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Frontiers

Heavy duty

Chinook proves itself in service with UK Royal Air Force

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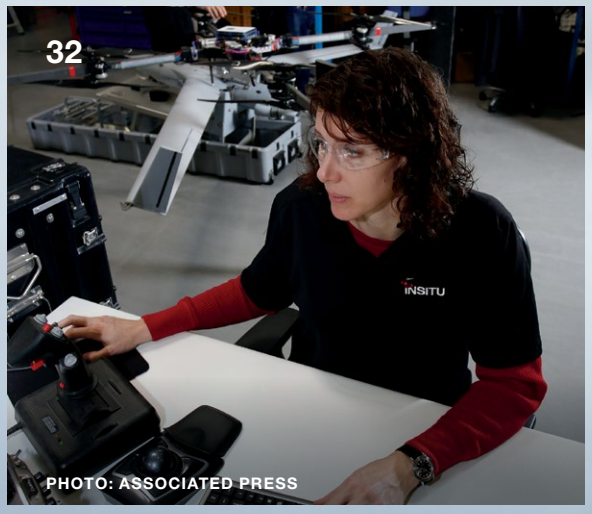

Cover: The Boeing-built CH-47 Chinook has performed a variety of missions for Royal Air Force of the United Kingdom for 35 years. **BOB FERGUSON | BOEING**

Photo: (Below) The Chinook, a medium-to-heavy-lift helicopter, has three cargo hooks and is capable of hauling vehicles and equipment. **BOB FERGUSON | BOEING**

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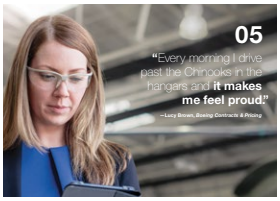
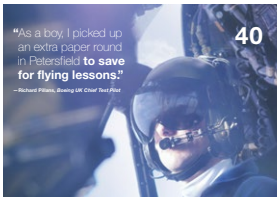


As a Boeing Contracts & Pricing representative in the UK, Lucy Brown is part of a team that supports maintenance and modifications for the Royal Air Force's CH-47 Chinooks. This ad is from a new series where employees share in their own words how they are helping build a stronger UK.

Part of the "A Better Way to Fly" campaign, this 787 Dreamliner 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.



Even though Richard Pillans is retired from the British military, he still feels like he's part of it as Boeing UK chief test pilot. This ad is another from a series highlighting how employees are helping build a stronger UK.

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Boeing employees and retirees can access Milestones—the lists of employee service awards, retirements, obituaries and safety achievements—on boeing.com/frontiers by clicking the Milestones button.

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"Every morning I drive past the Chinooks in the hangars and it makes me feel proud. They're the backbone of the UK military. They provide emergency response, carry troops, and if ever I needed to be rescued, I would want to hear one of those in the background. My team is responsible for making sure the Chinooks are maintained, modified and upgraded. Being even just a small part of this bigger picture is really rewarding."

SEE HOW LUCY IS BUILDING A STRONGER UK AT BOEING.CO.UK

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Magnificent 7s

Models from all nine of Boeing's commercial jet lines, known as the 7 series, take command of the runway at Boeing Field in Seattle during Boeing's centennial celebration in July. On display (from front): the 707, 717 (originally the MD-95), 727, 737, 747, 757, 767, 777 and 787 Dreamliner.

PHOTO: BOB FERGUSON | BOEING

RECIPE FOR SUCCESS

Photo: Two contract employees survey the massive new autoclave at the Composite Wing Center in Everett, Wash., prior to the building's grand opening.

Composite wings of 777X will be baked in one of world's biggest autoclaves

BY DAN RALEY | PHOTOS BY BOB FERGUSON

The new Composite Wing Center in Everett, Wash., is so vast it could accommodate multiple jetliner production lines, similar to what takes place next door in Boeing's main widebody factory. Yet this sprawling facility will put all of its energy into fabricating carbon-fiber wings for the coming 777X.

At 1.3 million square feet (120,800 square meters), the enormity of it—with the longest unsupported ceiling beams found anywhere and one of the world's largest autoclaves, per Boeing—left an indelible impression on employees at its spring grand opening. Among them was Mohssen Mohaghegh, who has spent much of his three-decade Boeing career assessing wing strength and durability.

As he sat under the 27-acre (11-hectare) roof, surveying the 1.1-million-pound (500,000-kilogram) autoclave before him, the stress engineer from nearby Mukilteo came to the following conclusion.

