



Frontiers

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Long-haul star

Performance capabilities of 787-9
are a 'game changer' for airlines

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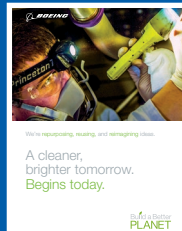
The stories behind the ads in this issue of *Frontiers*.

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Each year, The Boeing Store celebrates Boeing's birthday—and its heritage—in its stores and online. This year, Boeing's 98th anniversary, the stores are featuring the Boeing 727—on a T-shirt and free collectible pin—as well as daily deals on best-sellers. Visit your local store or online at www.boeingstore.com July 14–20.

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Build a Better Planet is the theme of a series of posters highlighting Boeing's commitment to responsible environmental leadership.

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This recruitment ad, showcasing the F/A-18F Super Hornet, emphasizes how an employee pursuing a career at Boeing can start at "full throttle." It primarily will run in career fair program guides at recruiting, diversity and college events.

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The second member of Boeing's Dreamliner family, the 787-9, was certified for commercial service last month and is being readied for delivery to launch customers. Airlines taking those first planes, including Air New Zealand, United, ANA and Virgin Atlantic, are enthusiastic about this longer version of the Dreamliner, which can seat about 40 more passengers than the 787-8 and has more range. They say it will give them a competitive advantage and open up new long-haul routes.

COVER: The first 787-9 for launch customer Air New Zealand rolls out of the paint hangar in Everett, Wash., in April, revealing a striking black color scheme. **BOB FERGUSON/BOEING**

PHOTO: A 787-9 soars near Mount Rainier in Washington state during its first flight in September 2013. **JOHN PARKER/BOEING**





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McDonnell Aircraft, a Boeing heritage company, began 75 years ago in St. Louis and produced spacecraft as well as jet fighters such as the iconic F-4 Phantom. PHOTO: BOEING



16 THE DUTCH: PARTNER, CUSTOMER, SUPPLIER

The Netherlands, with a long history in aerospace and with Boeing, is playing an important role in Boeing's international strategy for innovation and growth. PHOTO: TIM STAKE/BOEING



30 POSTCARDS FROM 'MARS'

At a remote spot in Utah, Boeing employees are part of a team learning what it might be like to live on Mars, and how to overcome the considerable challenges. PHOTO: ALEX WILSON/BOEING

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 **BOEING**

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brighter tomorrow.
Begins today.

Build a Better
PLANET

LEADERSHIP MESSAGE

Shep Hill

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

Flying into the future

Farnborough International Airshow is a showcase for Boeing technology and innovation, and a celebration of a century of aviation

In June 1919, British aviators John Alcock and Arthur Whitten Brown completed the first nonstop trans-Atlantic flight from St. John's, Newfoundland, to Clifden, Connemara, in Ireland. Some 95 years later, British Airways recently launched a direct 787 Dreamliner flight between London and Austin, Texas. It is Austin's first regular, nonstop trans-Atlantic connection.

While the flight to Austin is nearly six hours shorter and covers more than twice the distance of the original Atlantic crossing, both 'firsts' underscore that for a century, aviation has played an essential role in making the world a smaller, more connected place.

This month's Farnborough International Airshow in the United Kingdom celebrates an amazing century of aviation and gives

us an opportunity to showcase Boeing's breadth of products and technological innovation, on which millions rely every day to safely reach their destinations or stay protected as they serve their nations. It is also a chance to meet customers, suppliers and friends from across the globe to discuss collectively how we take this industry into its second century.

We are privileged to build on a position of strength. The economic relationship between the United States and Europe is the world's largest, comprising nearly half of world gross domestic product and one-third of global trade. Boeing is proud of its role in deepening the trans-Atlantic bond through mutually beneficial partnerships. In the U.K. alone, we sourced \$1.6 billion in 2013 from more than 250 suppliers of all sizes to deliver the most valuable products to our customers. One supplier, Rolls-Royce, powered both the original journey by Alcock and Brown as well as the market-shaping flight to Austin.

Beyond valuable supplier relations, our research and development with industry and academia has delivered breakthroughs in areas such as advanced manufacturing, sustainable biofuels and recycling of the carbon fibers used in modern airplanes. Boeing partners with a number of British companies, universities and institutes to advance aviation's long-term strategy of continuously reducing our carbon footprint and ensuring a sustainable future for our industry.

This commitment to an environmentally

progressive aviation sector is shared by our customers. No fewer than 10 U.K. airlines operate approximately 330 fuel-efficient Boeing airplanes, with a further 100 on order. Much of this backlog includes the 787 Dreamliner, which uses 20 percent less fuel than similarly sized airplanes, as well as the single-aisle 737 MAX, which recently surpassed 2,000 orders from 41 customers and will deliver lower operating costs to airlines and improved fuel efficiency.

On the defense side, Boeing platforms such as the C-17 Globemaster III, AH-64 Apache, ScanEagle and H-47 Chinook, along with associated training and logistics programs such as Support Chain Information Services, are at the heart of our support to the U.K. Armed Forces. The enduring partnership with the U.K. Ministry of Defence has been built on a shared vision to constantly deliver more capability at greater value.

Before embarking on his historic flight, the then-33-year-old Brown is said to have regarded aviation as an ideal tool for promoting peace and prosperity across the world. Together with more than 1,700 Boeing colleagues in the U.K. and nearly 170,000 employees around the world, Boeing looks forward to this year's air show and to continuing its contribution to this noble vision. ■

PHOTO: BOB FERGUSON/BOEING

At this year's air show, Commercial Airplanes will highlight the capabilities of the 787-9. See story, Page 22.





SNAPSHOT

Dream keepers

The first 787 Dreamliner for Dutch airline Arke receives an honorary fighter escort last month as it approaches the carrier's base at Amsterdam's Schiphol Airport after a delivery flight from Everett, Wash. Arke is one of six airlines operated by TUI Travel, the largest tourism group in the world. TUI has ordered 15 787s, six of which have been delivered and are in operation with three of the airlines. For more about Boeing's partnership with the Netherlands, see story, Page 16. PHOTO: ROYAL NETHERLANDS AIR FORCE



QUOTABLES

“We have not had a Critical Design Review of a deep space rocket since the sixties—so we are making history.”

—Virginia Barnes, vice president and program manager for the Boeing Space Launch System (SLS), describing Boeing’s progress on the SLS core stage. NASA’s massive new heavy-lift launch vehicle will send crew and cargo to destinations beyond Earth’s orbit. *Spaceflight Insider*, June 4

“We’ve gone from garage to global.”

—Insitu CEO Steve Morrow on the growth of the Boeing subsidiary in Bingen, Wash. Insitu builds the ScanEagle unmanned aircraft system as well as the larger Integrator. The company began in a garage, with its first unmanned aircraft designed to help fishermen track tuna. *Boeing News Now*, May 22



Melanie Willis

HAS WORKED FOR BOEING:

7 years

ORGANIZATION:

777 Final Assembly,
Commercial
Airplanes

HAS BEEN PART OF THE
777 TEAM:

3.5 years

WHAT WE DO

Work: flow

This employee is helping speed assembly of the 777 — with the 777X next

As told to Elizabeth Fischtziur, with photo by Marian Lockhart

Melanie Willis is a Manufacturing initiatives leader for 777 Final Assembly Manufacturing, Boeing Commercial Airplanes. In this *Frontiers* series that profiles employees and their jobs, Willis describes her role in streamlining the 777 production system.

Admit it: I'm an av-geek. I love airplanes. I grew up around them—my grandfather, dad and brother are all pilots—and Boeing was always a household name. Honestly, “airplane” was my second word, ever. I'm so fortunate to work with them daily as a Manufacturing initiatives leader for 777 Final Assembly.

It's a challenge to articulate my role, as it's ever-evolving. I've come to think of myself as a force multiplier. I streamline communication and allow the leadership team to expand the breadth and depth of areas it can influence. I manage projects that help us reduce waste in the system. These include everything from physically transforming space in our factory to reducing traveled work (work that is passed from shop to shop) and quality defects.

