defense by the Patent Board for the eighth year in a row. And a recent national college survey showed that Boeing was considered the top employer for engineering students.

Having said that, we're not perfect and we can't afford to be complacent. Our customer on both sides of the business are demanding more capability and technology, and lower costs—and they want to see these innovations in their hands sooner rather than later. And we've had our share of execution issues that cost us a lot of money and hurt our reputation and relationships with our customers. While we hear a lot about the role of suppliers in some

of those cases, we haven't met our own standards on in-house engineering quality in a number of instances, including the side-of-body issue on the 787 and the recent challenges on the KC-46. It's important that we're honest with ourselves on this subject, that we own our mistakes, and that we prevent them from happening in the future.

With so much work to do, why are we seeing employment reductions in some areas and why are we distributing work in different places?

The business environment for BDS is as challenging as at any time since the end of the Cold War. That's what is driving the layoffs at BDS and in areas of Engineering, Operations & Technology that directly support BDS programs. But unlike prior downturns, increasing international defense work and a growing commercial airplane business has helped mitigate some of the layoffs. Over the past two and a half years, more than 700 BDS employees and about 300 EO&T employees, all of whom were susceptible to layoffs, were absorbed by growing needs at Commercial Airplanes.

Also, because of the downturn in

OUR FUTURE

“We have to recognize and accept the realities of our markets and the increased expectations of our customers.”

PHOTO: BOB FERGUSON/BOEING





defense, there's engineering talent across the enterprise that has become available to do other work, and there are some skills and capabilities we don't want to lose to other companies or industries. It's a use-it-or-lose-it scenario that we have to factor into our decision-making on strategic work placement.

The other part of the mix is pressure to keep our bid rates competitive for winning new work. With less defense work to go around, our competitors are bidding very aggressively for every new contract, particularly in services and aftermarket support. For us to bid competitively on a flat-to-shrinking business base, we have no choice but to consolidate certain work and underutilized sites to provide greater value for our customers. We realize that creates disruption for our organizations and people, but if we're not competitive, we don't win and the work goes away altogether. That holds true for Commercial Airplanes and EO&T, too.

Is the establishment of new geographic centers for Information Technology, engineering design and Research & Technology a response to the defense environment?

Those efforts are more geared toward our strategy to strengthen the company for the long term, to build our capability and capacity as we scale up to meet increasing global demand for our products and services, and to increase our agility and competitiveness. Having a broader engineering, test and IT footprint provides greater access to current and future talent, gives us strategic redundancy of systems and processes, mitigates business continuity risk from natural or man-made events, and sets up logistics efficiencies by putting us closer to customer bases and supply networks. It also increases our base for political advocacy.

“That’s the thing about a more-for-less world: To succeed within it requires more, not less, innovation and development, and application and replication of technology.”

How many research and technology centers do we have internationally, and are we getting the results we expected from this strategy?

While the vast majority of our research and technology work is done in the United States, we have six international Boeing Research & Technology centers—Australia, Brazil, China, Europe, India and Russia—and they are helping us bring in new ideas and innovative processes into our programs. Our global customers expect us to have this type of presence in their countries. And working with the best technical talent and collaborating with top researchers in other parts of the world has proved to be a prudent strategy for us and a major differentiator in the marketplace. There’s simply no turning back from the need for global, diverse thinking when it comes to innovation and meeting market expectations.

Are customer expectations really that different today than a decade or two ago?

Absolutely, because the world is different. If you go back just to 2001, the average price of a barrel of oil was \$23. It’s been consistently above \$100 since then. Today, the Dubai and Beijing airports are in the top five largest in the world. In 2001, they weren’t in the top 30. That says a lot about the growth of air travel in those regions, but it also highlights the increased global competition among our airline customers.

If you think about it, our customers’ expectations are no different than our

own as consumers. We expect the new phone or TV we buy to cost less and do more than the one we’re replacing. Likewise, our customers want more value-creating innovation faster and at lower cost and risk. We talk about it as a “more for less” world as if that’s new, when the fact is, aerospace is just late to the party.

What are the implications for our engineering teams? Does it mean less investment in technology and reduced requirements or a slower pace of innovation?

That’s the thing about a more-for-less world: To succeed within it requires more, not less, innovation and development, and application and replication of technology. This isn’t about whether or not we innovate. It’s about delivering the innovation our customers want in ways that are more relevant to their needs and timelines versus ours.

We seem to be investing more in manufacturing innovation. Is that a trend that will continue?

Yes, it is a trend and a deliberate decision on our part. It’s similar and related to our moving more engineering and manufacturing work back inside the company after having stretched a little too far with outsourcing on the 787. It’s not enough to just focus on design and integration. Innovation in manufacturing and production is a big part of what will sustain our industry leadership. It

also has the potential to contribute significantly to workplace safety.

What are the keys to or inhibitors of our engineering success in the future?

First, we have to recognize and accept the realities of our markets and the increased expectations of our customers. Our competitors get it. We can pretend that’s not the case and keep doing things the same way, but we do so at our own peril.

Second, we have to think differently about the way we do our jobs and the emphasis and value we place on all forms of innovation. In a more-for-less world, process innovation that makes us or our customers more efficient, and streams of significant incremental advances that get to our customers sooner, are the real game changers.