"I look at this building, and these surroundings," Mohaghegh said, "and I see the factory of the future."

That will entail creating and curing eight separate wing parts for the 777X, which will have a wingspan of 235 feet (71 meters), the longest of any commercial or military airplane produced by Boeing.

Fitting these pieces into the Composite Wing Center's dark blue, cylindrical autoclave won't be a problem—it can hold more than 200,000 midsized pizzas stacked atop one another, or 21 pickup trucks, according to Boeing calculations.

"The recipe, for what you have to bake it at and for how long, is a family secret," Tiffany Lundberg, Composite Wing Center building integration manager, said playfully.

Actually it's no secret that the operating temperature in the autoclave will be about 350 degrees Fahrenheit (175 Celsius), topping out at 450 F (230 C), per Boeing.

The autoclave is one of about two

Photos: (Above) A spar-lamination machine will be used to make 777X wings out of carbon-fiber material in Everett. (Left) The machine will lay carbon fiber on a form, which will then be baked inside an autoclave, creating parts for a 777X wing at the Composite Wing Center.

dozen of various sizes managed by Boeing Fabrication and Boeing Defense, Space & Security in Missouri, South Carolina, Utah and Washington in the U.S.; multiple sites in Australia; and Manitoba, Canada. They essentially are industrial ovens that use high pressure and heat to bake composite materials into hardened airplane parts.

"It's like baking a cake," said Kenneth Buchanan, experimental test mechanic.

The Composite Wing Center autoclave fills up 91,000 cubic feet (2,575 cubic meters) of space, but it's not Boeing's biggest. By volume, the largest autoclave is the newest one at Boeing's North Charleston, S.C., factory, which fills 97,500 cubic feet (2,760 cubic meters) and went into operation last month to support rate increases on the 787 Dreamliner program and to manufacture the longer aft-body fuselage section of the 787-10.

The Everett and North Charleston autoclaves have different interior configurations because of the shapes and sizes of the parts that will be heated and cooled inside each of them. Everett cures a wing panel, spars and stringers; North Charleston a fuselage. The Composite Wing Center autoclave requires a higher floor, enabling the use of heating and cooling coils beneath it; North Charleston places its coils at the rear of the autoclave, notably lowering its interior working space.

At some point, the Composite Wing Center will have three autoclaves side by side, churning out composite wings, as production of the 777X increases.

"This is just the start of what's to come," Mohaghegh noted.

The Composite Wing Center, big enough to hold 25 football fields, is divided in two—the autoclave area on one side and spar-lamination machines on the other, with four levels of office space supplying a buffer. One area supports the other.

Spar-lamination machines roll back and forth on parallel sections of track in a "clean room," or a debris- and dust-free work area. Tugs repeatedly sweep the floor as construction continues inside the wing center. Two spar lamination and two skin lamination machines have been installed, as well as a stringer machine. At each machine, technicians lay down carbon-fiber material on a metal form. The machine stops and starts, moving vertically over the form below it.

Attached to the lower half of the machine, a robotic capsule equipped with a camera slides horizontally, inspecting the work during the ongoing testing. An entire composite wing, composed of upper and lower wing skins with stringers and front and rear spars, can be built in a day, according to Boeing technicians.

"The machine is very cool; it moves like we never imagined," said Arica Epps, a spar technician. "It's like going from a toy truck to the real thing."

Parts will be transferred from the spar-lamination machine to the autoclave by automated guided vehicles. Three are needed to transport a spar, which is the main structural piece of the wing.

The Everett autoclave is lined on the inside with stainless steel panels and temperature probes. It has a huge blue end cap that slides into place on rollers using overhead tracks. It is heated with natural gas burners, cooled with water and pressurized with nitrogen.

Unlike other Boeing autoclaves, this one has just a front entry, with parts moving in and out rather than through it. Large blower fans block off the rear section.

At Boeing Fabrication Advanced Developmental Composites in Tukwila, Wash., Tiffany Ferguson is a composite layout team leader for a group that creates 777X wing prototypes, models for the wings that will be reproduced at the new facility. She welcomed a chance to catch a glimpse of the Composite Wing Center to size up the entire process.

"It's nice to see where the handoff is and where the parts are going to go," Ferguson said. "It's going to be cool to see how this takes off and be part of it."

Carl Withers moved from Advanced Developmental Composites to become a Composite Wing Center operations manager. He said his team feels empowered by the building and the idea of working on something new. The autoclave alone proved eye-opening.

"Just the size is unbelievable," he said.

