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Frontiers

Sea change

U.S. Navy's P-8A Poseidon sets the standard for maritime patrol and other missions

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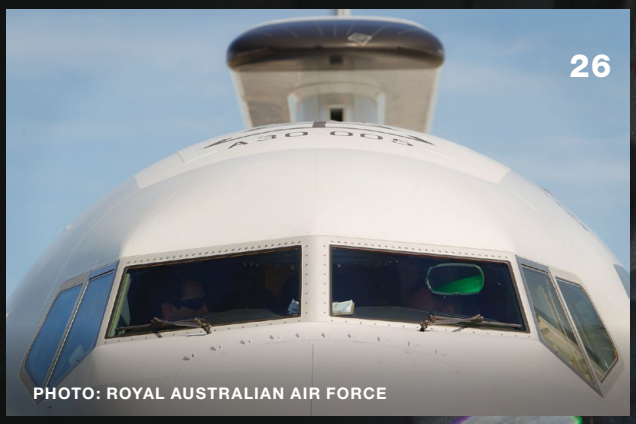

PHOTO: ROYAL AUSTRALIAN AIR FORCE

PHOTO: NASA

Cover: U.S. Navy ground crew direct pilots of a P-8A Poseidon on the flight line before takeoff at Cecil Airport in Jacksonville, Fla. **BOB FERGUSON | BOEING**

Photo: Navy pilots run preflight checklists in the flight deck of a P-8A in Jacksonville, Fla. **BOB FERGUSON | BOEING**

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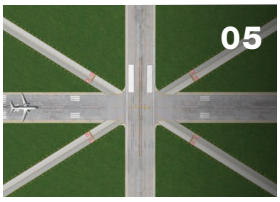

Boeing has doubled its workforce in the United Kingdom since 2011. This ad highlights how Boeing's partnerships help build a stronger United Kingdom. Learn more at boeing.co.uk/value.

Boeing employees are committed to environmental improvements—at work and in their communities. Adapted from a series of posters in support of Earth Day and World Environment Day, this ad urges everyone to take action on Earth Day (April 22) and help build a better planet.

Part of the "A Better Way to Fly" campaign, this 747 ad is from a series showcasing the many ways Boeing airplanes and services enable opportunity and success for customers. The ads are running in trade publications and online.

This is the third ad in the Japan "Tomomi" campaign. The ad speaks to the partnership Boeing has with the University of Tokyo, developing research and inspiring tomorrow's aerospace leaders.

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April 22

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boeing.com/environment

Build Something Cleaner

Shifting mindsets and behaviors

We want an inclusive work environment where our diversity fuels innovation and we win and prosper together as one team

Boeing people build amazing products and deliver innovative solutions that connect, protect, explore and inspire. But often our mindsets and culture—too bureaucratic, inwardly focused and political—get in the way of even greater achievements.

Every day, Boeing teammates should experience a work environment where they are engaged and inspired to contribute their best efforts and ideas; where collaboration comes easily and diverse perspectives and experiences are embraced; and where they feel accountable for results, and their managers value their contributions.

That kind of culture is the key to accelerating Boeing's performance while ensuring job opportunities and our position as the world's leading aerospace company.

Changing deeply ingrained aspects of a culture is not easy, but it is possible if we commit to a course of intentionally shifting these mindsets and behaviors:

- Actively pursue open dialogue and true collaboration as "One Boeing" to cut through complexity. To win in the marketplace, we must collaborate in a way that moves us forward.
- Solve first for big, "high-impact" decisions, then empower others to execute the details with authority.
- Evolve processes so their steps really help us deliver the right results; processes serve people, not the other way around.
- Turn our emphasis to the prevention of problems—deliver first-time quality—instead of fixing them afterward.
- Focus on a view of excellence that doesn't accept trade-offs between schedule, cost and rate at the expense of quality and safety.

Above all, the culture of Boeing should be inclusive, not just of different races and genders but also of ideas.

Shifting our mindsets and behaviors is not so much to fix something broken as it is an opportunity to create the culture we want. To succeed, we need leaders at all levels who have the courage and vision to think and behave differently—and who make room for others to do so as well.

As Boeing embarks on its second hundred years, the Executive Council—the company's most senior leaders—and I have committed to enacting changes that move the culture forward as quickly as possible. One change has already come about: This year, eligible non-management employees will have the ability to earn incentive awards based in part on their personal achievements.

This shift represents an intentional move toward a performance-driven, instead of process-driven, culture where employees can see a strong link between their individual contributions and rewards. More changes are on the way.

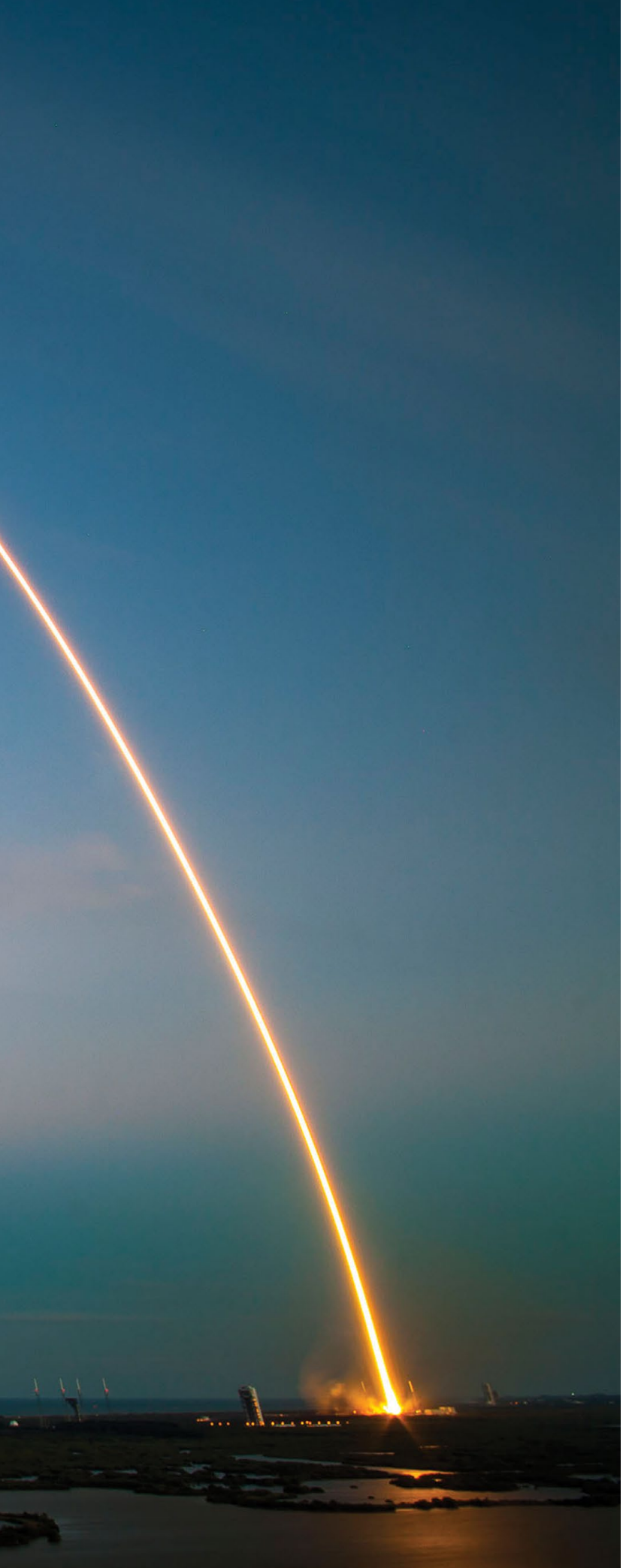
We can only build the performance-accelerating culture we want at Boeing if we do it together. I'll commit to questioning processes and why we do things "the way we've always done it." I'm asking you to help as well: Embrace the changes I've mentioned above. Do things differently where you work.