Finally, nothing is more important to ensuring our success than our focus on engineering excellence. We’ve done a lot of work here over the past few years, and while we have a ways to go, we can see it making a difference. We need everyone on the team to be accountable—for the quality of work they do, for being contributing team members to the program or function they support, and for actively partnering on their own career development. ■

PHOTO and GRAPHICS: (From top) Boeing’s Phantom Eye demonstrator. BOB FERGUSON/BOEING Illustrations of a 777-9X, CST-100 spacecraft and KC-46A tanker test aircraft. BOEING

SNAPSHOT

Crown class

The first 787 Dreamliner for Royal Jordanian shines as it awaits delivery at Boeing's Everett, Wash., delivery center, in late August. The airline, based in Amman, Jordan, will use the Dreamliner, acquired through leasing company AerCap, for fleet modernization. Royal Jordanian operates a network with more than 50 global destinations and plans to deploy the 787 on routes to North America, Asia, Europe and within the Middle East.

PHOTO: KATIE LOMAX/BOEING





QUOTABLES

“I don’t think we’ve even cracked the nut yet on how much Growler can do. ... it’s eye-watering.”

—Capt. Jeffrey “Caesar” Czerewko, the air group commander aboard the aircraft carrier USS *Ronald Reagan*, talking to reporters about Boeing’s EA-18G Growler electronic attack aircraft. *AviationWeek.com*, Sept. 10

“I think there will be a flock of people flooding to Boeing’s door.”

—Michael O’Leary, CEO of European low-cost carrier Ryanair, telling reporters he expects a lot of customer interest in the new 737 MAX 200, which is based on the 737 MAX 8 but can seat up to 200 passengers. Ryanair is a longtime 737 customer and committed to 100 737 MAX 200 airplanes, with options for 100 more. *Los Angeles Times*, Sept. 8



Juve Hernandez

HAS WORKED FOR BOEING:

3 years

ORGANIZATION:

Boeing Research
& Technology

HAS BEEN PART OF THE TEAM:

3 years

Starring role

This engineer has a passion for designing devices that help others do what they do—only better

As told to Jennifer Hawton, with photo by Fred Troilo

Juve Hernandez is a Materials, Process & Physics engineer with Boeing Research & Technology in Ridley Township, Pa. In this *Frontiers* series that profiles employees discussing their jobs, Hernandez explains why he's excited about rapid prototyping and the ways it can help Boeing programs.

Growing up in California I was surrounded by movie stars, but I was interested in a different type of star. I learned about space missions like the Mars Rover in high school and thought, *How cool—I want to be part of that, part of something bigger.* I knew that if I worked hard I could do it. I started reading everything I could find about space missions and eventually decided to get my degree in aerospace engineering.

I wasn't quite sure where I would end up working after college, but I thought it would be one of the big aerospace companies. That wasn't the case, as I spent quite a few years working in other industries. I took personal time and money to learn everything I could about new advances in technology like composite materials, 3-D modeling and additive manufacturing.

In 2011 I got my chance to work for Boeing, one of the largest aerospace companies in the world. The only problem was that the job was near Philadelphia. I've never lived anywhere but California or been that far from my family. I took the leap because I knew Boeing was where so much of the cutting-edge technology was being used and developed.

Although I wasn't familiar with the rotorcraft products being built in Ridley Township—the H-47 Chinook and V-22 Osprey—I knew I had the right skills to get a running start as a technologist with Boeing Research & Technology.

School and industry experience had equipped me with advanced tools—and I get to use them all to fix tough problems for my customers. I get to see all sides of the work since I'm the only Boeing Research & Technology person on second shift. I stand right next to the folks on the production line and get to help keep our line moving by using the cool, smart and innovative approaches and tools that our engineering and research and technology organizations are developing.

Recently we ran across an issue with crooked drill holes. There wasn't a tool or an easy way to align the part, and there wasn't room in the factory to drill straight because of the way the parts were put together. My teammates and I designed a device so the holes can be drilled easily and consistently. Without access to our rapid prototyping lab and Moonshine Shop, where we can quickly create versions of new specialized devices using additive

manufacturing, and the support team here, it would have taken two months to manufacture the device. But with rapid prototyping, it took two days.

I've been working since I was very young in environments from construction to shipyards. I wish people had been around to show me easier, more ergonomic or efficient ways to do all that work. That is where I get my passion for designing devices and techniques that help others do what they do, only better. If I can help one person I'm pretty excited; when my designs start getting copied and used in other places, I get really jazzed. Because I know I'm helping people and helping Boeing.

It is inspiring to be part of something bigger. Every time I see or hear a Chinook take off, I know that I'm part of the team that makes that possible. ■

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HISTORICAL PERSPECTIVE

THE FURY

The famous F-86 Sabre had a twin that helped change U.S. naval aviation

By Mike Lombardi



It needs no introduction. The F-86 Sabre was America's first swept-wing jet fighter and it became a legend during the Korean conflict, where it went up against Soviet-made MiG-15s in the skies over Korea and won most of those high-speed, air-to-air dogfights.

But the F-86 had a little-known twin, also made by North American Aviation, a Boeing heritage company. It was called the Fury, and this series of carrier-based fighters helped lead the U.S. Navy through the transition from piston-powered fighter planes to high-performance jets.

The story of the Fury, as well as the Sabre, began in 1944 when the U.S. military, to counter the growing threat of German Luftwaffe jets, enlisted North American Aviation to develop a common jet-powered fighter plane to be used by both the U.S. Navy and the U.S. Army Air Force. The planes were designated XFJ-1 Fury for the Navy and XP-86 Sabre for the Air Force. At that time the U.S. Navy used a different designation system that not only identified the mission of the airplane (F for Fighter) but also identified the manufacturer. The Navy code for North American was "J," a holdover from one of North American's predecessor companies, Berliner-Joyce.

In 1962 when a common designation system was adopted for all U.S. military airplanes, the FJ series became the F-1.

The XFJ-1 was first to fly. It borrowed the wings and tail from the successful design of North American's P-51 Mustang, but featured a fuselage where the pilot sat above the air intake, giving the airplane a rotund appearance.