Most important, I am the initiative leader for 777 Final Assembly flow reduction—a project I'm most excited about. Flow is the number of days we spend building an airplane from start to finish. The 777 is at its highest production rate ever—8.3 airplanes per month. So reducing flow is essential to meeting customer demand.

If we send airplanes to the field with lots of open jobs, it can

disrupt schedules for teams at the Everett Delivery Center that have to finish the work. So we're working on projects to transform the production system and improve the way we do business. I'm juggling a lot of moving pieces, but I know we're building a “domino effect” with each small upgrade helping improve other projects or processes.

Another part of my job is to help communicate to 777 teammates why these changes are important. A year ago I was working in Human Resources, so I'm aware of how plans can affect employees.

I aim to help others understand where we're going, that it's not just change for change's sake; it's strategic. It's about making changes now to streamline the production system so we can successfully transition to the 777X and position ourselves in a competitive environment.

In a way, my role now is not that much different than when I was in Human Resources. I apply daily the lessons I learned in HR, such as coaching, holding others accountable, and understanding and applying policies and procedures.

That's one of the best things about working for Boeing—there

are many different career paths you didn't even know existed.

I feel privileged to work in this role and to manage projects that will benefit the program and extend the 777's legacy. It's been a great learning experience; I have a front seat as we're making history. And I can't think of a more challenging and rewarding work environment. ■

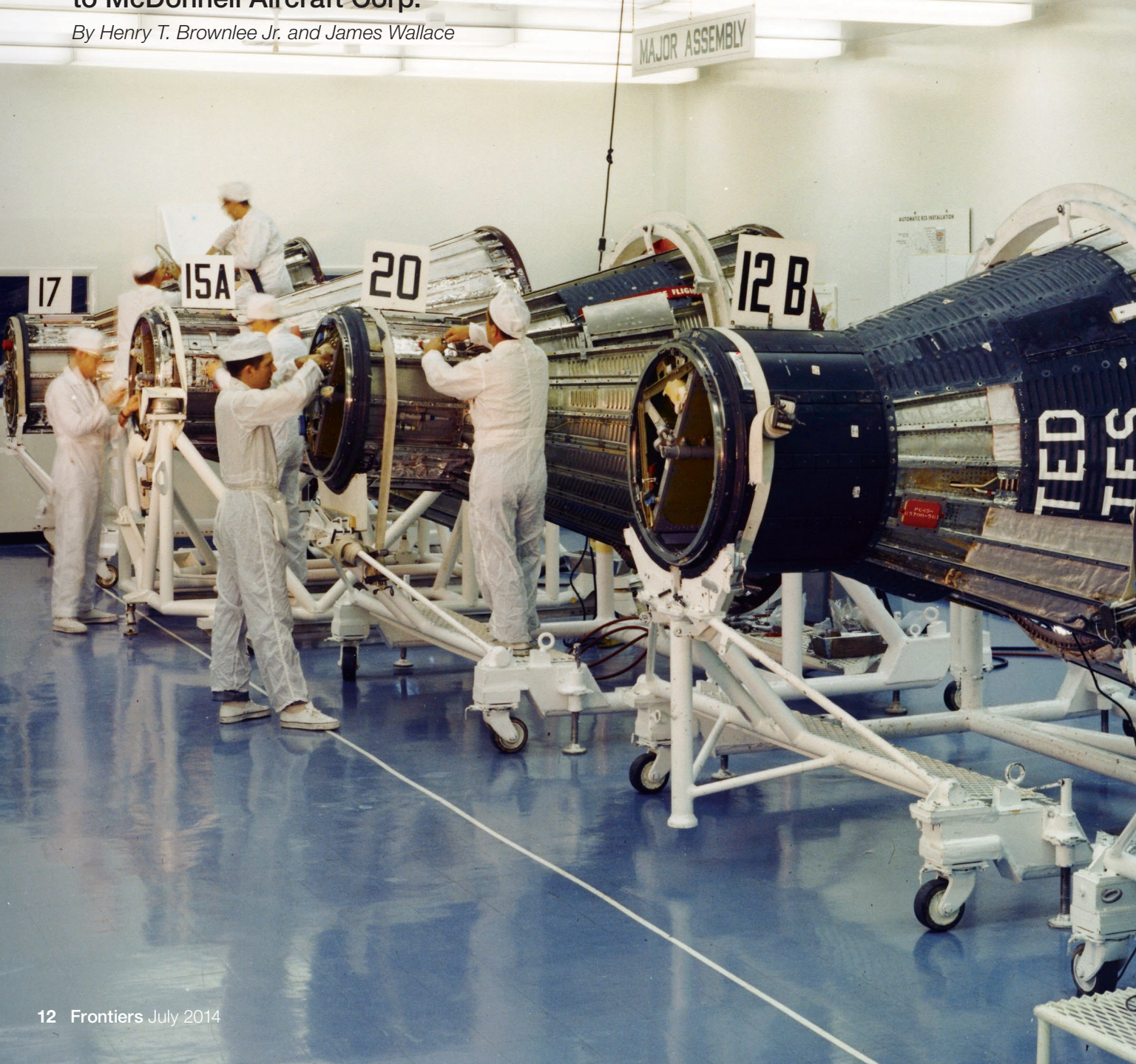
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HISTORICAL PERSPECTIVE

From JETS to SPACE

Boeing traces its St. Louis heritage
to McDonnell Aircraft Corp.

By Henry T. Brownlee Jr. and James Wallace



As a young aeronautical engineer James S. McDonnell, who traded \$10—supposed to be used to buy a winter coat—for his first ride in a Curtis Jenny biplane, envisioned every American family with a personal airplane.

“A world of flying people will be a world of better people,” he would write.

The Great Depression, which began with the 1929 U.S. stock market collapse, ended any dream of a plane for every family, but the company McDonnell founded in St. Louis at the end of the 1930s changed the world of aviation and aerospace.

McDonnell Aircraft Corp. first made a name for itself as a designer and builder of combat jet fighters for the U.S. Navy.

Later, when President John Kennedy challenged America to put a man on the moon and return him safely to Earth before the end of the 1960s, McDonnell Aircraft answered the call with the space capsules that carried the first U.S. astronauts into orbit, making possible the moon trips to follow.

Today, what was once McDonnell Aircraft is a part of Boeing, one of its many heritage companies.

McDonnell Aircraft was incorporated 75 years ago this month, on July 6, 1939, after McDonnell left his job as chief project engineer for land planes with Glenn L. Martin Aircraft Co. in Baltimore, Md., to start his own airplane company. He raised \$165,000 in seed money, primarily from family and close friends. Three months after McDonnell Aircraft was incorporated, it opened for business with 15 employees in a 1,600-square-foot (150-square-meter), \$100-a-month second-story room in the American Airlines building at the northwest corner of Lambert Field.

“A the end of the first year our backlog was zero, sales zero, earnings zero,” McDonnell, or “Mr. Mac” as he would affectionately become known, later recalled.

But with the outbreak of World War II, McDonnell Aircraft became a sub-contractor, manufacturing small assemblies for many companies and aircraft including the Douglas C-47 Skytrain and Boeing B-29 Superfortress.

It was during the war that McDonnell



Aircraft developed its first jet, when the company bid on a U.S. Navy contest for a carrier-based fighter. McDonnell’s FH-1 Phantom was the first jet-powered aircraft to be ordered into production by the Navy. It also was the first Navy aircraft to fly 500 mph (800 kilometers per hour), and the first to take off and land from a carrier.

It also gave McDonnell Aircraft a financial foundation to withstand the post-WWII drop in defense spending.

After the war, with company employment at more than 5,000, McDonnell designed and manufactured the F2H Banshee, F3H Demon and F-101 Voodoo jets. In 1957, the Voodoo set a world speed record of 1,207 mph (1,942 kilometers per hour). McDonnell delivered more than 800 of the fighter bomber.