At Boeing, performance doesn't only translate into numbers on a balance sheet but to engaged, inspired employees; a stellar reputation; and growth and prosperity. And it generates the innovations that will shape the course of history, as we have for the past 100 years. ●

Heidi Capozzi
Senior vice president
Human Resources
PHOTO: BOB FERGUSON | BOEING

Trail blazer

A Boeing-built 702HP (high-power) satellite is launched into orbit last month from Cape Canaveral Air Force Station, Fla., aboard a SpaceX Falcon 9 rocket. The SES-9 satellite will expand direct-to-home broadcasting and communication services in Northeast Asia, South Asia and Indonesia; provide maritime communications for vessels in the Indian Ocean; and deliver high-speed broadband services to remote areas in the Asia-Pacific region. It is the 11th satellite Boeing has built for SES. A 12th is in production at Boeing's Satellite Development Center in El Segundo, Calif. PHOTO: SPACEX



"It would readily change the world—like the cellphone and the computer—if we could routinely fly in and out of space."

—Kevin Bowcutt, Boeing's chief scientist for hypersonics and a Senior Technical Fellow in Huntington Beach, Calif., talking about his vision for a hypersonic "space plane." See story, Page 40.

"ISS is the cornerstone to deep-space exploration and a test bed for cutting-edge research and technology development that will enable human exploration of destinations beyond low Earth orbit."

—Mark Mulqueen, International Space Station (ISS) program manager, following the return of U.S. astronaut Scott Kelly after a year of living in the space station. *Boeing News Now*, March 2

"We assembled the first 747 in snowstorms as they were constructing the building around us."

—Dwight Bates, one of about 50,000 employees who worked together to build the first 747 in the late 1960s at the new Everett, Wash., factory. They became known as the "Incredibles." Read his story and those of others on Boeing's centennial story sharing website at boeing.com/our-stories. See a related video at boeing.com/frontiers/videos/april16.

Photos: (Top) Inside the Douglas factory, workers gather around the wings and center fuselage section of the XB-19, which was built vertically in one piece. BOEING ARCHIVES (Bottom) An experimental long-range bomber, the XB-19 was the largest aircraft built in the United States during World War II. BOEING

On the shoulders of giants

When the U.S. Army Air Corps wanted a bigger bomber, Douglas Aircraft responded with a giant—the XB-19

BY MICHAEL LOMBARDI

Seventy five years ago, when it was rolled out of the Douglas Aircraft plant in Santa Monica, Calif., the XB-19 was hailed as the "Guardian of the Hemisphere."

The four-engine experimental bomber took off from Clover Field for its first flight in June 1941. At the time, it was the largest airplane in the world, with a wingspan greater than the first 747 that would follow many years later.

And much like the legendary 747, the XB-19 had required a bigger building, bigger tools and a bigger imagination.

Donald Douglas called it "a triumph of American initiative and engineering."

But only one was ever built.

The Douglas XB-19 began in the mid-1930s as a U.S. Army Air Corps project and was designated the XBLR-2 (Experimental Bomber Long Range). It was an X-plane designed to test the limits of size, capacity and range. Boeing had worked on a similar project designated the XBLR-1, and later the XB-15. When introduced in 1937, the Boeing aircraft was the largest and heaviest ever flown in the United States. But the Army Air Corps wanted Douglas to go bigger.

Preliminary design of the XB-19 began in July 1935 and although the size and scope of the project caused some delays, the biggest obstacle was budget. With escalating cost that quickly exceeded the original $1.4 million government contract, Douglas contributed an additional $4 million of its own funds to complete the project, which was not finished until May 1941.

At 212 feet (65 meters), its wingspan was 63 feet (19 meters) more than the XB-15 and 17 feet (5 meters) greater than the early models of the 747. The XB-19's empty weight of 86,000 pounds (39,000 kilograms) easily doubled the XB-15. It had a crew of 16 and accommodations for eight additional crew members, plus a large galley to prepare hot meals for long-range missions up to a maximum of 7,710 miles (12,400 kilometers).

Douglas had indeed gone bigger.

Designing the airplane was not considered a great challenge for Douglas engineers, who had been evolving bigger airplane designs and were working toward the four-engine DC-4E. What the Douglas workers found to be a problem, however, was installation of the massive amounts of equipment.

Powerful airborne electrical systems were new in the 1930s and the XB-19 had one of the most powerful, with twin 15-kilowatt generators that powered four large radios and 24 intercom stations throughout the plane. It was one of the first planes to have an oxygen distribution system and the first to have power-boosted controls. The plane had a tricycle landing gear, a rarity at the time, and the main landing gear struts were so large that no tool was available to machine them—the closest were naval arsenal lathes used to manufacture 16-inch (40-centimeter) battleship guns.

The voluminous hangar at the Douglas plant in Santa Monica housed the showpiece of XB-19 manufacturing—the largest jig used anywhere in the aircraft industry. The wings and center fuselage were built vertically as one piece in the jig, which was more than 200 feet (60 meters) long, 48 feet (15 meters) high and weighed 105,000 pounds (47,600 kilograms). Almost 200 workers were needed on the jig, distributed over seven different levels. When the aircraft's huge sections were completed, Douglas consulted with the engineers who worked on the Golden Gate Bridge in San Francisco to move and join them together.

On June 27, 1941, a crew of seven, led by Maj. Stanley Umstead, took off in the XB-19 from Clover Field, Santa Monica. Unnoticed in the crowd of onlookers was actress Carole Lombard, sitting on top of her Cadillac coupe; beside the car was actor Clark Gable.

The airplane was transferred to Wright Field, Ohio, in January 1942, where it was used as a flying laboratory, contributing data and experience that assisted the design and operation of other large airplanes such as the Boeing B-29 and especially the Convair B-36, which assumed the mantle of America's largest airplane in 1946.

The 1940s were a period of accelerated technological advancement and the XB-19's long development ensured its rapid obsolescence. By 1943 the usefulness of the airplane as a flying laboratory had come to an end. Its 2,000-horsepower Wright R-3350 radial engines were replaced with the unique 2,600-horsepower Allison V-3420 inline engines and it was re-designated the XB-19A and used as a cargo plane. On Aug. 17, 1946, the XB-19A made its final flight to Davis-Monthan Field in Arizona, where it eventually was scrapped.

Despite its limited success, the size, complexity and audacity of the program served as a source of pride and inspiration for the men and women of Douglas Aircraft and, indeed, the entire fledgling U.S. aerospace industry. Most important, perhaps, it encouraged them to design bigger and better aircraft and take on seemingly impossible challenges. As Donald Douglas wrote, the XB-19 was "a tribute to the vision and daring of men who plan and build. It is the product of a thousand brains and million hands." ●

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BOEING

Ocean

U.S. Navy's P-8A Poseidon proves itself in service, regardless of the mission

BY VINETA PLUME | PHOTOS BY BOB FERGUSON

Through the windows of the flight deck, U.S. Navy Cmdr. Andrew Klosterman and Cmdr. Edward Kribs look out into the shrub-mottled, barren beige landscape of Fallon, Nev., like a scene out of *Star Wars*, Kribs notes. They begin to taxi a P-8A maritime patrol and reconnaissance aircraft, a hunter of submarines, toward a perpendicular runway framed by distant hills ahead.

The pilots are here to test the aircraft's high-pressure altitude performance. At nearly 4,000 feet (1,200 meters) above sea level, Fallon is far from the vast oceans over which the P-8A Poseidon typically reigns.

They have no chance of achieving their mission. A third Navy pilot, Lt. Donnell Exum, has disengaged the aircraft's flight-critical radar altimeter. And when a button overhead lights up red, indicating the failure, Klosterman and Kribs choose to stop, return the plane to the line and consult the maintenance crew.