While the XFJ-1 was being evaluated, captured German data on the swept wing arrived at North American and was applied to the XP-86, sending it on a divergent development path and creating an airplane that would become one of America's most storied fighters.

The Navy chose to stay with the straight-winged FJ-1 due to its better low-speed handling, necessary to land on its carriers, which were built to operate



World War II piston-powered aircraft. Thirty FJ-1s were built and in 1948 they became the first jets to operate in squadron strength from an aircraft carrier.

The FJ-1 soon was eclipsed by the McDonnell F2H Banshee and Grumman F9F Panther and by 1949 the FJ-1s were transferred to the U.S. Navy Reserve. When war broke out on the Korean Peninsula in June 1950, naval aviators flying Banshees and Panthers found themselves outclassed when they encountered the MiG-15 swept-wing fighters. So the Navy once again turned to North American.

The company's swept-wing F-86 was able to match and defeat the MiG-15, and North American developed a version of the F-86E modified for carrier operations that included a lengthened nose gear, folding wings and a tailhook. Six .50 caliber machine guns were replaced with four 20mm cannons. The Navy ordered 200 of the fighters, designated FJ-2.

North American further modified the FJ-2 with a 7,700-pound-thrust (34.25-kilonewton) British Sapphire engine built under license by Curtiss-Wright. In March 1952 the U.S. Navy ordered 389 of these more powerful jets, designating them as the FJ-3, and later added an order for 149 more. The first production FJ-3 flew from North American Aviation's Columbus, Ohio, plant in December 1953.

At that time company engineers in

Columbus already were working on an all-new Fury known as the FJ-4. The first one flew on Oct. 28, 1954. The "Fury Four" was a major redesign that included a new fuselage and a 50 percent increase in internal fuel capacity. The U.S. Navy ordered 152 FJ-4s, and followed with an order for 222 of the FJ-4B—the last of the Furies.

In 1962 the FJ-4 went on its last operational cruise on board the carrier CV-16 *Lexington* and continued to fly with Reserve squadrons well into the 1960s. In all, the Columbus plant delivered 1,112 Furies to the U.S. Navy and Marine Corps.

The Fury had done its job—introducing high-performance swept-wing jets to carrier aviation—and it paved the way for supersonic jets such as the McDonnell Douglas F-4 Phantom. The Fury was an important piece of the legacy of carrier-based aircraft developed by Boeing and its heritage companies, a history that continues today with the Navy's F/A-18 Super Hornet and EA-18 Growler. ■

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To learn more about the F-86 Sabre, visit www.boeing.com/F-86.

PHOTOS: (Left) FJ-3s from VF-21 Mach Busters fly over the USS *Forrestal* during its shakedown cruise in the winter of 1956. (Above) An FJ-1, foreground, flying with an XFJ-2B illustrates the transition to swept wings.

SOUND



STAGE

For employees on the St. Louis fighter lines, it's about pride—and hearing those jet engines roar

By James Wallace and photos by Bob Ferguson



PHOTO: Just off the flight ramp in St. Louis, the hush house is where Advanced F-15, F/A-18E/F Super Hornet and EA-18G Growler (shown) twin fighter engines are tested at full power for the first time. Prior to initial engine run, flight mechanics inspect every aircraft for foreign object debris. From left: flight ramp mechanics Dan Straeter; Randy Wyatt; Aaron Boswell, flight ramp manager; Keith Echele; and Rich Stanfill.



When a new Super Hornet, Growler or Advanced F-15 is ready to take off for the first time from the runway near Boeing's fighter production plant in St. Louis, it's a good bet that A.J. Wilson is listening to those powerful jet engines.

It's his job, and that of his team, to prepare the engines for every fighter built in St. Louis.

From inside the hangar where he works, the earth-shaking roar produced by each fighter's two engines can be not only heard but felt. Sometimes Wilson steps outside just to watch.

"Nothing like the roar of those engines," said Wilson, an F/A-18 flight mechanic and the engine shop lead supporting both the F/A-18 and F-15. The engine shop is responsible for making sure that every arriving new engine is inspected, filled with oil and prepared for installation.

"I'm responsible for those engines," Wilson said. "So I have hands-on experience getting every one of those fighters into the air. When you watch one take off for the first time, knowing



“Everybody here takes a lot of pride in being here and what we do.”

—A.J. Wilson, flight mechanic



PHOTOS: (Clockwise from far left) Randy Allen, F/A-18E/F and EA-18G assembly mechanic, performs precision drilling on the outer wing of an aircraft; Lila Kennedy, outer wing assembly mechanic for the F/A-18E/F and EA-18G; A.J. Wilson, flight mechanic; an F/A-18F Super Hornet in flight. **BOEING**







that you had a hand in the work, there is a satisfaction that is hard to explain.”