The F-101 was followed by the iconic F-4 Phantom II, which could fly at twice the speed of sound. More than 5,000 were built.

In addition to fighter jets, McDonnell Aircraft designed and manufactured glide bombs at its St. Louis facilities.

But the company’s crowning achievement came when it was selected by NASA in January 1959 to design and build the Mercury spacecraft that would carry U.S. astronauts into orbit. McDonnell followed with the bigger Gemini capsule that held two astronauts.

By 1963, McDonnell was the largest employer in Missouri. James McDonnell, who wanted to diversify into commercial aviation, had talked with Douglas Aircraft in California about a possible merger. The Douglas board, in December 1966, sent out bid invitations to several companies for a possible merger. McDonnell submitted the winning bid, and the McDonnell Douglas merger became official on April 28, 1967.

From that merger would come many new commercial, space and military products, including the F-15 and F/A-18 fighters still being built in St. Louis.

McDonnell Douglas merged with Boeing in August 1997.

Today, a new generation of Boeing employees, inspired by those who came before them from heritage companies McDonnell Aircraft, Douglas, North American Aviation and others, are working on projects and programs that will continue to shape and lead the future of aviation and aerospace. ■

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PHOTOS: (Far left) McDonnell Aircraft Corp. manufactured all 20 spacecraft for Project Mercury, which studied the effects of space on astronauts, at its St. Louis facility.

BOEING ARCHIVES (Above) McDonnell’s 3,000th F-4 Phantom II. BOEING



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Rapid Prototyping

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Next-Generation Systems





DUTCH MASTERY

Boeing's long relationship with the Netherlands is helping open opportunities in other countries

By Bill Seil

The Netherlands has been a pioneer in aviation for more than a century, and Boeing has long been part of that Dutch journey—as a partner, customer and supplier.

Last year, the Netherlands celebrated 100 years of military aviation and the 60th anniversary of the Royal Netherlands Air Force. The Netherlands is an important Boeing Defense, Space & Security customer, flying both Apache and Chinook helicopters. The country's air force also was the first international customer for the AH-64D Apache combat helicopter.

Dutch aviation pioneer Fokker rose from modest beginnings in 1911 to become the world's largest aircraft manufacturer in 1925. An early Fokker U.S. subsidiary, Fokker Aircraft Corp. of America, later became part of Boeing heritage company North American Aviation. Since then, Fokker and Boeing have developed a number of significant partnerships over the past two decades.

KLM Royal Dutch Airlines, part of the Air France–KLM Group, is one of the world's oldest international airlines. KLM has been flying Boeing airplanes since the early 1930s, beginning with the DC-2 built by Boeing heritage company Douglas Aircraft. Today, KLM and Air France combined have one of the largest fleets of 777 jetliners in the world and have ordered 787 Dreamliners.

Headquartered in Amsterdam, Boeing Netherlands has more than 150 employees. They include representatives of all of the company's business units and some of its subsidiaries, including Jeppesen and Aviall.

Shep Hill, president, Boeing International, and senior vice president, Business Development and Strategy, said the Netherlands is important to Boeing, both for great customers and for local expertise that is boosting the

“Netherlands is helping us develop new, creative partnering models.”

—Matt Ganz, president, Boeing Germany and Northern Europe



PHOTO: ASSOCIATED PRESS

PHOTO ILLUSTRATION: A view of Amsterdam at night. CITY: SHUTTERSTOCK; AIRPLANE: BOEING



company's global productivity.

He noted that the country draws diverse, educated people from throughout Europe and around the world. This creates a talent pool that helps global companies operate efficiently and effectively, Hill said. One example is the company's Regional Finance Center in Amsterdam, which provides payment and accounting services throughout Europe, the Middle East and Africa.

"We were able to assemble an international team of well-educated people with multiple language skills who are very efficient and effective when working together," Hill said. "Diverse teams like this help drive the productivity we need as we do business around the world."

Matt Ganz, president, Boeing Germany and Northern Europe, said the Dutch economy is very open, and it relies to a high degree on international trade.

"As Boeing expands its international footprint, the Netherlands is helping us develop new, creative partnering models," Ganz said.

Boeing, with Dutch industry and the

University of Twente, in 2009 launched the ThermoPlastic Composite Research Center at the Twente campus at Enschede in the Netherlands. "We brought them the general idea, and they embraced it and took it to the next level," said Ganz, who also serves as vice president, European Technology Strategy. Pia Snijder, based in Amsterdam, is Boeing Research & Technology's global technology alliances and strategy director for Northern Europe. She notes that BR&T-Europe in Madrid is involved in a number of partnerships in the Netherlands, including an ongoing cooperative agreement to improve air traffic operations in the Netherlands.

The growing role of the Netherlands in Boeing's international strategy for innovation and growth was a factor in locating the company's newly appointed director for Northern Europe, Maria Laine, at the company's office in Amsterdam. Laine reports to Ganz, who is based in Berlin.

Boeing spends more than \$100 million annually with Dutch suppliers, and over the past 10 years has worked with its supply chain to undertake more than

300 projects with 80 Dutch companies. Boeing subsidiary Aviall has a regional headquarters and main distribution center in Amsterdam, supporting Europe, Africa, Russia and Israel. Boeing also has long-standing partnerships in the Netherlands to provide maintenance, repair and operations services.

The company also works to advance K-12 education in the Netherlands by supporting hands-on learning opportunities. One example is the Lego Solar Race car competition, where students are challenged to solve problems and be creative in the application of their knowledge of science, technology, engineering and mathematics (STEM). In addition,

PHOTOS: (Clockwise from above) KLM Next-Generation 737s and 777s on the tarmac at Amsterdam's Schiphol airport. **SHUTTERSTOCK** A researcher at the ThermoPlastic Composite Research Center in Enschede, Netherlands, studies new materials to reduce aircraft weight and emissions. **TPRC** The Chinook Maintenance Training Device at the Rotary Wing Training Center in Gilze-Rijen, a subsidiary of the World Class Aviation Academy. **BOEING**



MULTIPLIER EFFECT: THE SEARCH FOR NEW COMPOSITES

Composite materials have brought major changes to aerospace, and the search for new carbon-fiber materials is an important research challenge for Boeing and the industry.

Boeing, Fokker, TenCate Advanced Composites and the University of Twente are founding members of the ThermoPlastic Composite Research Center (TPRC), which is based in Enschede in the Netherlands.

TPRC was launched in 2009 and opened as a laboratory in June 2012.

“For us, it’s a way to accelerate the development of thermoplastic technologies and applications that benefit our business units,” said Pia Snijder, Boeing’s global technology alliances and strategy director for Northern Europe.

“There’s also a multiplier effect—we get a lot from our investment,” she added.

As a board member with the research center, Snijder works with a variety of outside partners, both large and small, who are doing research in the field of thermoplastic composites. Since it opened, the research center has grown from four members to 12. Snijder is hoping membership will grow beyond aerospace to the automotive industry and others with an interest in thermoplastic composites.

Thermoplastic composites tend to be lighter than other composite materials, and they are more ductile and impact-resistant. While Boeing Research & Technology Global Technology takes the lead for the center, both Commercial Airplanes and Defense, Space & Security are involved.

The composites research center is modeled after the Advanced Manufacturing Research Centre, which was founded by Boeing and the University of Sheffield. Based in South Yorkshire, England, it conducts machining research involving high-performance alloys and composites. ■

BR&T-Europe hosts interns from the Netherlands, with many coming from the Technical University of Delft.

Todd Nelp, vice president of European Sales for Commercial Airplanes, said it is impressive that the Netherlands, with a population of about 17 million people, has four successful airlines that fly Boeing airplanes.

Boeing Commercial Airplanes' major customer in the Netherlands is the Air France-KLM Group, which includes Dutch-based KLM Royal Dutch Airlines, Transavia and Martinair Cargo. Another Dutch carrier, Arke, part of TUI Travel, operates charter flights.