Aluminum wings for current 777 models are built in Everett's main factory. Composite wings for the 787 Dreamliner are put together in Japan and shipped to Everett and North Charleston for assembly-line installation. The Composite Wing Center will streamline the process and lower costs, according to Boeing.

Employees say this latest addition to the Boeing landscape, centered on that huge autoclave with others to come, represents a new era of manufacturing innovation.

"Composite is the wing of the future," Buchanan said. "This will keep us competitive." ●

DANIEL.W.RALEY@BOEING.COM

Twice the met

Whatever the mission, the twin-rotor CH-47 Chinook answers the call for the Royal Air Force

BY DAN RALEY | PHOTOS BY BOB FERGUSON

Dark green CH-47 Chinook helicopters lift off one by one from Royal Air Force Odiham, an airfield an hour southwest of London, and disappear over the horizon. Next stop is a training mission, ship deployment or relief effort.

Built by Boeing, the British-based tandem rotorcraft are in such demand these days that the men and women

tle

Photo: A member of the Royal Air Force approaches a CH-47 Chinook on the flight line. The RAF has 60 CH-47 Chinooks in service, with most of them stationed at RAF Odiham in England. This total is surpassed only by the U.S. Army and Japanese military.

who fly them have a standard refrain whenever their services are requested.

"As we like to say, the answer is two Chinooks; now what's the question?" said RAF Flight Lt. Dave Grindal, a 27 Squadron member who has 4,000 hours as a pilot on the iconic aircraft.

Two helicopters typically are all that's needed when transporting troops, delivering cargo or evacuating wounded from a battlefield, according to the pilots and crew who fly them.

For 35 years, the CH-47 Chinook has answered the call of United Kingdom military needs and humanitarian efforts. It has rushed to battle in the Falkland Islands and in Afghanistan. It has rescued residents in peril when flooding has submerged large sections of the English countryside. It continues to dazzle spectators with its acrobatic nimbleness at European air shows.

Developed more than a half-century ago and first used in combat by American troops during the Vietnam War, the medium-to-heavy-lift helicopter has been a resilient aviation presence for this European region. The Chinook has welcomed continual technology upgrades to stay relevant where other aircraft of its generation have put in their service time and been retired.

The RAF remains so reliant on the Chinook, in fact, it took delivery in December of the last of 14 new helicopters—the latest Mk6 model with a new, machined monolithic airframe, UK-specific avionics and mission systems, aircraft defensive systems, and interoperable communication and navigation equipment.

These newest Chinooks have increased the UK fleet to 60—a total exceeded only by the United States Army and Japanese military.

"You get in it and it feels like a proper battlefield helicopter," said Squadron Leader Hannah Brown, 27 Squadron second in command and one of three female RAF Chinook pilots. "You feel safe inside it. You feel like it's going to get you home.

"The replacement for a Chinook

Photos: (Far left) RAF Chinook crew members, such as Sgt. Kev Robertson, are stationed in the back of the helicopter with fellow troops, cargo or fuel tanks. (Above) Royal Air Force Odiham makes three hangars available for Chinook repairs and maintenance.


ROYAL
AIR FORCE

is another Chinook."

Odiham (pronounced Odee-um) is surrounded by lush rolling hills, historic villages and the occasional castle ruin. In operation as a military airfield since before World War II, it houses three Chinook squadrons and up to 86 four-person flight crews. The helicopters line up in orderly fashion on the shale-colored flight line or occupy three large maintenance hangars for equipment modifications, repairs or scheduled service.

The day begins when pilots and crew, dressed in green flight suits and black helmets, make the long walk from their squadron headquarters to a waiting Chinook. Auxiliary power comes on with a deep whine, enabling a comprehensive preflight inspection of all systems. Ten minutes later, two sets of rotors roar to life. Sagging blades straighten as they spin in a furious manner. The Chinook taxies to the runway and glides into the air.

"We've been partners for decades," said Chuck Dabundo, Boeing's Chinook program manager. "Their special operations forces have used baseline Chinooks and we're looking at variants

Photos: (Far left) RAF personnel unhook a freight container from a hovering Chinook during a training exercise at Royal Air Force Odiham. (Below) Through an open hatch in the floor of the helicopter, Chinook crew members watch cargo being lowered to the ground.

for them that our special operations forces use that will make them even more effective. We have a good interplay with them."

Senior Aircraftman Kyle Phillimore, RAF aircraft maintenance mechanic, grew up in Salisbury, 40 miles (60 kilometers) from Odiham, and as a child watched Chinooks pass overhead. It's a big reason why he chose to work on the aircraft. Its distinctive sound told him whenever a Chinook was near and had him straining to catch a glimpse.