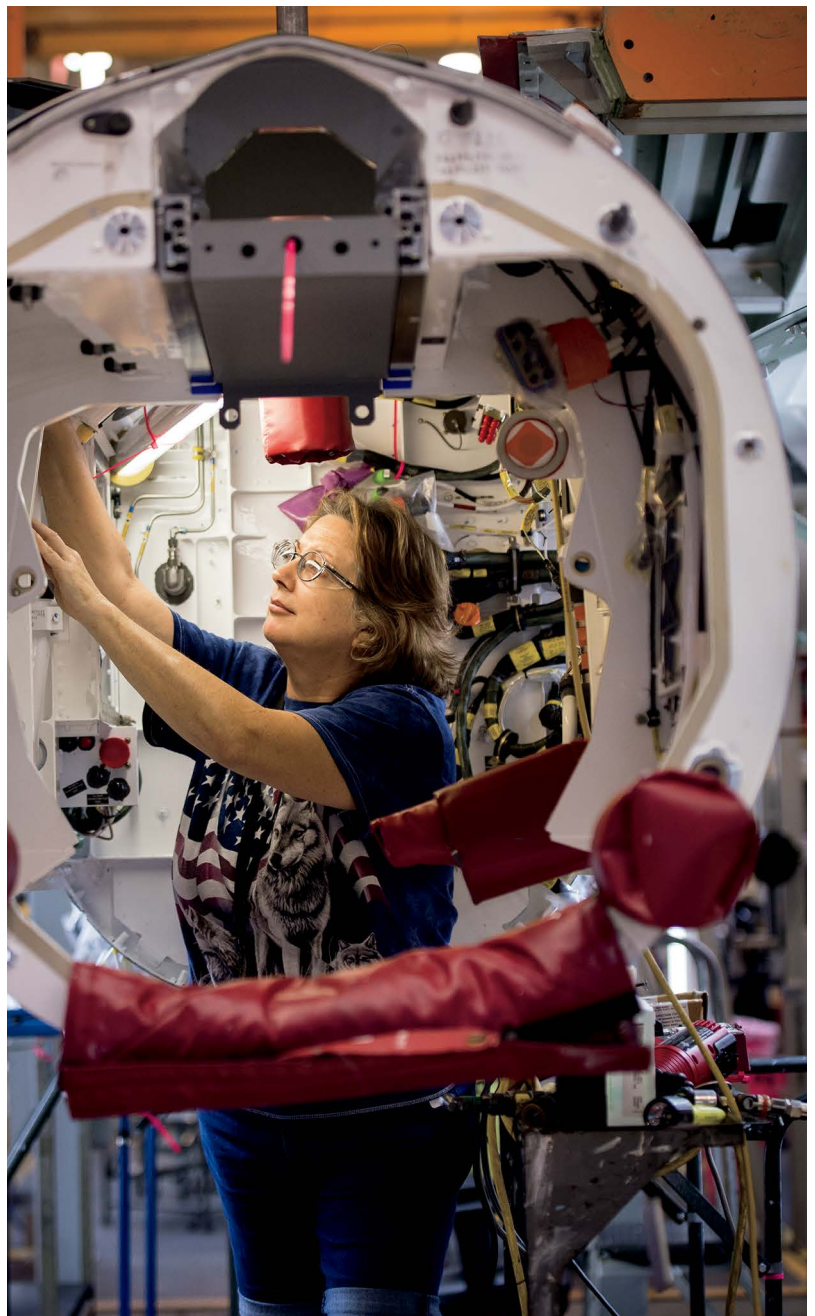
Pride is one word to describe that feeling, according to Wilson and other employees who assemble Boeing’s three fighters in St. Louis.

The F-15 is a tactical, multi-role fighter operated by the U.S. Air Force and a number of other countries. The F/A-18 Super Hornet is the mainstay carrier-based fighter for the U.S. Navy and, like the F-15, has an international presence. The EA-18G Growler is a modified version of the Super Hornet with state-of-the-art electronic warfare capabilities.

“Everybody here takes a lot of pride in being here and what we do,” explained Wilson, who joined Boeing just over seven years ago and has spent almost the entire time working on the fighters. He started as an F/A-18 flight mechanic.

More recently, Wilson has had the opportunity to join other Boeing employees in taking the Super Hornet to air shows, including Dubai. The last Dubai show was a career highlight, he said.

“Seeing that F/A-18 fly across that skyline of Dubai was one of the really



PHOTOS: (Clockwise from far left) Advanced F-15 flight operations mechanic Steve Hickey performs detail work on the aft section of a new Advanced F-15 as it progresses through the St. Louis assembly line; Paul Robertson, flight mechanic, helps ensure safe towing operations for an EA-18G Growler on its way to the hush house; Kelly Dili, F/A-18E/F and EA-18G electrician, routes electrical wiring in the nose barrel of a fighter.



big moments in my Boeing career,” Wilson said. “If you have ever been there, you know that is one awesome skyline. And with that jet doing its maneuvers, it was one awesome sight.”

The Super Hornet and Growler are built on the same St. Louis production line.

Earlier this year, Boeing delivered the 100th Growler to the U.S. Navy, which wants more. But continued production of the Growler after a couple more years will depend on additional funding by Congress.

Wilson could be speaking for many other employees when he talks about the importance of continued fighter

production in St. Louis, regardless of the model.

“It’s important to Boeing, but it’s also important for our country,” he said. “These planes are necessary. They make it safer for our pilots, for our military on the ground and for our country overall.” ■

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Katie Kelly contributed reporting from St. Louis.

Frontiers is interested in reader stories for future editorial use. Tell us about your own experience with a Boeing jet fighter at boeingfrontiers@boeing.com.

PHOTOS: (This page, clockwise from top) Trent Parks, Advanced F-15 sheet metal assembler and riveter; Samantha Lampe, F-15 assembly mechanic, works on electrical components; John Vo, F-15 assembly mechanic, performs an inspection to ensure foreign objects have not entered the aircraft during assembly. (Opposite page) Arlene Moore, sheet metal assembler riveter for the F/A-18E/F and EA-18G programs, inspects the outer wing of an aircraft following machine operations.



LONG LIVE THE QUEEN

By James Wallace





*Age cannot wither her,
nor custom stale
her infinite variety.*

—William Shakespeare,
Antony and Cleopatra

The Boeing 747 is one of the world's most recognizable airplanes, a giant of the skies that changed the face of commercial aviation. Today, the latest version, the 747-8, is bigger and far more efficient than previous models of the jumbo jet. But it still maintains

the classic 747 shape that has turned heads for nearly a half-century.