"The Dutch are very open, very honest and very demanding as a customer," Nelp said. "We've maintained an excellent relationship with them over the years."

In 2012, Air France-KLM finalized an order for 25 Boeing 787-9 Dreamliners. Transavia, which offers low-cost scheduled flights and inclusive tours, operates an all-Boeing fleet of 737-300s and 737-800s. Arke recently received its first 787-8 Dreamliner, which is part of an order for 15 Dreamliners placed by TUI.

Nelp said KLM is upgrading its widebody fleet, which now includes Boeing 747s, with the 787 Dreamliners. He sees potential in the Netherlands market for future sales of additional 787s, as well as the 777X and the 737 MAX.

On the defense side of Boeing's business, the Royal Netherlands Air Force is a longtime customer for Boeing rotorcraft, with a current fleet of 17 Chinooks and 29 Apaches. Boeing, as a partner in the Rotary Wing Training Center near Royal Netherlands Air Force Base, Gilze-Rijen, handles all Chinook maintenance training. Training is done using a Chinook helicopter adapted to serve as a maintenance training device.

In addition, the Netherlands military flies Boeing Airborne Warning & Control System, or AWACS, aircraft as part of NATO, as well as Boeing C-17s as part of a 12-member Europe-based Strategic Airlift Capability consortium. "The Dutch have a reputation for being partners, negotiators and very savvy consumers," said Joe McAndrew, vice president, International Business Development, Europe and Israel,

for Boeing Defense, Space & Security.

In 2013, Boeing and the Royal Netherlands Air Force signed the company's first-ever Integrated Fleet Support contract, which combines supply maintenance and spare parts for the Dutch Apaches and Chinooks. The agreement will save the Dutch money and increase aircraft availability.

"This was a great idea that fit in with our 'One Boeing' philosophy. We're looking to see where it can be applied to rotorcraft fleets of similar size," said Indra Duivenvoorde, a Boeing strategic partnership project manager for the Netherlands and Belgium.

Ligia McLean, manager, International Strategic Partnerships for Defense, Space & Security, said Boeing's partnership with the Netherlands took a major step forward in the mid-1990s when Fokker Aerostructures supported the sale of Apache helicopters to the Royal Netherlands Air Force. The agreement included Fokker supplying the forward avionics bays, which opened the door to additional military sales for Boeing and additional supplier contracts for Dutch industry, McLean said. Today, Fokker supplies various metal and composite structures for both the Apache and Chinook, as well as the Apache's landing gear and wiring for both commercial and military aircraft.

"We have worked side by side with Fokker on strategies and sales that have helped both our companies grow," McLean said. "That, I believe, is the difference between a supplier and an international partner." ■

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PHOTOS: (Clockwise from top left) A Royal Netherlands Air Force pilot views the arrival of Arke's first 787-8 Dreamliner.

ROYAL NETHERLANDS AIR FORCE A Boeing Next-Generation 737 in Transavia livery.

JIM ANDERSON/BOEING Visitors view a Chinook helicopter at the Royal Netherlands Air Force Open Days air show; during the Cold War, the Royal Netherlands Air Force was in command of F-15A Eagles flown by the 32nd Tactical Fighter Squadron; a Fokker airplane flown in the Richard E. Byrd Arctic Expedition in 1926. **BOEING**

GRAPHIC: Map of Europe. **SHUTTERSTOCK**





FINANCE IN ANY LANGUAGE

At Boeing's Regional Finance Center in Amsterdam, it's not unusual to hear conversations taking place in multiple languages.

The 25-member team, which provides payment and accounting services in Europe, the Middle East and Africa, is well equipped to handle the many currencies and legal requirements involved in Boeing's business operations. Together, they represent about 20 different nationalities. While all speak English, many are multilingual.

"There are times when I start a conversation in French, continue in Dutch and finish in English. That's fairly common in our team," said Dorothee Groeneweg, a senior manager in Boeing Shared Services International Finance, who leads the Amsterdam team.

The international labor pool of Amsterdam makes it much easier to build an internationally diverse group, she said.

The finance center is responsible for most non-production

transactions, including office-related payments, invoices from U.S. employees on assignment and payroll for local hires. They handle transactions in 17 different currencies and make about 2,500 payments each month.

In operation since 2007, the Amsterdam center's team continues to learn. It regularly brings in new tools and processes to manage complex tasks, Groeneweg said.

It is one of five regional finance and payment centers operated globally by Shared Services International Finance. Others are in Hong Kong, India, Russia and the United States.

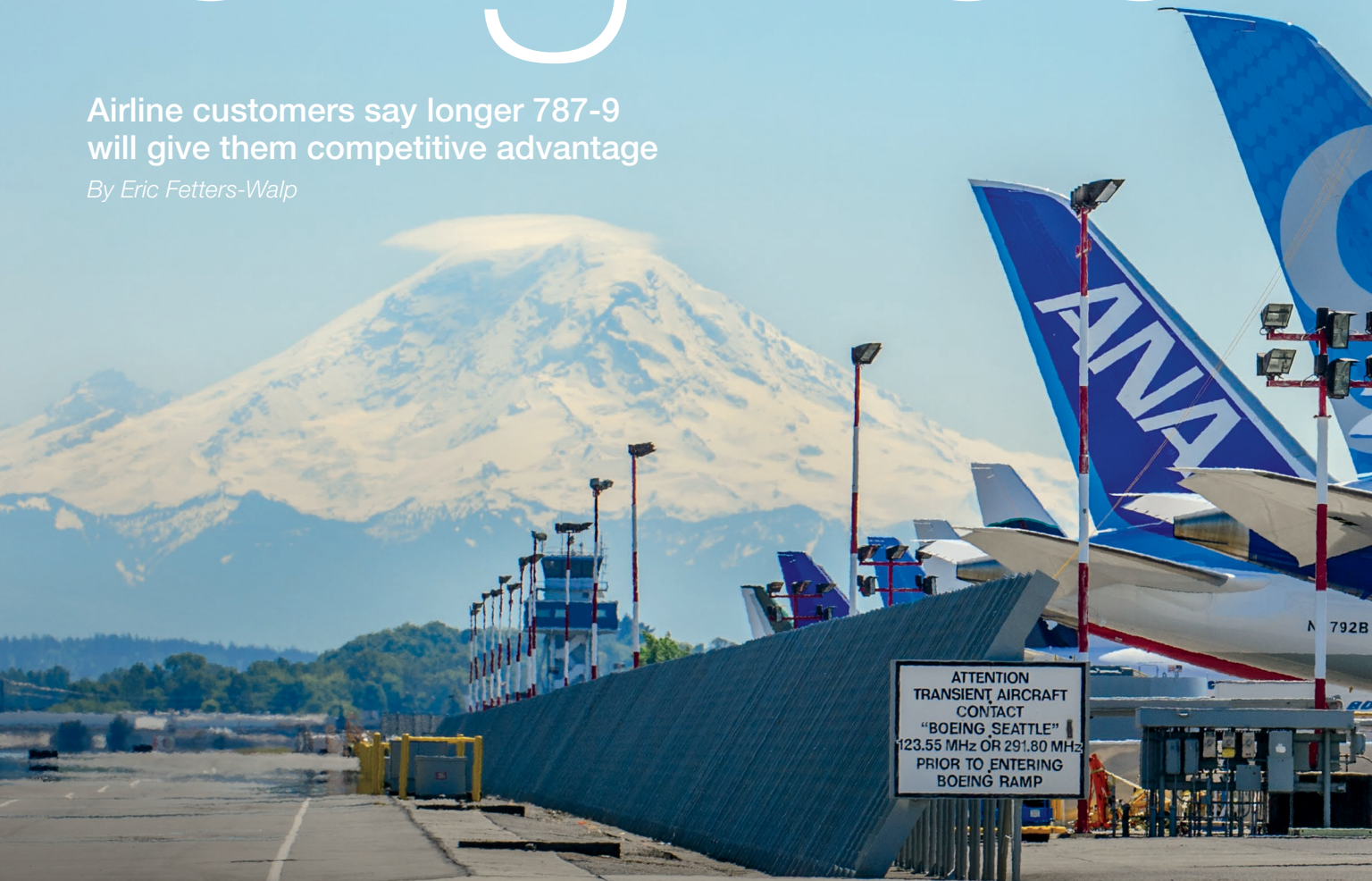
As Boeing expands its international business activity, the ability to overcome language and cultural barriers—and work in multiple financial and regulatory systems—is becoming increasingly important, Groeneweg noted.