It's the right decision, and just one in a series of eight simulated malfunctions and decision-making scenarios that Exum will use to challenge his students this morning

reign

Photo: U.S. Navy mission operators concentrate during simulated scenarios inside a Boeing Weapons Tactics Trainer at Naval Air Station Jacksonville, in Florida.

inside a ground-based, full-motion P-8A simulator at Naval Air Station Jacksonville, in Florida. Known as the OFT, for Operational Flight Trainer, the simulator is complete with a "glass," or electronic, flight deck including high-fidelity touch screens and a head-up display. It involves far more automation than anything Kribs and Klosterman experienced flying the P-3 Orion, a 1960s-era, four-engine turboprop aircraft built by Lockheed Martin. The P-8A, which is replacing the Orion, is a military derivative of the Boeing Next-Generation 737-800 commercial jet and has presented these pilots with a new philosophy of flying—and of communicating with each other—they said.

With the aircraft now in full-rate production at Boeing's plant in Renton, Wash., the Navy's Poseidon fleet is quickly growing, and training on the P-8A is proving to be an increasingly urgent need in getting crews mission-ready, according to the Navy. That urgency is underscored by the widespread use of the Navy's P-8As, especially in the Western Pacific.

The P-8A's mission capabilities include anti-submarine and anti-surface warfare; intelligence, surveillance and reconnaissance; and search and rescue.

"Information overload," is how Kribs described the initial move to the P-8A. The veteran pilot's 15 years on the P-3 included "front-row tickets to Operation Iraqi Freedom" in 2002—along with Klosterman, who also has flown P-3s for 15 years and, by pure

Photo: A U.S. Navy P-8A Poseidon departs Cecil Airport in Jacksonville, Fla.

coincidence, been with Kribs to every duty station since flight school. "Flying the P-3 for so long," added Kribs, "you can imagine the habits we formed that we have to unlearn—and learn new techniques to get with this digital age."

For students of the P-8A, that training begins at NAS Jacksonville. It's home to the Navy's Integrated Training Center—a 165,000-square-foot (15,300-square-meter) facility where, upon completing a syllabus of self-paced interactive courseware in "electronic" classrooms, students move from hands-on, lower-fidelity devices, designed to help them gain their initial touches on the hardware, on to gradually more immersive, high-fidelity trainers.

"We call it the 'crawl, walk, run' phases of training," said Christian Shalters, Boeing manager for aircrew training and a former naval flight officer on the P-3.

He and a team including graphic artists and instructional systems designers in Jacksonville, Boeing Mission Systems in Seattle and Boeing Training Systems in St. Louis—together with input from the Navy and its test and evaluation units at Patuxent River, Md.—develop all of the training materials and help troubleshoot the equipment that NAS Jacksonville depends on to get its students up to task.

In addition to the Operational Flight Trainer, where pilots train, the facility includes several of another system known as the WTT, for Weapons Tactics Trainer. Students more commonly refer to it as the

"tube"—it simulates the tube, or fuselage, section of the aircraft. The tube is where the P-8A's mission crew of tactical coordinators and acoustic and non-acoustic operators train.

Inside the tube, five mission operators sit along a rail of interchangeable workstations. They include a tactical coordinator, or TACCO, in Navy parlance; a "co-TAC," who assists the TACCO; two acoustic operators;

and an electronic warfare operator, or EWO. Outside the tube sit the instructors, who simulate all of the communications and targets that the students will be investigating and tracking. In a scenario involving multiple air- and sea craft, for example, each instructor will coordinate simulated communications between the various planes, helicopters, ships and submarines. In an even more advanced scenario, a Weapons Tactics Trainer can be coupled with an Operational Flight Trainer—creating a Weapons System Trainer—so that pilots and operators share the same gaming area, with synchronized visuals, sensor data and communications. If an operator detects a ship on the radar, for example, the pilot in the OFT will see that same ship when in visual range. The students in the tube then can employ additional sensors as needed—allowing instructors to put it all together as if the whole crew were on one aircraft.

Lt. John Falzetta, a pilot who has deployed twice to the 7th Fleet based at Kadena Air Base in Japan, once in a P-3 and more recently in a P-8A, said training in the Operational Flight Trainer helps make it feel "a lot more normal the first time you get into the aircraft."

The Michigan native still remembers

Photos: (Clockwise from top left) Inside a P-8A Poseidon, where sonobuoys are stored; the main cabin of a P-8A; a Navy P-3 Orion returns to Cecil Airport after completing a mission.

the first time he stepped into an actual P-8A aircraft: It smelled nice, it was new. He was amazed on that first flight by the powerful thrust and much steeper climb angle on takeoff compared with the P-3. And the amount of automation—having so much more situational awareness and not having to worry about hand-flying the aircraft, as with the P-3—has allowed him to be more tactically relevant as a pilot, he said.

Nowhere is that more critical than on a mission, where operating safely depends on good communication and coordination between the flight and mission crews. It's the pilot's job to provide that bird's-eye view, Falzetta said.

For example, if a TACCO wants to deploy sonobuoys into the ocean to listen for submarines, the TACCO relies on the pilot to enable that task using the aircraft's pneumatic launcher. To ensure accurate placement of the sonobuoys, a pilot may choose to fly low; future updates to the aircraft will allow pilots to perform this task at higher altitudes, with increased sensor performance, Boeing said.

Once launched into the ocean, the sonobuoys float up to the water's surface, each deploying its hydrophone to a predetermined depth. It's then up to the acoustic operators to observe and interpret the data received and displayed on their monitors.

"It's kind of like looking at that movie *The Matrix*," said Lt. Graham, a P-3 pilot turned P-8A instructor pilot, describing the way the sound's frequencies appear on the monitor to the operators tracking them. "It's all just kind of cascading down in front of them and it looks like a bunch of static."

But it's no ordinary static. To an acoustic operator, it's a language of signals and frequencies—which change depending on how the submarine is operating. If a sub suddenly detects it's being tracked or if it "hears" a buoy splash, Graham explained, it might sprint or change direction.

Pilots who have flown the P-3

Photo: Inside a Boeing Operational Flight Trainer, Lt. Donnell Exum, foreground, coaches Cmdrs. Andrew Klosterman, background left, and Edward Kribs through a series of simulated flight scenarios at Naval Air Station Jacksonville, Fla.

regard it as a very capable aircraft—and the Navy still flies it. But what sets the P-8A apart, in addition to the increased situational awareness that its automation allows, is the aircraft's range and speed—and expandability, the Navy said.

"No other plane has the ability to go out so far, search large areas and come back," said Klosterman about the P-8A. "We can go out there and do that, and execute four, five, six different types of missions," he said.

The P-8A has a range of 1,200 nautical miles (1,380 miles, or 2,200 kilometers) with four hours "on station"—when the aircraft is where it needs to be to perform the mission. This capability made the P-8A especially effective in the long-range search effort over the vast Indian Ocean for Malaysia Airlines flight MH 370, which went missing in late 2014; the Navy deployed two P-8As for the mission.

Exum, the instructor pilot from the Operational Flight Trainer, considers the P-8A "a technical masterpiece." He flew the P-3 for two and a half years and has flown the P-8A for two, having piloted missions in Africa, Italy and Japan. The first thing he noticed about the P-8A was the thrust—its two CFM56-7BE engines provide more than 27,000 pounds (121,500 newtons) of it. "It's a lot faster," he said. "And the ability for it to climb—it's exponential compared with the P-3."

Then there's the expandability. Whereas the P-8A's open-architecture mission system allows for growth and greater adaptability, the P-3 is

(Continued on Page 24)

Photos: (From left) U.S. Navy pilots arrive on the flight line at Cecil Airport in Jacksonville, Fla., early in the morning to prepare for the day's mission; ground crew prepare a P-8A for a dawn launch; U.S. Navy airman Ashlee Skelly supports P-8A Poseidon aircraft as they return to and launch from the flight line.

Pride on the ‘line shack’

Out on the flight line, U.S. Navy airman Ashlee Skelly relishes the dirty work of maintaining aircraft—wiping down struts, servicing oils, fueling—and has the dust on her arms to prove it.