With Boeing identification number RA001, the first 747 rolled off the assembly line at a sprawling new plant in Everett, Wash., in September 1968. The plant had been constructed for production of the 747, and that first plane was named *City of Everett*.

It flew for the first time from Paine Field near the Everett plant on Feb. 9, 1969. The Boeing test pilots on that cold and cloudy winter day were Jack Waddell and Brien Wygle. At the flight engineer's station was Jesse Wallick. Their names had been hand-painted on

the fuselage "hump" that gave the 747 such a distinctive look and served as the cockpit and the upper passenger deck.

The 747 was significantly bigger than any commercial plane that had been built before; it was as graceful in the air as it looked on the ground and soon became known as the "Queen of the Skies."

But RA001 never carried passengers for an airline. Boeing used it for testing 747 systems and other technology, and later as a flying test bed for the huge

PHOTO: Boeing's first 747, shown here after it was recently repainted in its original 1968 livery. GUY AMICO

and powerful new engine developed for the 777. Over the years, RA001 made about 12,000 test flights, the last of which came in 1993. When it landed for the final time, at Boeing Field, that's where it stayed, eventually becoming part of the outside airplane collection on public display at the Museum of Flight.

Being outside and in the wet Seattle weather for so many years took its toll on the once-gleaming silver and white airplane with the bright red stripe down the side of the fuselage and up the massive tail. Even those first flight-crew names had faded long ago.

Today, RA001 looks as it did when it left the Everett paint shop 46 years



ago and was readied for that historic first flight. Thanks to a restoration project by the museum, RA001 has been repainted in almost the exact color scheme. Even the more than two dozen airline logos that adorned the front of the fuselage will be redone.

The exterior painting is scheduled to be completed this month. Work continues to restore the interior. Meanwhile, RA001 is on public display at the museum's Airpark—an icon of aviation, and a sentimental reminder of the legacy of one of aviation's most beloved airplanes.

"It's been a huge job," Ted Huetter, promotion manager for the Museum of Flight, said of the restoration project.

"But it looks like a brand-new airplane, just like it must have looked that day when it was rolled out for the first time for all the world to see." ■

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Frontiers is interested in reader stories for future editorial use. Tell us about your own experience with the Boeing 747 at boeingfrontiers@boeing.com.

PHOTOS: (Below) The first Boeing 747 takes off from Paine Field near the Everett, Wash., plant on its inaugural flight Feb. 9, 1969. **BOEING ARCHIVES** (Inset) Before it was repainted, RA001 had spent years outside at Boeing Field and showed many signs of wear. **GUY AMICO**



Replicating excellence

Reusing inventions across Boeing makes the company more competitive

By Elizabeth S. Davis

Jan Vandenbrande and his colleagues at Boeing Research & Technology want to help engineers more efficiently spend their time building better products. That's why they developed Design Explorer—and then helped spread it across Boeing.

It's a software program that helps existing simulation software find the best possible solutions to challenging design problems. And the program is versatile enough to be used not only to design airplanes and their components but also to help find the best paths forward on matters that don't relate to aerodynamics or parts design. It even is being used, for example, to efficiently manage spares inventory.

"Finding the best solution is innate to almost anything all of us do. So tools like Design Explorer are worth replicating because they strengthen Boeing by helping people quickly discover that solution," said Vandenbrande, senior

PHOTO: Technical Replication Award winners Kay Blohowiak (left) and Jill Seebergh (right), both Technical Fellows in Boeing Research & Technology Chemical Technology, are shown with Vanessa Gemmell (center), sponsoring Environment Domain leader, in the BR&T Tankline Laboratory. Blohowiak and Seebergh are part of a team that developed a process for providing an alternative to hazardous surface preparation methods for metallic structures. **MARIAN LOCKHART/BOEING**





manager and Technical Fellow of the Geometry and Optimization group responsible for Design Explorer.

As a result of their work, Vandenbrande and his team are among seven companywide teams that will receive Boeing Technical Replication Awards this month. The awards recognize inventions that are replicated across Boeing, allowing others in the company to reap their benefits.

Along with Boeing's Special Invention Awards, the Technical Replication Awards—both of which are issued annually—represent the company's highest honor for innovation.

Boeing's position as a leader in technology and innovation is strengthened not solely by developing novel tools, processes and products but also by implementing these breakthroughs across the company, to help more teams run more effectively, according to John Tracy, Boeing chief technology officer, and senior vice president of Engineering, Operations & Technology.

"Our inventions and technological advancements enable Boeing to be a strong company," Tracy said. "By internally replicating our achievements when appropriate, by making them available to our customers and by licensing them externally, we generate value and ensure our future."

The complex software developed by Vandenbrande and his team originally was derived from research funding and collaboration between Rice University in Houston and the Applied Math Group at Boeing Research & Technology.

"Now, for a new airplane we can use this tool to explore the entire design space and choose the best design," explained Vandenbrande, who also won a Technical Replication Award last year. The software is continuously upgraded to tackle larger problems.

Another replicated invention being recognized this year, the Electrical Load Analysis Tool (eLAT), is used

on all production and post-delivery commercial airplanes. It manages electrical load data from the initial design stage through to an airplane's retirement. The load analysis team is extending the tool to Boeing defense and space products. In addition, it can be applied in multiple industries, said Ralph Boy, Associate Technical Fellow and eLAT's creator.

The tool, which promotes a "One Boeing" approach to formatting and analysis, emerged from challenges in the early 2000s, such as a loss of data on servers damaged by a Seattle-area earthquake, that prevented Boeing from using existing methods of conducting load analyses. Without completion of this analysis, Boeing couldn't deliver airplanes to its customers.