"It's a very challenging environment, but it's also a lot of fun and full of opportunities," she said. "There's never a dull moment." ■

Ready for the long haul

Airline customers say longer 787-9 will give them competitive advantage

By Eric Fetters-Walp



Air New Zealand's Bruce Parton doesn't mince words when talking about why his airline is happy to take the first 787-9 to deliver.

"We think the Dash 9 will be a game changer for our airline. It suits us very well as far as the missions we have, and it has huge customer appeal," the airline's chief operating officer said.

In the coming months, Air New

Zealand, United Airlines, ANA and Virgin Atlantic Airways will be among the first airlines to receive the 787-9. Each has distinct plans for using the model to improve the efficient operation of existing long-haul routes, or connect new city pairs, just as the 787-8 has done. For example, United Airlines, the first North American-based airline to take delivery of both the 787-8 and the 787-9,



plans to fly the model six times a week between Los Angeles and Melbourne, Australia—it will be the world's longest Dreamliner route at 6,790 nautical miles (7,927 miles, or 12,757 kilometers).

"The Dreamliner gives us tremendous competitive advantages," said Ron Baur, United's vice president of Fleet. "With up to 30 percent more range than similarly sized aircraft, the 787 opens up new

nonstop destinations that we would not otherwise be able to operate. It gives us even more flexibility and range to capitalize on our extensive worldwide route network."

The 787-9 is 20 feet (6 meters) longer than the 787-8 and can carry more passengers and cargo, yet fly farther—450 nautical miles (520 miles, or 830 kilometers).

The 787-9's extra capability on long-haul routes makes it attractive to many airlines, but it's essential for service to and from New Zealand, one of the most geographically isolated

PHOTO: Three 787-9s—two in Boeing livery and the first for ANA—lined up at Seattle's Boeing Field, with Mount Rainier in the background. JIM ANDERSON/BOEING

nations in the world. And with fewer than 50 jetliners in its domestic and international fleet as of May, Air New Zealand is a relatively small airline trying to capture travelers' attention.

"We're a small country," Parton said, referring to New Zealand and its population of 4 million people. But the country and the airline strive to "make ourselves matter. Tourism is one of New Zealand's largest export industries and Air New Zealand

plays a significant role, carrying around one-third of all international arrivals to New Zealand. Our success and that of New Zealand are inextricably linked."

The airline plans to use its first 787-9 between Auckland, New Zealand's largest city, and the Western Australian city of Perth—more than 2,868 nautical miles (3,300 miles, or 5,310 kilometers). That will be followed by longer routes between Auckland and Shanghai and Auckland and

"Tourism is one of New Zealand's largest export industries and Air New Zealand plays a significant role."

—Bruce Parton, chief operating officer of Air New Zealand



PHOTO: The first Boeing 787-9 in Air New Zealand livery, on Boeing's Everett, Wash., flight line. **BOB FERGUSON/BOEING**



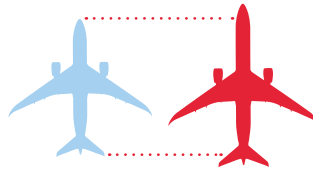
Tokyo, according to the airline.

Japan's ANA (All Nippon Airways) already is well acquainted with the Dreamliner, as the airline was the launch customer for the 787-8.

With its higher passenger capacity, ANA, like other airlines flying the 787-9, will use the model mostly on international routes. While the airline hasn't released specific information about where it will fly, it will open new markets for ANA, according to Ryosei Nomura, ANA's public relations manager.

"We plan to utilize the 787-9 to launch new destinations and increase the frequency of long- and midhaul international services," he said.

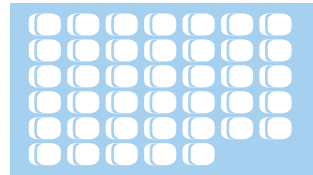
Virgin Atlantic Airways, which has 16 787-9s on order and options for more, touts the environmental advantages of the new model compared with other airplane types of similar size. Virgin Atlantic CEO Craig Kreeger said the stretched 787-9 will reduce fuel costs by 27 percent on the routes where it replaces the airline's four-engine A340-300s. At this point, Virgin Atlantic plans to use the 787-9 on many of the airline's existing routes from Heathrow, Gatwick and



The 787-9 is

20

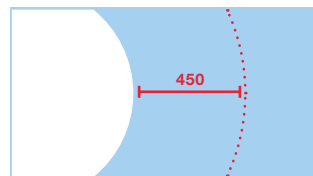
feet, or 6 meters, longer than the 787-8



The 787-9 can accommodate

40

more passengers than the 787-8, depending on the cabin configuration



An increased range of

450

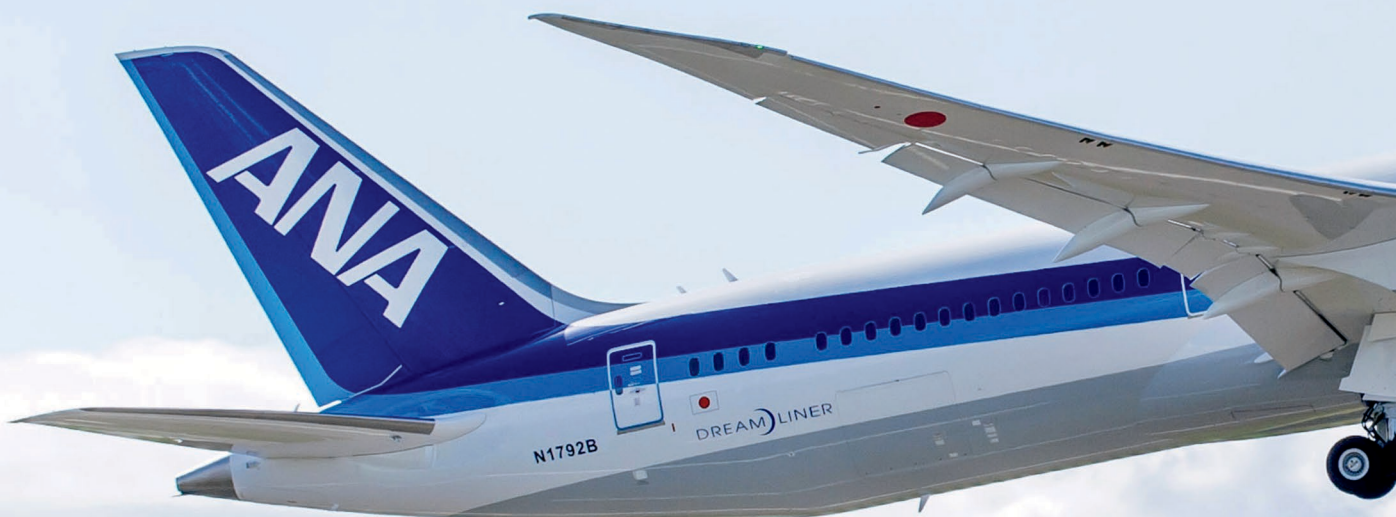
nautical miles (520 miles, or 830 kilometers), compared with the 787-8



United's first planned 787-9 route, the longest 787 route to date, is

6,790

nautical miles (7,927 miles; 12,757 kilometers), from Los Angeles to Melbourne, Australia





Manchester to the U.S., Caribbean, Africa, the Middle East and Asia. It also gives the airline the potential to start routes to new markets on several continents, according to the airline.