With the Navy for nearly two years, Skelly started out on the “line shack” as part of a team that tends to the aircraft as they return to and launch from the flight line. She developed her skills supporting the P-8A Poseidon.

The Navy, together with Boeing, is taking steps to help future airmen refine their skills even before they get to a flight line. Not far from the Navy’s Integrated Training Center at Naval Air Station Jacksonville, in Florida, Boeing is building an on-base Maintenance facility to teach Navy personnel more than 1,000 maintenance procedures it will need to support the P-8A.

Students will learn everything here, starting with training courseware in the “electronic” classroom and then moving on to do their “lab sections” using interactive Virtual Maintenance Trainers, said Boeing’s Sandy McPherson, whose team has been working on the facility for nearly two years.

To complement the virtual trainers, Boeing is building a series of hands-on devices—a combination of fabricated parts and actual pieces of real airplanes—to mimic life-size areas of the P-8A. The goal is to aid students’ situational awareness, she explained.

“People don’t really understand how big some of these things are until you stand next to them,” McPherson said of the mocked-up parts. They are all fabricated to look and feel real to help students get used to how much space they actually have to work, she said, so they can avoid bumping their elbows or heads.

In a hangar at the back of the facility, a Boeing team is mocking up what resembles a P-8A in its entirety. It’s an ordnance load trainer, complete with a full weapons bay, where students will practice loading and unloading Harpoon missiles weighing 650 pounds (300 kilograms) and torpedoes.

In another room, an avionics bay mock-up—held up by pylons so the height from the ground is the same as it would be with a real aircraft—students can practice removing and installing boxes that, save for their metal connector handles, have been 3-D printed as well as weighted to simulate the real parts’ center of gravity.

Many of the parts throughout the facility are 3-D printed. They include antennas, electronic controls, the aircraft’s radar ball, rotary launchers for the sonobuoys—even a fully 3-D printed auxiliary power unit. The team couldn’t buy a real one, McPherson said, because it would have cost over a million dollars, used.

Besides, McPherson said, “If they break it or drop it, we can print them another one.” ●

"pretty much packed to the gills right now," said instructor pilot Graham, noting the aircraft's age and how changing missions throughout the years have been addressed by continually adding on to the aircraft.

Cmdr. Andrew Miller, P-8A Fleet Introduction Team officer-in-charge and a P-3 pilot for 15 years who has been flying the P-8A for three and a half, noted the "P-3 stretched the extent of everything you could get out of it." The P-8A system is undergoing its first major architectural update, which includes compressing 14 drives of data storage down to three, Miller said. The Navy will retrofit more than two dozen P-8As with the new architecture through its planned incremental updates.

In January, the Navy awarded Boeing a contract to upgrade the P-8A and announced successful testing of the improved Boeing Harpoon missile, a candidate weapon for the P-8A.

From an acquisitions strategy, the challenge is staying smart enough to be concurrent with or ahead of the technology—though it costs a lot of money to be cutting edge, Miller said. To help curb those costs, the Navy is trying to be as common as it can with the 737 "green" aircraft, which the Navy regards for its reliable airframe and the fact that parts are available just about everywhere.

Currently the Navy has budgetary approval to purchase 109 of the aircraft. The last is planned for delivery in 2021. Boeing had delivered 35 production aircraft through February, all based at Jacksonville until squadrons from Naval Air Station Whidbey Island, Wash., and Marine Corps Air Station Kaneohe Bay, Hawaii, complete transition training. Five test aircraft have also been delivered.

Other countries are taking note. To date, Boeing has delivered

eight P-8Is to India. The company expects to deliver the first P-8A to Australia, which ordered eight of the aircraft with an option for four more, this year. And the United Kingdom has publicly announced plans to purchase nine P-8As.

Crews from Australia and the U.K. already have been training with the U.S. Navy. NAS Jacksonville is host to 10 Australians, who support U.S. Navy training and will be the Royal Australian Air Force's first P-8A instructors, and through a cooperative program agreement, there are Australian personnel assigned to the Maritime Patrol and Reconnaissance Program Office in NAS Patuxent River, Md. The United Kingdom Seedcorn project provides maritime patrol staff at NAS Jacksonville and NAS Patuxent River to learn P-8A systems and maintain the skillsets their crew will need back in the U.K.

While they do, Navy pilots such as Lt. Cmdr. Kevin Harrington, who returned to flying the P-8A less than a year ago after spending a couple of years working on an aircraft carrier, will continue performing P-8A missions wherever their wings take them. And Harrington's wings have taken him far. Prior to the tour on the carrier, he spent two years at Patuxent River performing operational testing of the P-8A and flew test missions all around the world—Hawaii, Guam, Scotland, Australia, Japan.

Next stop: Whidbey Island in Washington state, which soon will be receiving its first P-8A trainers. ●

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To learn more about the P-8A Poseidon maritime patrol aircraft, see the November 2014 issue of *Frontiers*.

Photo: Before dawn, ground crew ready U.S. Navy Poseidons for the day's missions.

Sky patrol

Australia's Wedgetail fleet earns rave reviews for unmatched capabilities

BY ERIC FETTERS-WALP

It's the kind of military mission tailor-made for a Wedgetail.

In the skies above Iraq and Syria, jet fighters and other military aircraft belonging to several nations are actively patrolling and fighting ISIS ground forces. Communication and coordination among aircraft is critical.

Enter Boeing's Royal Australian Air Force E-7A Wedgetail, which is helping make aircrews safer in those crowded skies, and helping the U.S. and coalition forces take the fight to ISIS.

Named for Australia's largest bird of prey, the wedge-tailed eagle, and operated by the Royal Australian Air Force, the E-7A Wedgetail Airborne Early Warning & Control (AEW&C) aircraft is getting rave reviews.

"The E-7A Wedgetail is now a combat-proven capability. It continues to excel on operations

Photo: The Royal Australian Air Force (RAAF) has deployed one of its Boeing E-7A Wedgetail Airborne Early Warning & Control aircraft to fly missions with an international coalition over Iraq and Syria. RAAF

as a key element of the coalition's air battle plan in the fight against [ISIS]," said Group Capt. Stuart Bellingham, officer commanding of No. 42 Wing.

Peter Krieg, Operations and Field Services Representative manager for the Wedgetail program, added that the performance of the aircraft has been so good that a number of coalition forces prefer to be airborne when the Wedgetail team is on-station.

The Wedgetail routinely flies missions lasting more than 12 hours in support of Operation OKRA, part of the multinational fight against the Islamic State. Additionally, the aircraft has flown other sorties above the Middle East and search and rescue missions during the past two years with the Royal Australian Air Force.

"The customer is proud of the Wedgetail's capabilities and has built up an excellent reputation with both U.S. and coalition forces" in the Middle East, Krieg said.

Wedgetail was deployed by the RAAF to assist the military fight over Syria and Iraq and has spent notable hours in the air as part of its mission. In early 2015, the single deployed aircraft completed—with the assistance of midair refueling—a continuous flight of 16 hours 18 minutes. By the end of last year, it surpassed that milestone with a 17-hour mission flight. Polly Ringoen, program management specialist with Boeing Defense, Space & Security's Airborne Surveillance Command & Control, said that is the 737 platform's longest nonstop flight ever; officials supporting the 737 and its military derivative programs do not dispute that.

Boeing's Wedgetail AEW&C fleet with the Australian air force achieved final operational capability in May 2015. In announcing that milestone, the RAAF stated that the aircraft "has already proved to be highly reliable and effective on operations and this achievement will further Australia's capabilities."

From the start of the program, Boeing aimed high to meet the Royal Australian Air Force's demand for next-generation airborne surveillance, command and control capabilities, according to program officials.