"Innovation grew from this challenge," said Boy, a systems

engineer with the Airplane Systems team at Boeing Commercial Airplanes. "Our servers and methods are now bulletproof and have layers of redundancy built in to mitigate any occurrence of failure."

Boeing is applying this concept across the company. The Electrical Load Analysis Tool allows engineers to collaborate to create the tools they need to get their work done. It also lets them share their knowledge inside and outside Boeing and bring additional revenue back to the company, Boy said.

Another profitable technology now being replicated is the Torque Multiplier. Used in aircraft manufacturing, this tool



correctly and quickly torques fasteners—the nuts and bolts that hold structures together. More important, it reduces the potential for worker injuries.

Fasteners range in size from very small to very large. Calibrated pneumatic nut runners and torque wrenches can tighten small-to-medium fasteners. But heavy manual wrenches or cumbersome hydraulic systems are needed for large ones, and using these bulky tools carried risks, according to Brenda Carlson, a senior engineer in Boeing Research & Technology.

When employees apply manual force for high-torque fasteners, too frequently they can strain their muscles. Before the Torque Multiplier, shoulder injuries, surgeries and

medical retirement were not infrequent experiences, Carlson said.

“With the push of a button, a twin-spindle multiplier can tighten two fasteners at once, or with a small torque multiplier, mechanics can do fasteners in tight spots,” Carlson said. The tool also dramatically reduces time needed to complete work.

Before the Torque Multiplier, Carlson said, it took at least three people nearly a full shift to torque an airplane’s nose gear fasteners. Today, one person can complete the task in under an hour—without the risk of getting hurt.

Carlson said employees no longer mind doing these jobs and noted that since introducing this tool, the company has realized significant labor and cost

savings. Best of all, there haven’t been any new torque-related shoulder injuries for those using these tools. ■

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A list of this year’s Special Invention and Technical Replication awards winners will be published in Boeing News Now on the Boeing intranet later this month.

PHOTO: The Torque Multiplier, one of the inventions being recognized with a Technical Replication Award, reduces the time needed to tighten fasteners and virtually eliminates the potential for shoulder injury that was associated with previous tools. **GAIL HANUSA/BOEING**



Vision for

An aerial night view of a city, likely Riyadh, Saudi Arabia, showing a dense urban landscape with numerous lights from buildings and streets. A prominent skyscraper is visible on the right side of the frame.

Saudi Arabia charts a course of opportunities for its people, with Boeing as a partner

By Bill Seil

In February 1945, the United States presented the Kingdom of Saudi Arabia with a gift—one that led to the birth of commercial aviation there.

It was a DC-3, made by Boeing heritage company Douglas Aircraft. The airplane, presented by President Franklin Roosevelt to King Abdulaziz Al-Saud, was used to carry passengers and cargo between Jeddah, Riyadh and Dhahran. The success of this service led King Abdulaziz to order two more DC-3s, launching Saudi Arabia's aviation industry.

Since that time, Boeing and Saudi Arabian Airlines, or Saudia, have maintained a solid relationship. In

1961, Saudia entered the jet age with the delivery of a Boeing 707. Since then, Saudi Arabian customers have taken delivery of 150 Boeing airplanes through August 2014.

Saudi Arabia is also an important customer for Boeing's military products. Boeing's relationship with the Royal Saudi Air Force began in 1978 with the purchase of Saudi Arabia's initial F-15C/D fleet. In December 2011, Saudi Arabia and the United States government signed a foreign military sales agreement—the largest such agreement in U.S. history. This included the purchase from Boeing of 84 new F-15SA fighters; upgrade packages

the future



for 70 existing F-15S fighters; 70 new AH-64E Apache helicopters and 36 AH-6i helicopters; as well as support and training.

“Saudi Arabia is located in a very important and complex part of the world, which dictates both its security environment and its corresponding defense procurements,” said Shep Hill, president, Boeing International, and senior vice president, Business Development and Strategy. “Beyond its security, Saudi Arabia also has a desire to diversify its economy to provide more opportunities for its youth. This has led to a particular focus on commercial aviation and

the skills and career opportunities aviation both demands and enables.”

Hill said Boeing’s activities in Saudi Arabia are aligned with the government’s drive to offer outstanding educational opportunities and open doors for young people to pursue challenging careers both within Saudi Arabia and around the world. The focus is primarily on fields related to science, technology, engineering and mathematics.

For example, Boeing is a member of the King Abdullah University of Science and Technology (KAUST) Industrial Collaboration Program, a group of global industry leaders

who have joined with the university to foster strong and productive partnerships. It is also a co-founding member of Alfaisal University, one of the first private, nonprofit research and teaching universities in Saudi Arabia.

In addition, the company has been a leader in developing local industry, and it has a majority ownership interest in Alsalam Aircraft Co., an aircraft

PHOTO: Boeing Saudi Arabia’s headquarters is located in Riyadh, Saudi Arabia’s capital city, shown here with a view of the Kingdom Centre, the nation’s tallest building. SHUTTERSTOCK



maintenance, repair and overhaul center for commercial and military aircraft. Alsalam, based in Riyadh, employs approximately 3,000 people.

Ahmed Jazzar, president of Boeing Saudi Arabia, said the Saudi people have long had a fascination with aviation, and the Boeing name is held in high regard.

More than 170 Boeing employees are based in Saudi Arabia, and Jazzar said that number will increase as the company continues to gear up to support its 2011 military contracts.

Boeing has been very active in Saudi Arabia, including support for education, research and development, and health and human services, Jazzar

said. "This differentiates us from companies that swoop in, make sales and get out. This is a market where relationships matter. If you don't have relationships, you've got nothing."