“A key factor for us is the reduction in operating costs, such as fuel and maintenance costs,” Kreeger said. It also will deliver improved aircraft availability because of better technical dispatch reliability and reduced maintenance, he said.

Helping with the maintenance factor is the Dreamliner’s Airplane

Health Management, a standard feature on the airplane that alerts airline personnel about potential maintenance issues in real time.

Virgin Atlantic officials also note that the 787’s noise footprint on both takeoff and landing is “significantly better” than airplanes of similar size, making a noticeable difference in communities around airports. Additionally, the Dreamliners will help Virgin Atlantic reach its goal of reducing the airline’s carbon-dioxide emissions by 30 percent by 2020, Kreeger said.

“We want to continue to be an industry-leading airline on sustainability, and the 787 will help us to deliver that,” Kreeger said.

United’s Baur said that the efficiency and environmental attributes of the Dreamliner are matched by the features noticed by the average

GRAPHIC: (Above) An artist’s concept of the 787-9 in Virgin Atlantic Airways livery. **BOEING**
 PHOTO: (Below) ANA’s first 787-9 takes off from Everett, Wash., on its inaugural flight.
TIM STAKE/BOEING



passenger: large windows, greater cabin pressure at cruise, dynamic lighting and technology to smooth out turbulence. Together, he said, they are “revolutionizing the flying experience for our customers and crews.”

Those passenger-friendly features are selling points on long-haul flights, said Air New Zealand’s Parton. “Customer experience is everything for us,” he said. His airline’s first 787-9 already has made a splash due to its striking, customized black livery.

“It was a milestone moment for both Air New Zealand and Boeing to see the aircraft emblazoned with the koru and New Zealand fern, and we are certainly looking forward to seeing it touch down in New Zealand as well as at other ports throughout Asia and the Pacific,” Parton said.

At ANA, taking delivery of the new Dreamliner model will help the airline continue to grow. It has 30 787-9s on order at a time when Japan’s airlines are expanding ahead of

the 2020 Olympics in Tokyo.

“The 787-9 will enable us to modernize and expand our fleet further as we seek to become one of the world’s leading airline groups,” Nomura said. “The aircraft will give us maximum flexibility and will allow us to meet the growth in demand.”

Like ANA, United is familiar with the Dreamliner, having flown the 787-8 since 2012. Baur said the model continues to exceed the airline’s expectations. “It not only delivers on the efficiency



promised, but it is by far the most popular aircraft in our fleet for both customers and employees,” he said. “The 787 has the highest customer satisfaction scores of any aircraft in our fleet, and we get dozens of letters from customers who loved flying the 787.”

Just as the 787-8 has attracted fans worldwide who prefer flying on it compared with other twin-aisle airplanes, Kreeger said the 787-9 will help differentiate Virgin Atlantic from its competitors flying from the

U.K., as it will be the first in Europe to fly the new model.

“We believe that our passengers will really enjoy this improved passenger experience,” he said, “and it will leave them wanting to come back and fly on it again and again.” ■

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PHOTO: The first Boeing 787-9 for United Airlines rolls out of the Everett, Wash., factory. **PAUL GORDON/BOEING**





Is this **MARS?** No, it's **UTAH**

Boeing and NASA employees partner with academia to practice what it might be like to live on the Red Planet

By Alex Wilson

Alejandro Diaz surveyed the red desert through his clear, spherical helmet. Beside him, an orange space suit—its legs and arms filled with sandbags to form the shape of a human—lay on a wheeled stretcher. A taut rope tied around the front axle extended up a hill about 100 feet (30 meters) to a member of Diaz's team, who wore a similar suit and a white backpack that pumped fresh air into it.

Diaz lifted a foot from the dusty red soil and started his ascent.

Along with another space-suited member of the team, the three worked to pull the stretcher up the steep mound of sandstone and iron oxide,

which gives the soil its red pigment. It was a test: how best to transport an injured astronaut across the rugged terrain of Mars.

Only this wasn't the Red Planet but a remote part of southwest Utah, an hour's drive from the closest town, population 217, and a 10-hour drive from Diaz's job as a Boeing engineer with Advanced Space Exploration in Huntington Beach, Calif.

"Now granted, we can't simulate

PHOTO: Boeing's Kavya Manyapu, crew engineer, scouts locations for simulated rescue operations at the Mars Desert Research Station. **MARS DESERT RESEARCH STATION**

the gravity or the atmosphere. But from an operational perspective, this could be very similar to what it'd be like to live on Mars," explained Diaz, who in Huntington Beach supports the Landing and Recovery Systems team of Boeing's Commercial Crew Space Transportation-100 (CST-100).

The CST-100 will carry astronauts to the International Space Station and other low-Earth-orbit destinations—in a commercially owned spacecraft to dramatically reduce costs. It represents another chapter in Boeing's long leadership in space exploration. Boeing and its heritage companies built the Mercury and Gemini capsules that first carried U.S. astronauts into orbit, as well as the Apollo spacecraft that carried astronauts to the moon and then the space shuttles. And Boeing built the U.S. sections of the International Space Station.

In addition to the CST-100, Boeing is building the core stage of the Space Launch System, a powerful new rocket designed to send manned spacecraft well beyond Earth orbit and into deep space, perhaps one day as far as Mars.

Meanwhile, the Mars Desert Research Station in Utah allows

PHOTO: Manyapu, left, fixes the MACHO rover with Humberto De Las Casas from Peru. They studied the use of rovers designed by the University of North Dakota to complement humans on Mars. **MARS DESERT RESEARCH STATION**



“From an operational perspective, this could be very similar to what it’d be like to live on Mars.”

—Alejandro Diaz, senior engineer, Advanced Space Exploration, Boeing





Boeing a deeper understanding of what daily life might be like on Mars, Diaz said. It allows Boeing employees an opportunity to work with others from academia, industry and NASA, developing a firsthand knowledge of the intricacies involved with doing fieldwork in an environment similar to Mars, Diaz said.

Going once a year for two weeks to live in isolation, Boeing employees have been crew members since the station opened in 2003. They join teams of six to seven members. Diaz's most recent team included one professor in literature, two Boeing employees, two engineering graduate students from Peru, one astrobiology graduate student, and one NASA flight controller who works on the International Space Station program.

The teams' approaches vary, but they all work to answer fundamental questions about how to overcome the challenges of living on Mars: What would someone eat? What happens with wastewater? What is life like in isolation?

The atmosphere on Mars is a hundredth that of Earth, but it has just as much carbon dioxide. What little water exists is frozen or trapped in rocks, and all of it is toxic to humans due to

a chemical called perchlorate. And, perhaps the biggest problem, exposure to solar radiation on Mars could kill a human in as little as two years.

"We have an opportunity to come here and stay for two weeks trying to test various technologies," said Kavya Manyapu, a flight-test engineer on the CST-100 capsule in Houston. "Be it a biologist or an engineer or a geologist, we can see how difficult it is to perform work while wearing a space suit, and do all the science you'd need to on Mars."

That's just what the Mars Society, a nonprofit that promotes human exploration and life on Mars, had in mind when it built the Utah Mars Desert Research Station.

Team members must wait 10 minutes in a depressurization chamber before heading outside in their orange-colored suits, which can get uncomfortably hot. Sleeping quarters are tight, and food is typically powdered. But the crews endure it all with the hope that these early tests will provide a proof of concept, a sort of launching pad for the technologies that will ensure successful human life on Mars.

On average, Mars and Earth are separated by 140 million miles (225 million kilometers). Even when the planets are closest, at 33.9 million miles

(55.6 million kilometers), there could be an enormous delay in communications, especially in emergencies.