Photo: Two RAAF E-7A Wedgetail aircraft stand ready on the flight line during Exercise Red Flag Alaska, held in the U.S. state in 2014. RAAF

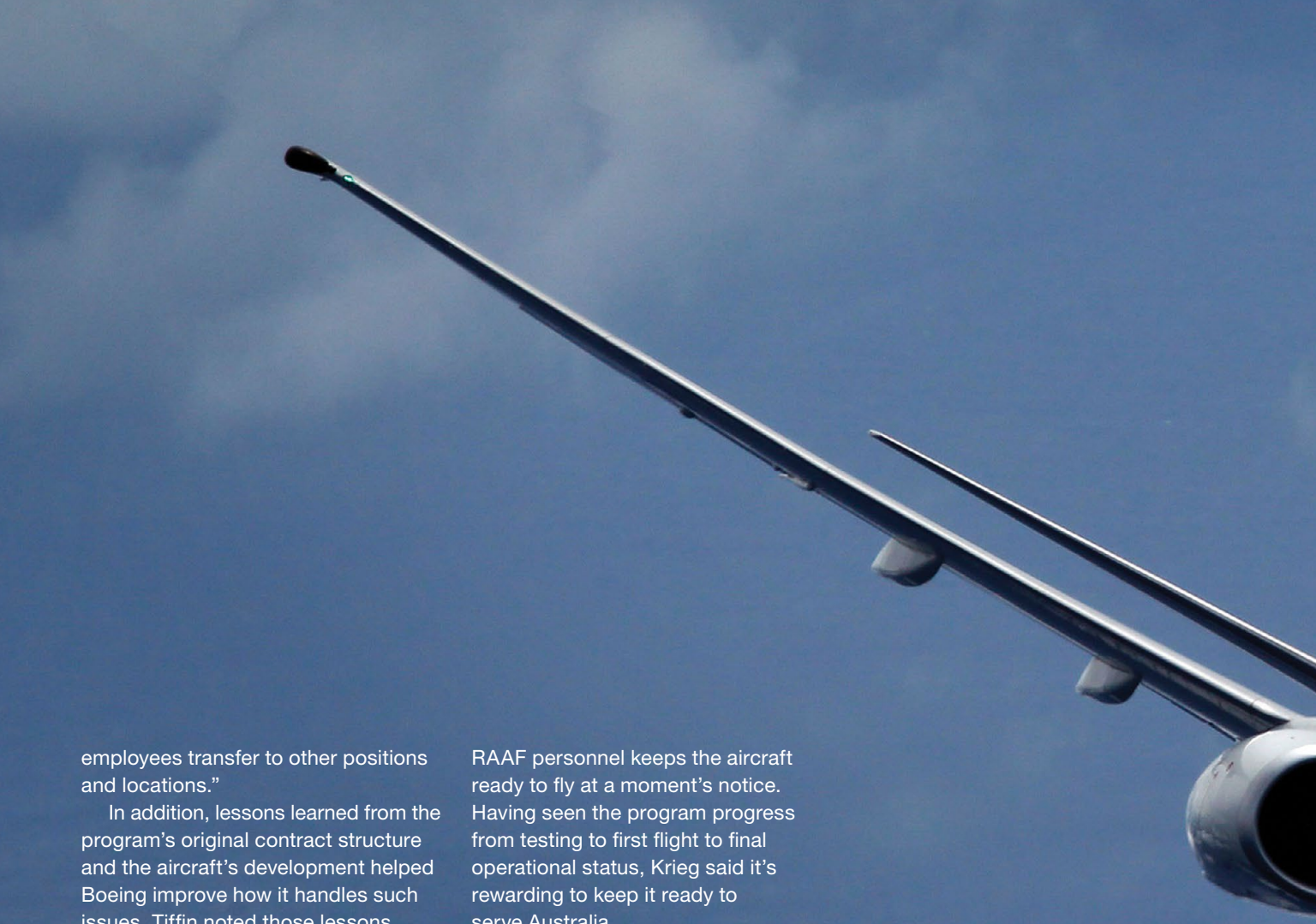
Technical integration challenges slowed the aircraft's development, but as technology improved in the intervening years, the program's team added capabilities not included in Australia's original request. An example of this is Internet protocol chat, which increasingly is used for communication between U.S. military and allied aircraft.

"In the end, we closed all the problem reports in development and we delivered what we said we would deliver," said Susan Tiffin, who served as the program's chief engineer between 2008 and 2012. "I'm just tickled that it's working so well."

With its distinctive Multi-Role Electronically Scanned Array, or MESA, radar extending up from the modified 737-700 fuselage, the Wedgetail has consoles for 10 mission operators to work and collaborate simultaneously. Its powerful radar, developed by Northrop Grumman, and other sophisticated technology allow it to provide air control and battle-space management from the sky. For example, it can gather tactical information from numerous sources at once, allowing control console operators to analyze that information and then distribute it to other aircraft and surface-based forces, according to the Australian Defence Force.

While Australia has taken delivery of the six Wedgetails it ordered, Boeing's work with the RAAF is far from finished. Ringoen said representatives of the RAAF, the Wedgetail program office, Boeing Defence Australia and subcontractors all share the same building at RAAF Base Williamtown near Newcastle in New South Wales. That's where the Wedgetail fleet, operated by the air force's No. 2 Squadron, is based.

"Every day I walk in, I see two, three or four of our airplanes parked there. The customers, the maintainers, the aircraft and the program people are all in one place," Ringoen said. "Our whole success here is based on the relationship between Boeing and the RAAF. ... Keeping that bond strong remains a priority as new faces join the program and longtime



employees transfer to other positions and locations."

In addition, lessons learned from the program's original contract structure and the aircraft's development helped Boeing improve how it handles such issues. Tiffin noted those lessons have been used on more recent military aircraft programs, including the similar Peace Eye surveillance aircraft built for the Republic of Korea and the Peace Eagle aircraft built for Turkey.

Krieg, meanwhile, is embedded with the RAAF maintenance team at RAAF Base Williamtown. His primary job now is to make sure the combined team of contractor and RAAF personnel keeps the aircraft ready to fly at a moment's notice. Having seen the program progress from testing to first flight to final operational status, Krieg said it's rewarding to keep it ready to serve Australia.

"We have uniformed and contractor personnel working side by side, all with a common interest and goal," he said. "It's a great model for creating openness and for getting the job done." ●

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Wedgetail by the numbers

06
Number of aircraft delivered to the Royal Australian Air Force

17
Length in hours of record-setting Wedgetail mission flight in 2015

200
Approximate range in nautical miles (230 miles, or 370 kilometers) of Northrop Grumman's Multi-Role Electronically Scanned Array, or MESA, radar

5,000
Range in nautical miles (5,750 miles, 9,250 kilometers) of the Airborne Early Warning & Control airframe

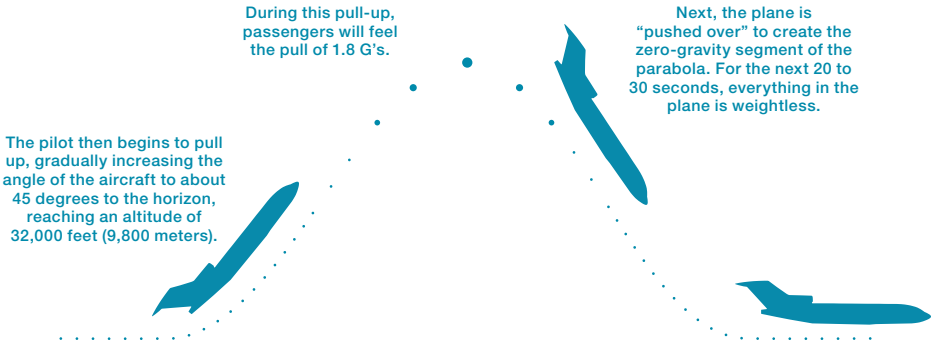
1.5 million
Number of square miles (4 million square kilometers) the Wedgetail can cover during a 10-hour mission

Photo: An E-7A Wedgetail aircraft with RAAF's No. 2 Squadron soars through the clouds on a training sortie. RAAF

SPACED OUT

Boeing's airplanes lend a wing to U.S. space programs

Photo: Apollo 11 astronaut Edwin Aldrin prepares for weightless conditions on board a Boeing KC-135 tanker prior to the first moon landing. NASA



Note: Chart depicts the parabola flown by the Zero G 727.