In 2013, Boeing and Sikorsky Aircraft Corp. announced a joint venture to provide Saudi Arabia with comprehensive support for its fleet of rotorcraft, which includes opportunities for Saudi nationals to perform hands-on work.

Given the rapid growth of Boeing's defense business in Saudi Arabia, Boeing Defense, Space & Security in July announced a leadership reorganization there.

Mike Kurth, Defense, Space &

Security's newly appointed senior vice president for Saudi Arabia, said while the 2011 sale of military products to Saudi Arabia was "huge" for Boeing, the confidence the Saudis expressed for Boeing products and support also gave the company a boost in international markets.

"The platform sales are one thing," Kurth said. "But the significant support and training required can deliver great value and provide us a strong presence in Saudi Arabia for years to come. We must be very focused on supporting this growth."

Kurth sees this relationship growing, with new partnerships being formed in Saudi Arabia. He also sees Boeing



Pathways for success

Ensuring long-term economic vitality and helping young Saudis start successful professional careers is a major area of focus for Saudi Arabia.

“Saudi Arabia has a national policy focused on expanding private sector opportunities for its citizens and encouraging young Saudis to pursue careers in fields that will drive economic growth there,” said Coleen Burke-Finney, Boeing’s director of International Policy Integration.

Boeing is an active participant in Saudi programs to diversify the nation’s economy and develop a skilled workforce, with a focus on careers in science, technology, engineering and mathematics (STEM), she said.

“Boeing is working with the Saudis to encourage students to enter STEM-related fields, as well as open career opportunities.”

In support of those goals, Boeing is a co-founding member of Alfaisal University, one of the first private, nonprofit research and teaching universities in Saudi Arabia. The university has colleges offering curricula in business, engineering, life sciences and medicine.

Boeing, through its Kingdom of Saudi Arabia Engineering Fellowship Program, partnered with the Saudi Arabian Cultural Mission to offer select Saudi nationals educated in the United States a temporary assignment to work at Boeing in the United States, with the potential for later working for Boeing within Saudi Arabia.

In addition, Boeing makes charitable contributions to provide health and human services within the Kingdom of Saudi Arabia. These range from free dialysis sessions to services for children with mental and learning disabilities.

Earlier this year, Boeing renewed its support for KELLANA—The Prince Fahad bin Salman Charity for Renal Disease—by providing an additional 23 dialysis machines to aid the growing number of patients who have renal failure. Boeing has been supporting the charity since 2012, when it provided 30 dialysis machines to hospitals across the country.

Boeing also supports the King Abdulaziz Philanthropic Society for Women, which addresses a shortage of qualified Saudi women to work in important areas, such as teaching in small to medium-size schools.

Hope for Exceptional Needs, supported by Boeing, provides early intervention for disabled children and their parents. It focuses on improving the lives of children with mental and developmental disabilities by training parents and caregivers in cognitive development skills. It’s designed to get these children off to a more solid footing early in life. ■

employing more Saudi nationals.

Boeing’s *Current Market Outlook* forecasts that Middle Eastern airlines will need approximately 2,950 new airplanes valued at \$640 billion over the next 20 years. Saudi Arabian Airlines is a strong customer for Boeing widebody jetliners, with a fleet that includes 777s and 747s. In 2010, Saudia placed orders for eight 787-9 Dreamliners and 12 777-300ERs (Extended Range). When the first two 777-300ERs were delivered in January 2012, Saudia

PHOTO: A Boeing 777-300ER (Extended Range) in Saudi Arabian Airlines livery.
SAUDI ARABIAN AIRLINES

announced an order for eight more.

Marty Bentrott, Commercial Airplanes' vice president of Sales for the Middle East, Russia and Central Asia, said Saudia bought the 777-300ER to build on its large fleet of 777-200ERs.

"If you look at where Saudi Arabia is situated geographically, the 777-300ER is perfectly suited to meet the airline's requirements for destinations where it has higher load factors," Bentrott said. "It was a perfect solution, and we're hoping that Saudia will pick up more of them."

Saudia's single-aisle fleet includes a number of leased Airbus A320s. As those leases approach expiration, Boeing will be competing aggressively to replace the airplanes with the 737 MAX, according to Bentrott.

Saudi Arabia, along with the Middle East as a whole, is an important and growing market for Boeing Business Jets, said Steve Taylor, Boeing Business Jets president. Boeing Business Jets dominates the VIP market in the Middle East, with 49 percent of the large single-aisle market and more than 65 percent of the twin-aisle market, Taylor said.

"Several government operate Boeing Business Jets, including Saudi Arabia with four BBJ 747s," Taylor said.

Boeing also is investing in facilities to enhance Saudi Arabia's technological capabilities and support research and development activities in the nation.

Paul Oliver, vice president, International Business Development for the Middle East and Africa, Defense, Space & Security, said tools like this can help Saudi Arabia go beyond an oil-driven economy to a range of new industries offering growing job opportunities.

"We're investing in capabilities, technologies and knowledge transfer in Saudi Arabia to assist in its objective of diversifying its economy," Oliver said. "We're particularly interested in investments that help grow the aerospace and defense industry there."