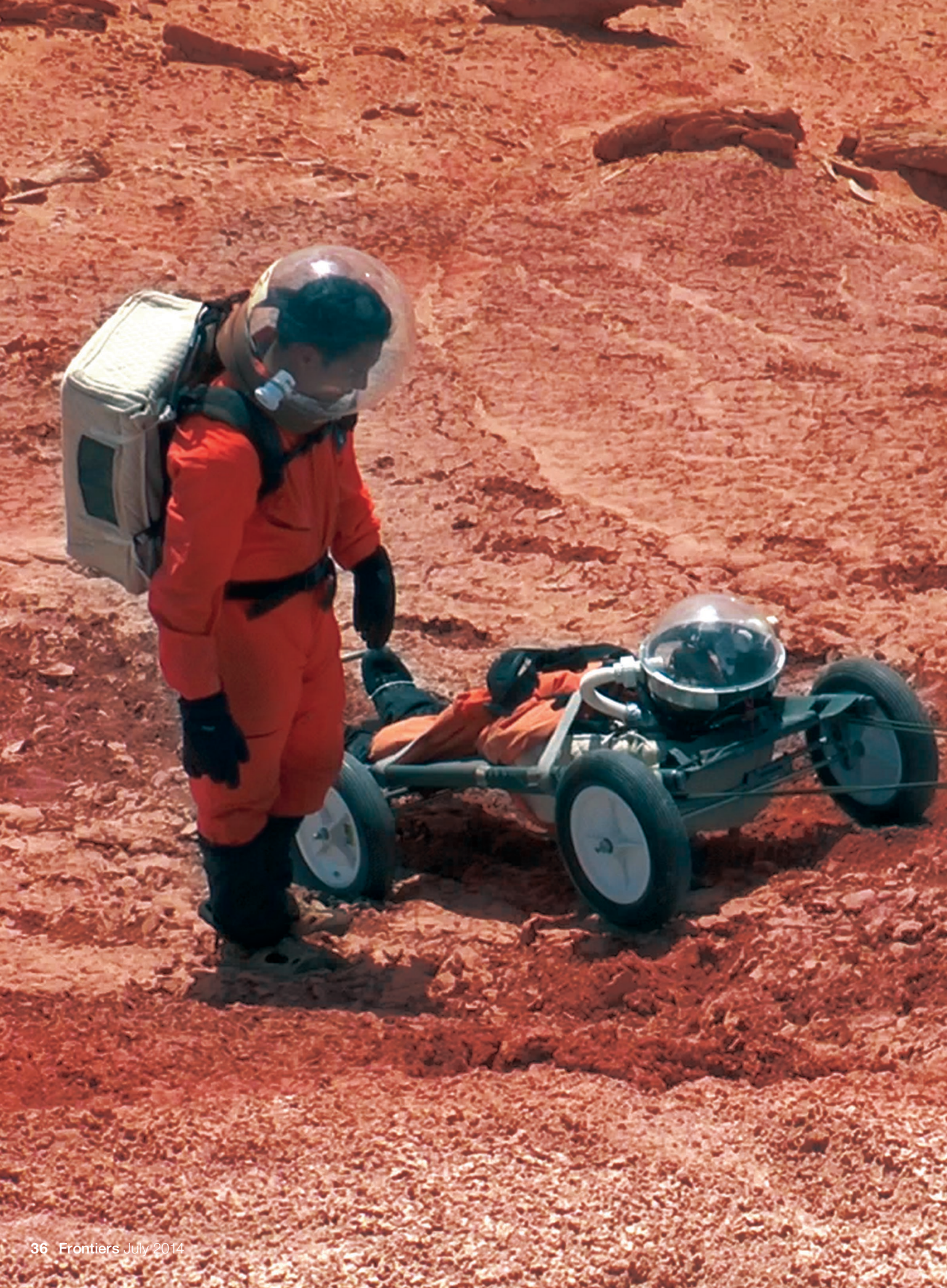
Boeing employees are working on that problem, too.

The goal, explained Charles Dutch, director of avionics and software for Boeing's Space Launch System in Huntsville, Ala., is to have voice and other data communications occurring over the millions of miles through space as fast, or faster, than they do through fiber optic cables on Earth.

At light speed (186,000 miles per second, or 299,000 kilometers per second), it would take 12 and a half

PHOTOS: (Opposite page, clockwise from top) Crew biologist Josh Borchardt, left, from the University of North Dakota, and Peter Morgan-Dimmick of NASA retrieve a water sample from a gorge; crew members perform yoga, meditation and stretching as part of exercising protocol to cope with stress. **MARS DESERT RESEARCH STATION** Morgan-Dimmick, from left, Borchardt and Boeing's Alejandro Diaz test rescue operations. **ALEX WILSON/BOEING** Borchardt, foreground, and Manyapu set up plant growth experiments using Mars soil simulant. (This page) Borchardt uses an all-terrain vehicle to simulate a rover and traverse the long distances the group travels while conducting experiments. **MARS DESERT RESEARCH STATION**





MARTIAN facts:

THE MASS OF MARS IS

1/10

THAT OF EARTH, BUT SINCE EARTH IS TWO-THIRDS WATER, IT HAS NEARLY THE SAME AMOUNT OF LANDMASS

TEMPERATURES RANGE

-58–76 F

(MINUS 50–60 C)

THE CARBON-DIOXIDE-RICH ATMOSPHERE IS

~100 times

LESS DENSE THAN EARTH'S

ORBIT TAKES

687

EARTH DAYS

ON AVERAGE EARTH AND MARS ARE SEPARATED BY

140 million miles

(225 MILLION KILOMETERS)

250 MILLION MILES: THE FARTHEST POINT

33.9 MILLION MILES: THE CLOSEST POINT

GRAVITY IS

1/3

THAT OF EARTH

Sources: Boeing, NASA, space.com and space-facts.com

minutes for a transmission to reach Mars from Earth when it is 140 million miles away. And data transmissions may need to be in the hundreds of megabits or gigabits per second.

"We've typically been using radio-frequency technology for long distance, but if you need higher data rates, you need higher frequencies," Dutch explained. "Laser communication systems close some of the gap, but having small, low-power lasers with extremely accurate pointing for two-way, high-rate communications from Earth and Mars still needs development."

Even with faster communications between Earth and a Mars outpost, the engineering challenges of one day sending astronauts and others to Mars are daunting—not to mention figuring out how to live and work in such a harsh and distant environment. Manyapu has begun work with the

Florida Institute of Technology on how isolation affects crew dynamics, stress and cognitive performance.

Meanwhile, at the Mars Desert Research Station, the Red Planet's alien landscape doesn't seem that distant. Observing the team's space-suited figures, it's easy to imagine the first human footprints on a distant planet.

Every member of the Utah crew would like to make those footprints.

Diaz was shortlisted last year by NASA to become an astronaut. The youngest member of the Utah crew, Josh Borchardt, an astrobiology graduate student from the University of North Dakota, holds out hope to begin the arduous process of creating Earth-like conditions on the Red Planet. He has shown in his Utah greenhouse that Mars' soil is hospitable to plant life—important, because plants also would provide something more than basic human needs to those living on Mars, he said.

"I did not expect how much I needed to see plants," Borchardt said of his time spent at the Utah station. "We need little bits of Earth around us all the time—especially going to Mars."