BY KATE EVERSON

In 1976, a Boeing 727-200 began flying Braniff International Airways passengers to various locations in the Americas. Forty years later, the same aircraft flies passengers to the moon, Mars and beyond—or so they feel.

Now known as Zero Gravity Corp.'s *G-Force One*, the plane uses a parabolic flight path to create microgravity inside its cabin, replicating lunar and Martian gravity, before releasing passengers into total weightlessness.

How does it do this? From level cruise flight the pilot first pulls the aircraft steeply upward, so passengers feel about 1.8 G's, or 1.8 times Earth's gravitational pull. The pilot then performs a "pushover," or transitions to a sharp descent. That transition and dive, which completes the shape of a parabola, makes everything not tied down in the aircraft momentarily weightless.

But this 727 isn't the only Boeing airliner to contribute to extraterrestrial studies. Repurposed aircraft have filled NASA's needs, from a flying space telescope to space shuttle taxi. They also helped NASA prepare the first U.S. astronauts for space travel.

"Our planes have always proved to be adaptable and quickly derived to fulfill other missions," said Boeing historian Michael Lombardi. "That's where we've really been able to support NASA—in those unique roles."

During the early years of America's space program, overland transportation of oversized cargo for NASA was difficult or impossible, given the physical limitations of railroad tunnels, narrow roads, low bridges and power lines. Large rocket parts made on the West Coast, for example, had to be shipped to Cape Canaveral, Fla., by barge through the Panama Canal.

Enter the "Pregnant Guppy," a Boeing Stratocruiser heavily modified by Aero Spacelines Industries. In 1962, it featured the largest cargo compartment of any aircraft at the time, capable of carrying the 40-foot-long, 18-foot diameter (12-meter-long, 5.5-meter-diameter) S-IV stage of the Saturn I rocket for the Apollo program.

With the Pregnant Guppy, NASA was able to deliver crucial oversized cargo to the Cape in 18 hours versus 18 to 25 days aboard a barge, according to the space agency.

The even bigger Super Guppy followed few years later. Today, NASA still uses one to carry outsized loads. The original Super Guppy flew more than 3 million miles (4.8 million kilometers) in support of Apollo, Gemini, Skylab and the International Space Station programs, according to NASA.

The space agency also used a

DON'T TAKE WEIGHTLESSNESS LIGHTLY

BY KATE EVERSON

You lie on a padded mat, trying to follow the 20-minute training video instructions: Stare at a single point on the ceiling. Do not read, as much as your eyes might be drawn to the red all-caps tags on the ceiling: "NO HAND HOLD."

Nope, no hand to hold as you prepare to experience weightlessness on one of Zero G Corp.'s passenger flights. Everyone here is a stranger—unless you count recognizing Joey Fatone of the 1990s-era boy band 'N Sync, chuckling 12 feet (nearly 4 meters) away across the floor of Zero G Corp.'s Boeing 727. Apart from some seats in the back, the plane, based in Arlington, Va., is empty so that paying passengers and scientific experiments alike can freely experience short microgravity and zero-gravity weightlessness.

When you hear the crew yell "On the pull!" you already feel it: The plane starts climbing so fast you experience 1.8 times Earth's gravitational pull, pinning you to the mat.

Then—release. As the pilot pushes over into a dive, you float off the floor, and your nose taps the N in "HAND." The lightest push off the ceiling propels you into the throng of strangers also learning to function without gravity.

It's a liberating paralysis, if there is such a thing. Although you can move, writhing around doesn't make a difference in zero gravity, unless you make contact with a wall or another passenger—something that happens a lot.

A foot in the face is par for the course. An Australian businessman laughs as he careens into you. A sweepstakes winner's ponytail fans out like an exploded cigar. Fatone cheers louder than the crowds at his concerts 15 years ago. The only stationary thing in the cabin is the smile on your face.

After 23 impossibly fast seconds, the crew shouts that the plane is pulling out of its dive. As your body sinks to the floor, your heart sinks at the ending sensation. But the smile stays firmly on your face. ●

modified Boeing KC-135 tanker to train the first U.S. astronauts for the weightless effects of spaceflight, in much the same way that Zero G uses the 727.

When the space shuttles came along, two modified 747s known as the Shuttle Carrier Aircraft ferried the shuttles back to Kennedy Space Center from their secondary landing site at Edwards Air Force Base in California.

One of those NASA 747s was even used as a "launch" vehicle. The first shuttle, *Enterprise*, was never meant to go into space, but needed to be tested in flight from a high altitude. Using a piggyback configuration, one of the modified 747s carried

Photos: (Far left) The author, center, experiences weightlessness aboard the Zero G 727. STEVE BOXALL | ZERO GRAVITY CORP. (Above) A modified Boeing 747 releases the Space Shuttle *Enterprise*, top, in 1977. NASA (Far right) A stage of the Saturn I rocket for the Apollo program is loaded onto a Super Guppy in the 1960s. BOEING

Enterprise high over the California desert in 1977, then made a shallow dive and released the shuttle so it could glide back to a landing.

NASA has also used another 747 for a much different mission.

The Stratospheric Observatory for Infrared Astronomy, or SOFIA, is a 747SP with a highly modified fuselage that transformed the commercial plane into a flying science observatory. Engineer Art Scheuermann, who has worked with Boeing since 1987, took a three-year break to work for Raytheon on the project.

"You can pretty much just modify the area of the airplane associated with the new mission—such as new structure to support a telescope—and the primary aircraft systems will work just fine as originally designed and built," Scheuermann said.

His experience redesigning commercial planes for space-related purposes didn't end there. In January 2004, Scheuermann went to work part time for Zero Gravity Corp. to help adapt its 727 for weightlessness flights. Most alterations were to the interior, where the company installed padding for passengers that could be replaced with adaptive padding when scientific payloads need to be bolted to the floor for microgravity experimentation. The hydraulics system, which functions based on Earth's gravity, also needed to be modified to work in weightlessness conditions, he explained.

Today, Scheuermann periodically serves on the very aircraft he helped certify for zero-g flight operations, where he's "just like any flight attendant on any airline, with the exception that we let people float around weightless as opposed to serving them drinks," he said. Some flights involve research; others are tourist-filled. Then there are the occasional celebrity sightings, including physicist Stephen Hawking, pop culture icons Ozzy and Sharon Osbourne, and supermodel Kate Upton.

After all, Boeing's modified airplanes aren't camera-shy. Director Ron Howard shot much of *Apollo 13*, his 1995 film about the aborted moon mission, on a NASA KC-135 during parabolic flight.

David B. Nowell, cinematographer for the film's weightlessness unit, said the crew and actors did 564 parabolas in the modified KC-135 to get about 90 minutes of footage. Because computerized special effects were still in their infancy, parabolic flight was the cheapest and most authentic way to film weightlessness. Add into the equation how adaptable the KC-135 platform was to meet the film crew's needs, Nowell added, and using the Boeing airplane was a clear solution.

"There was nothing that had to be completely changed," Nowell said. "Even the electrical system was there to be used as needed—it was just a matter of tying into what they had." ●

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10 things employees should know about India

BY DAN RALEY

India is surrounded by some of the most inviting natural borders found anywhere, staring up at the majestic Himalayan mountain range and looking out over the Arabian Sea, Bay of Bengal and Indian Ocean from more than 4,600 miles (7,400 kilometers) of continuous coastline. Yet this is a country also establishing new boundaries—foremost in aerospace.

One of the world's most populated places, India is experiencing unmatched economic growth, which, in turn, has spurred an aerospace boom.