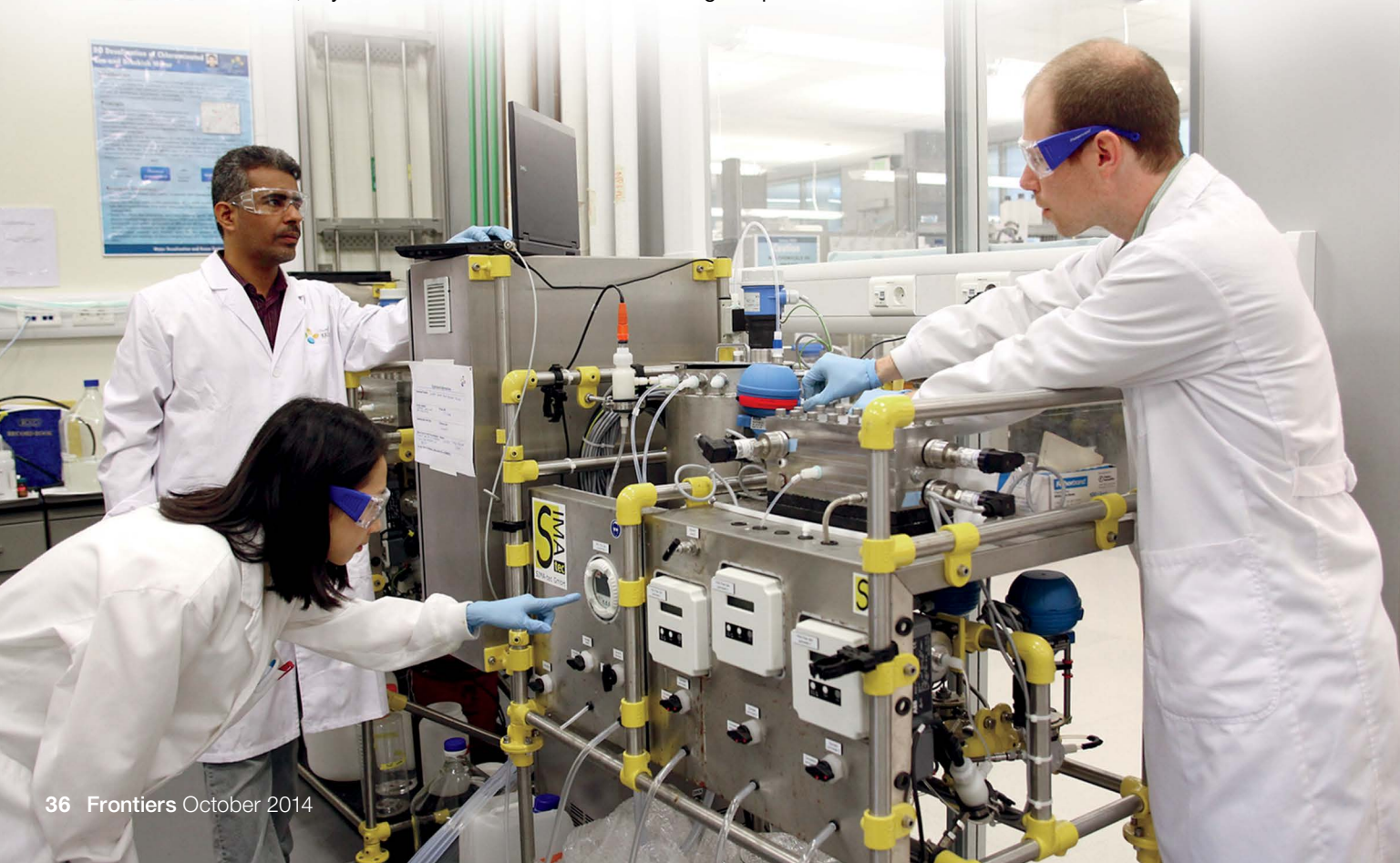
Bill Lyons, director, Global Technology, Boeing Research & Technology, said research activities range from work in composite materials, to solar energy, to extracting titanium powder from mineral sand. Boeing's expertise in

solar cells, Lyons said, can help Saudi Arabia reach its goal of developing a solar energy industry, with increased domestic use of solar power.

While Boeing is involved in research projects at various locations in Saudi Arabia, most of the work is centered at KAUST, located near Jeddah on the Red Sea. The university is a "world-class facility," Lyons said. "It's a laboratory where you've got the best facilities, the best equipment and some of the best minds from around the world, all brought together. It's really an example of how Saudi Arabia has developed as a nation, and how it is developing its own competencies in the global marketplace." ■

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PHOTO: Researchers are shown at King Abdullah University of Science and Technology, or KAUST. Boeing is collaborating with the university on six major projects in advanced materials, computer modeling, solar power applications and industrial water treatment and opened a Boeing Research & Technology office there last month. **KAUST**



MILESTONES





A photograph of a Royal Canadian Air Force CH-147F Chinook helicopter in flight, viewed from a low angle. The helicopter is positioned on the left side of the frame, with its main rotor blades blurred due to motion. The background features the Parliament Hill building in Ottawa, Ontario, characterized by its Gothic Revival architecture with multiple towers and arched windows. The sky is a clear, pale blue. The text 'IN FOCUS' is printed in white, bold, uppercase letters in the upper right corner of the image.

IN FOCUS

Higher honors

A Royal Canadian Air Force CH-147F Chinook lifts off from Parliament Hill in Ottawa, Ontario, following National Day of Honour activities May 9. The ceremony paid tribute to the sacrifices made by Canadian warfighters who contributed to the Afghanistan mission and the burden borne by their families. This photo was taken by Jason Arthur, a Chinook pilot with the 450 Tactical Helicopter Squadron in Petawawa, Ontario. Earlier this year, Boeing delivered the last of 15 "F" model Chinooks ordered by Canada.

PHOTO: JASON ARTHUR



معاً، نحلق عالياً

تجمع شركة بوينج والمملكة العربية السعودية علاقة طويلة الأمد، يعود تاريخها إلى نحو ٧٠ عاماً، حيث تفضل الشركة بدورها الحيوي الذي تلعبه في دعم جهود المملكة لتعزيز نمو قطاع الطيران التجاري والدفاع والتقنيات المتقدمة.

شراكة ترتقي إلى الريادة

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