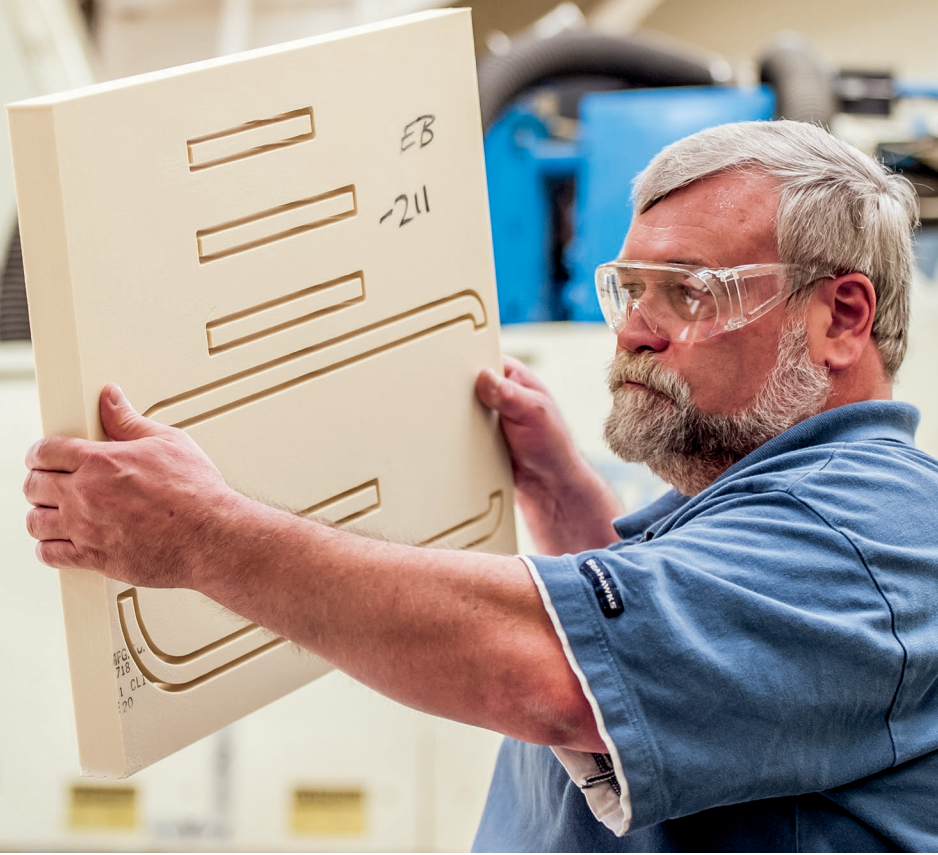
He and the others on the Utah team know that creating a sustainable habitat on Mars would be a monumental undertaking. But that does not deter them from dreaming, while also working on solutions to the many challenges.

"Space exploration fulfills an innate curiosity that I believe all humans have to explore our boundaries," Diaz said. "All of the research we are doing now will hopefully help humans settle the next frontier—space." ■

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View a related video at boeing.com/frontiers/videos/july14

PHOTOS: Diaz, far left, with a simulated injured crew member on a modified stretcher, tests rescue operations. ALEX WILSON/BOEING



Calculated improvement

Ordering only the right amount of material needed to fabricate parts means a big reduction in waste—and costs

By Patrick Summers

An employee team at Boeing South Carolina that helps fabricate parts made from large sheets of composite material for the interior of the 787 Dreamliner is showing that simple steps to reduce waste and adopt best practices can bring both environmental and business benefits.

In this case, the simple solution was an easy-to-use calculator that ensures a precise amount of material is ordered to manufacture a part.

“If we improve our accuracy at the front end when we order material, we streamline our operations and

reduce the back-end waste that otherwise would need extra handling and special disposal,” said Matt McCalley, environmental engineer at the North Charleston site.

Before the calculator was part of the process, the system used to order raw material would designate a full sheet of composite material for an aircraft part that might only require a fraction of that amount.

“The former process would include leftover material and created unneeded inventory,” said Greg Moser, manufacturing engineer.

Ordering the right amount of material is a critical step in reducing waste and cutting costs. Moser estimates in the past two years the calculator has helped the South Carolina site reduce the amount of composite material ordered by 37 percent, or 44,000 pounds (20,000 kilograms), adding up to \$1.1 million in avoided costs.

To help create this more efficient process, Moser and his teammates turned to the calculator, a best practice first developed at the interior parts fabrication facility in Everett, Wash.

“What we want to do is reflect what’s consumed in the building of the part, not the finished product,” said Brett Price, the Everett manufacturing engineer who designed the calculator. “The calculator helps engineers order the right amount of material.”

Use of the calculator earned the site a 2014 Boeing Conservation Award, given annually to projects that promote efficiency, recycling and other resource conservation efforts. It also supports Build a Better Planet, Boeing’s strategy to improve the environmental performance of its operations and products.

Said Price: “Any reduction in waste is definitely better for the environment.” ■ patrick.a.summers@boeing.com

PHOTOS: (From left) Brett Price inspects cuttings to a section of foam that’s part of the fabrication process for composite parts for the 787 Dreamliner in Everett, Wash. **GAIL HANUSA/BOEING** At Boeing South Carolina, Matt McCalley, left, and Greg Moser inspect composite material that will be used in fabricating parts for the 787. **ALAN MARTS/BOEING**

CUSTOMER PROFILE

The crane and the Dream

LOT Polish Airlines is relying on the 787 for a bright future

By Chamila Jayaweera

In Poland, the common crane often symbolizes hope or regeneration. It's a characterization the Polish national airline carrier, LOT, has embraced over its 85-year history, with a design of a crane in full flight displayed on the tails of its airplanes.

The symbolism is especially timely as LOT, European launch customer for the 787, works to rebound from financial problems as well as early reliability issues with the Dreamliner, which led to negative media reports in Poland.

"We have definitely seen our share of ups and downs," said Sebastian Mikosz, chief executive officer for LOT Polish Airlines.

But Mikosz said the airline has worked closely with Boeing to overcome the obstacles.

"We are more committed than ever to restoring our company's image," he said.

Established in 1929, LOT is one of the world's oldest continuously operating airlines. Boeing's relationship with LOT spans almost three decades,

beginning with the carrier's order of five 767s in 1988. The airline's current Boeing fleet includes three 737s and six 787s, with two more on order.

LOT took delivery of its first Dreamliner in 2012 and was first to operate the 787 in the European market. Mikosz said that helped the airline attract customers who wanted to experience the innovative airplane firsthand. He credits the Dreamliner with turning around the airline's financial picture in 2013.

"This is the first time in five years we have been able to report profits," Mikosz said. "We credit Boeing's Dreamliner with increasing the number of business- and premium-class passengers who fly with LOT."

The carrier vigorously promotes its long-haul flights connecting Europe to destinations such as Beijing, Toronto, Chicago and New York and showcases its partnership with the Star Alliance, a global airline network made up of more than two dozen member airlines.

LOT also stands to benefit from growth in the European market.

"We expect the European aviation market to grow over the next 20 years, with airlines in Europe looking at acquiring more than 7,400 new airplanes," said Todd Nelp, vice president of European Sales, Boeing Commercial Airplanes. "That is a significant number, and we are confident LOT will be part of that growing equation as they build upon their strong legacy."

Mikosz said he looks forward to a strong future for LOT.

"We are very excited to have a partner like Boeing as we look ahead," he said. "Like the crane, which has persevered over the years by sheer instinct, those who make up the LOT team are also determined to keep flying strong." ■

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PHOTO: LOT Polish Airlines took delivery of its first 787 Dreamliner, shown, in 2012. **BOEING**



MILESTONES



IN FOCUS

Eye on the sky

Boeing's unmanned Phantom Eye demonstrator prepares for a test flight just before daybreak last month at NASA's Armstrong Flight Research Center at Edwards Air Force Base, Calif. Phantom Eye is a high-altitude, long-endurance unmanned aircraft system. The vehicle uses a unique, highly efficient liquid-hydrogen propulsion system that produces only water as a byproduct. The Phantom Eye demonstrator is designed to carry a 450-pound (200-kilogram) payload while staying aloft for up to four days; a full-size version is expected to carry 2,000 pounds (900 kilograms) and stay aloft for up to 10 days. These characteristics will allow Phantom Eye to provide constant intelligence, surveillance and reconnaissance, or ISR, missile defense, or communications support—all while saving infrastructure, personnel and fuel costs for customers. This flight reached an altitude of 43,400 feet (13,300 meters). PHOTO: BOB FERGUSON/BOEING





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