"Look across the world and there are very few places with the parameters that we find in India," said Pratyush Kumar, president, Boeing India. "Today, it is the fastest-growing large economy in the world and expected to remain like that for the foreseeable future."

Boeing has a history with India that dates more than 75 years, beginning with Tata Airlines' operation of a heritage company DC-3. This long-standing relationship, Kumar noted, involves the concentrated use of Boeing commercial and defense aircraft, partnerships in research and development with universities, agreements in manufacturing and sourcing, and Boeing's large-scale India supply chain.

As this aerospace connection evolves, following are 10 things Boeing employees should know about this nation.

Photos: (Above) A view of Dashashwamedh Ghat, in Varanasi on the Ganges River. SHUTTERSTOCK (Far right, clockwise from left) A Jet Airways 737-800. SHUTTERSTOCK India is the largest non-U.S. operator of the C-17 Globemaster III; an Indian Navy P-8I maritime patrol aircraft. BOEING

1

India's Gross Domestic Product grew in 2015 by 7.5 percent, unsurpassed among the largest economies worldwide.

The country's 1.3 billion people, the second-largest population globally, include 800 million who are 35 years old or younger, which has helped create a robust middle class that has spending power. India, for example, has 1 billion mobile-device users.

This expanding middle class has expressed a strong desire to travel, creating untold opportunities for airplane sales and corresponding alliances, said Marc Allen, president, Boeing International.

"When we think about the value of building up our global scale and depth, we talk about three core aspects: capability advantage, cost and productivity advantage, and market advantage—and every single one of those is part of the India profile," Allen said.

2 **The country experienced the world's greatest increase in air passenger traffic last year, up 21 percent.**

India's most traveled air route connects Mumbai and New Delhi, the country's commercial and government centers, respectively. More than 50 flights move daily in each direction; in 1992, it was just four flights per day.

With low-cost airline tickets in India now equal to the highest fares on trains, more people are choosing the convenience of air travel, reducing 12- to 48-hour trips to a few hours, according to Dinesh Keskar, senior vice president, Asia Pacific & India sales, Boeing Commercial Airplanes.

3 **Over the next 20 years, Boeing projects India will buy 1,740 commercial airplanes worth $240 billion.**

Indian airlines are pursuing expanded fleets and routes like never before, a trend that will extend well into the future, according to the Boeing *Current Market Outlook*.

"We see the growth in the market continuing," Keskar said, noting that Boeing has a comprehensive family of airplanes that will help the country's airlines continue to expand and prosper.

A steady Boeing customer, India has received or ordered more than 300 Boeing commercial airplanes since 1960, two-thirds of them from the 737 series. Jet Airways and SpiceJet, respectively, have announced orders for 75 and 42 of the more fuel-efficient 737 MAX.

4 **India ranks as one of Boeing's largest defense customers.**

India was the first international customer for the P-8I maritime patrol aircraft. It has eight. And it's the largest non-U.S. operator of the C-17 Globemaster III, with 10.

The country has ordered 22 AH-64E Apaches and 15 CH-47F Chinooks. Boeing entered a joint venture with supplier Tata Advanced Systems to manufacture components for each of those rotorcraft inside the country.

India also continues to purchase Boeing's Harpoon missile.

"The Indian Air Force's C-17 aircraft and the Indian Navy's P-8I aircraft have demonstrated an excellent record in supporting the missions for which they have been deployed, and our customers have expressed satisfaction about the operational readiness of both aircraft," said Dennis Swanson, vice president, Boeing Defense, Space & Security, India. "This builds trust with the customer and helps us win future campaigns.

5 India was among the first countries to order the 787 Dreamliner.

Air India, the country's national carrier and one of the early 787 customers, operates 21 Dreamliners and is scheduled to take delivery of six more. The airline first flew the twin-aisle jet on international routes to Frankfurt, London and Paris, and recently announced it will begin using the 787 domestically as well.

Jet Airways also has 10 Dreamliners on order.

6 The 787-9 floor beam is built in India, supporting the "Make in India" initiative.

Local supplier TAL Manufacturing Solutions produces composite 787-9 floor beams in Nagpur in central India. Overall, Boeing sources key components from 30 companies in India, supporting 3,500 local jobs, according to Ashwani Bhargava, Boeing director of India supplier management.

The country introduced the "Make in India" campaign in 2014, encouraging overseas collaborations with India manufacturing firms, Bhargava said.

The 787-9 floor beam is an example of the accelerated sourcing in the country, he said, adding: "We are closely connected with the suppliers here and the India supplier base is evolving."

7 India is seeking improvements for more than 100 of its airports over the next decade.

With the steady increase in air travel, government leaders acknowledge that the country's aviation infrastructure, commercially and militarily, needs upgrading and expanding.

Boeing tracks airport needs countrywide and offers its expertise in facilities, maintenance and air traffic flow, according to Boeing officials in India. Jeppesen, a Boeing subsidiary, has provided software upgrades to three major airports in southern India.

"People, like me, want to fly," said Tithi Paul, an office administrator in New Delhi with Boeing Commercial Airplanes. "More and more people are taking vacations. They might be traveling for the first time, and traveling with an entire family. It's a growth phenomenon."

8 Boeing established the largest aviation maintenance, repair and overhaul center in India.

To service the country's 737, 777 and 787 fleets, Boeing constructed a world-class MRO facility near Nagpur for Air India, which the airline operates, Keskar pointed out.

Simulators for each of these Boeing commercial airplanes have been installed to allow pilot training to be offered in-country, making it more economic and convenient for customer airlines, Keskar said. Previously, pilots had to travel to locations such as Seattle or Singapore for instruction.

Boeing also is building a maintenance facility to support the C-17 at Hindan Air Force Base near Delhi.

9 Boeing has founded multiple research alliances in India.

Boeing shares in several joint ventures in the country, among them research collaboration at the Indian Institute of Science in Bangalore and Indian Institute of Technology in Mumbai, plus information technology participation with subsidiary Continental Data Graphics in Chennai.

"The investment and benefit that we've experienced lately in the country is a real sign of the possibilities that are out there," Allen said.

10 About 1.2 million engineers and scientists graduate from schools in India each year.

Much of the world's future engineering talent may come from India, which offers a deep talent pool and graduation rates far superior to most countries, according to Kumar.

"You look for that support from the next generation," Kumar said. "This is among the top places to look." ●

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Photos and illustration: (Far left, clockwise from left) Two Air India 787s at India's Delhi Airport. SHUTTERSTOCK An artist's concept of a SpiceJet 737 MAX 8 in flight; a LEAP-1B engine on the first 737 MAX 8 at the Renton, Wash., factory. BOEING (Above, from left) Inside Indira Gandhi International Airport in India; a Next-Generation 737 simulator. SHUTTERSTOCK On site at Boeing supplier Bharat Forge, in Pune, India. TIM REINHART | BOEING

In the fast lane

Boeing's foremost hypersonics expert feels the need for speed

BY DAN RALEY

As Boeing approaches the start of its second century in July 2016, *Frontiers* visits with some of the men and women who have helped make Boeing a global leader in aerospace.

Kevin Bowcutt's youthful curiosity was a lot like the hypersonic aircraft he later designed—it took off in a hurry.

Exposed to his first science class in grade school, he was fascinated by technology. He wanted to know how everything worked. He built things at home without prompting, such as a self-made motor, a generator, a telegraph.

During this time of discovery, Bowcutt developed a passion for flight. He assembled balsawood gliders and bought remote-controlled airplanes. He even devised a plan to save money by mowing lawns and doing other odd jobs to purchase his own Piper Cherokee airplane, an idea his father discouraged.

"I wanted to learn to fly before I drove," Bowcutt said. "That was my dream."

Today, Bowcutt is still looking to the skies for inspiration and pushing technological boundaries however he can. As Boeing's chief scientist for hypersonics and a Senior Technical Fellow in Huntington Beach, Calif., he's done things that others said couldn't be done.

Bowcutt was a key contributor to the hydrogen-powered X-43A scramjet, the fastest aircraft on record—it reached speeds of Mach 9.6 in 2004, or just under 10 times the speed of sound. A scramjet is an air-breathing engine that requires no turbo-machinery; instead, it uses vehicle motion to compress ingested air before burning the supersonic airstream.

He led the conceptual design and optimization of the X-51A WaveRider, an unmanned, experimental vehicle that relied on its own shock waves for compression lift and set the record for the longest air-breathing propelled flight at hypersonic speed—it flew on scramjet power for 3.5 minutes at Mach 5.1 in 2013.

With increasing attention given to Mars and extended space exploration, Bowcutt wants to build a space plane. It would need to be hypersonic, using a combination of turbine engine, scramjet and rocket propulsion to leave Earth's atmosphere, and be reusable for continuous voyages to make it affordable, he said.

The cost to launch a vehicle into space currently runs $5,000 to $10,000 per pound, he explained. The repeated use of a space plane could dramatically lower this expense, even to a few hundred dollars per pound, encouraging additional markets that would establish space travel as something commonplace, Bowcutt said.

"It would readily change the world—like the cellphone and the computer—if we could routinely fly in and out of space," he said.

As Boeing prepares to celebrate its centennial, Bowcutt is among the many men and women who have made milestone contributions to Boeing or its heritage companies. He is considered one of the world's leading experts in his field, according to George Orton, Boeing hypersonics project engineer.

"His multidisciplinary design and optimization process is unique in the industry—no one else has it," Orton said. "He can look at all different sorts of vehicles and apply this technique that he's developed. Without him, I don't think we could have been as successful."

As part of the coming centennial celebration, Bowcutt also is sharing his expertise with the Curiosity Machine, an educational resource intended to inspire the next generation of innovators. He has created design challenges for inquisitive students not unlike him so long ago.

Bowcutt first encountered hypersonics technology while attending graduate school at the University of Maryland. He joined a research project funded by the U.S. Army that was used to design aerodynamic shapes that would "break the hypersonic lift-to-drag barrier."

President Ronald Reagan's 1986 State of the Union speech—one in which he described a proposed Orient Express airplane that would fly from the U.S. to Japan in a few

Photos: (Top) Kevin Bowcutt, Boeing's chief scientist of hypersonics, wants to build a space plane. PAUL PINNER | BOEING (Bottom) Boeing hypersonics advisory board members, from left, Mark Nugent, Bill Bozich, Bowcutt, Jeff Erickson and Mark Ganda display a model of the X-51A WaveRider hypersonics vehicle in 2003, 10 years before its first and only flight. DANA REIMER | BOEING

hours and was a possible spinoff of the National Aerospace Plane—had a profound effect on Bowcutt. In the aftermath, the young researcher was sought out to do a national TV news interview as one of the only people actively conducting hypersonics research.

He discovered that one of his former college professors, Fred Billig, a pioneer of scramjet engine development, was a technical adviser to the National Aerospace Plane program. Billig helped Bowcutt land his first engineering job at Rockwell International and join in that work.

For eight years, Bowcutt and hundreds of engineers worked on a scramjet-powered space plane before the program ended; he was handpicked to serve on two national teams that made last-ditch efforts

to resolve scramjet and airframe design issues.

Always adventurous regarding flight, Bowcutt applied to become an astronaut during the 1990s. Although not selected, he later participated in the Space Shuttle *Columbia* accident investigation.

As Rockwell International merged with Boeing, Bowcutt worked on NASA's X-43A scramjet-powered experimental vehicle, which made two successful hypersonic flights on hydrogen fuel. It reached Mach 7 the first time and nearly Mach 10 on the second and final flight.

At the same time, the U.S. Air Force began developing a hydrocarbon-fueled scramjet. Bowcutt created the concept that became the X-51A. And he came up with a bigger breakthrough.

"The bottom line was, we went beyond the X-43A and proved the scramjet was a practical hypersonic propulsion system," he said. "The X-51A was a true flying machine, the right flight weight—and it could run for minutes. The technology was basically proved there. It worked."

A hypersonic airplane seems like a logical next step. Sharing his vision, Bowcutt explained that hypersonic technology might one day lead to a Mach 5 business jet or commercial airliner—the same Orient Express concept that inspired his career.

A similar hypersonic aircraft could carry a reusable, air-breathing second stage for added boost that would permit it to travel to and from space in aircraft fashion, allowing for commercialized travel.

But there is much to sort out. Bowcutt, who has been a member of the Boeing Technical Fellowship since 1998, has lost none of his enthusiasm for looking skyward and coming up with a new creation.

"Not only did the X-51A fly, but it was a world first—and that was very satisfying," Bowcutt said. "But I'm hungry. My ultimate dream is that space plane, that reusable space plane that changes the world." 100

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Photo: A Boeing Senior Technical Fellow for nearly two decades, Kevin Bowcutt is considered one of the world's leading experts on hypersonics.
PAUL PINNER | BOEING

Photo: The first 787-9 for Saudia awaits delivery at the Everett, Wash., factory in February. BOEING

Key for the Kingdom

From the DC-3 to the 787 Dreamliner, Boeing has had a long partnership with the national airline of Saudi Arabia

BY SAFFANA MICHAEL

When it launched operations in 1946 to serve hajj pilgrims from neighboring countries, Saudi Arabia's fledgling national airline had one destination in mind—the Red Sea port of Jeddah, gateway to Mecca. Then known as Saudi Arabian Airlines, it operated with a single DC-3 that had been a gift to King Abdul Aziz Al Saud from U.S. President Franklin D. Roosevelt.

Fast-forward to the present. The airline, now called Saudia, serves 55 global destinations with a modern, mixed fleet that includes 48 Boeing jets—including 777s and three new 787-9 Dreamliners delivered in February.

The first of eight on order, the Dreamliners are part of Saudia's effort to grow and upgrade its fleet, enhance the travel experience and grow digital connectivity, said Saleh bin Nasser Al-Jasser, the airline's director-general.

"Today, we are proud to be moving passengers locally, regionally and internationally, which means we need a versatile fleet of airplanes for short-, medium- and long-haul routes," he said. "The 787 will now become an integral part of our fleet as we continue our modernization and expansion plans."

The first three Dreamliners are already in service—to Dubai; Istanbul; Casablanca, Morocco; Manchester, England; and Paris. The airline first offered nonstop international service in 1981 with flights from Jeddah to New York on a Boeing 747.

Over the past 55 years, the airline has taken delivery of more than 130 Boeing and heritage-Boeing airplanes, including 707s, 737s, MD-11Fs, DC-9s and MD-90s.

"Boeing airplanes have played a significant role in the expansion of Saudia and in the development of the aviation industry in Saudi Arabia," Al-Jasser said.

Assuming leadership in 2014, he promised a new spirit of innovation to improve performance and customer service. Last year, Saudia shifted to electronic navigational charts, expanded Web-surfing capabilities for passengers on international flights, and became the world's first airline to introduce a comprehensive flight guide in Braille. Passengers can even store their boarding pass in an Apple watch and check in at the gate by placing their wrists under the bar-code reader.

Saudia won recognition for those efforts last October, earning "most improved in social media" in awards given by Singapore-based aviation consulting firm SimpliFlying.

"Technologically advanced airplanes such as the Boeing 777 and 787 enable us to provide a memorable in-flight experience for our passengers," Al-Jasser said. "And we are continuously innovating to be inclusive and diverse in the services and facilities we offer our passengers. ●

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ともに学ぶ。
ボーダーを超えて、世界を変える若い力を育てる。
これもボーイングが、日本とのパートナーシップを
通じて実現したいこと。
東京大学をはじめとする日本の大学と連携し、
ワークショップの共催や研究のサポート、サマーセミナーや、
エクスターンシップを行っています。
全ての壁を超え、絆を深め、共に未来を創る。
限りない空と可能性が、私たちを待っています。
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