"You could always hear them before you see them, so you looked for them," Phillimore said.

One of the 27 Squadron helicopters carries the yellow and green logo of a fierce-looking elephant, nicknamed Nellie. The squadron's association with the elephant dates to its first aircraft type, the Martinsyde G100. This airplane, used during World War I, drew comparisons to the animal because it was so big. Names of the squadron's first commander, current commander and a former squadron crewman recently lost in Afghanistan also are painted across the Chinook fuselage.

A large number of Odiham men and women have been deployed to Afghanistan on multiple occasions. Their helicopters, which can carry 55 troops, 10 tons of freight or up to three tanks of extra fuel, are outfitted in protective armor up to head level, a necessity when operating in combat.

Grindal has been sent to Afghanistan six times. The RAF pilot once flew his Chinook to three medical evacuations over 90 minutes. He took on enemy fire. At one point, brown cardboard particles rained down on Grindal in the cockpit, a problem he couldn't immediately pinpoint. Once on the ground, he had his explanation.

"It turns out we had 33 bullets in the aircraft," Grindal said. "It flew back perfectly well. A round had gone through the cockpit and hit a safety switch and destroyed it, and then gone through the soundproofing, which explained the small pieces of cardboard floating down. That showed me what the Chinook could do."

This past December, Flight Lt. Chris W. Dodd and his 27 Squadron Chinook crew were on emergency standby duty at Odiham when they were summoned to northern England to help deal with massive flooding in Yorkshire and Lancashire. Dodd was readily familiar with the response zone—he grew up in the area and relatives still live there.

Dodd and the others ferried the local police commissioner to assess damage from above. Using one or more of the three trademark hooks on the belly of a Chinook, they brought in external loads of pumping equipment and generators. They repaired a building. They lowered 400 tons (360 metric tons) of sand in two days to quell the rushing waters.

The Chinook helped stabilize a region that Dodd called home. For the pilot, the job was personal and satisfying.

"It was one opportunity I wanted to have—to know that I achieved something and actually helped those people get their life back on track," Dodd said. "I knew where we were and people directly affected by floods."

While the Chinook has kept the same general exterior, the Mk6 version of the helicopter's new glass cockpit, or all-digital flight system, with four display screens, allows pilots to call up and display instrumentation and resources such as a moving GPS map and an infrared camera all at once, and multitask. They have digital tablets to further address flight issues and connect with crew members in the back of the helicopter.

A pilot now can plot a sortie on a computer in a flight planning room, transfer it to a memory card, walk it to the helicopter and load it. Everything is more efficient. Accurate readings have replaced estimates. Pilots previously had to unfold a paper map when changing mission parameters.

"With a change, you could be writing it up at the last minute or changing it while in airspace," pointed out Flight Lt. Chris J. Dodd, no relation to the Odiham pilot of a similar name. "This makes it so much quicker and better."

Growing up in England, Sgt. Ben

Continued on Page 22

Photo: It is the job of RAF Sgt. Ben Howard, a 27 Squadron crewman, to monitor flight and weather conditions from the rear of the Chinook and share pertinent information with the pilots while airborne.


BOEING
RESCUE

CH-47 Chinook
Royal Air Force

Howard, a 27 Squadron crewman, watched the movie *Top Gun* and wanted to be a fighter pilot. The Chinook changed his mind. Weighing 13 tons (nearly 12 metric tons) before fuel or cargo is added, the helicopter provides its own stirring acrobatics, leaving civilians awestruck at public demonstrations, he said.

The Chinook climbs with its nose pointed straight up in the air or dives directly at the ground, rotor blades in a full vertical position in both cases, before banking sharply and pulling out of these maneuvers. Spectators don't expect a medium-to-heavy-lift helicopter to behave in such a manner, according to Howard.

"We take the aircraft and fly it to its limits," Howard said. "It's a crazy adrenaline rush. It's like a roller coaster for 15 minutes. It shows the public how agile it is when it seems like a flying bus or coach. People are really surprised when they see it."

To keep them flying, Boeing has 120 employees who work at Odiham alongside RAF personnel, among them mechanics and test pilots. Boeing keeps its own hangar and stations people in each of the other maintenance facilities. Chinooks are delivered by ship from Boeing's helicopter production factory in Philadelphia and brought to the Odiham hangars for extra systems installation unique to the RAF before entering service.

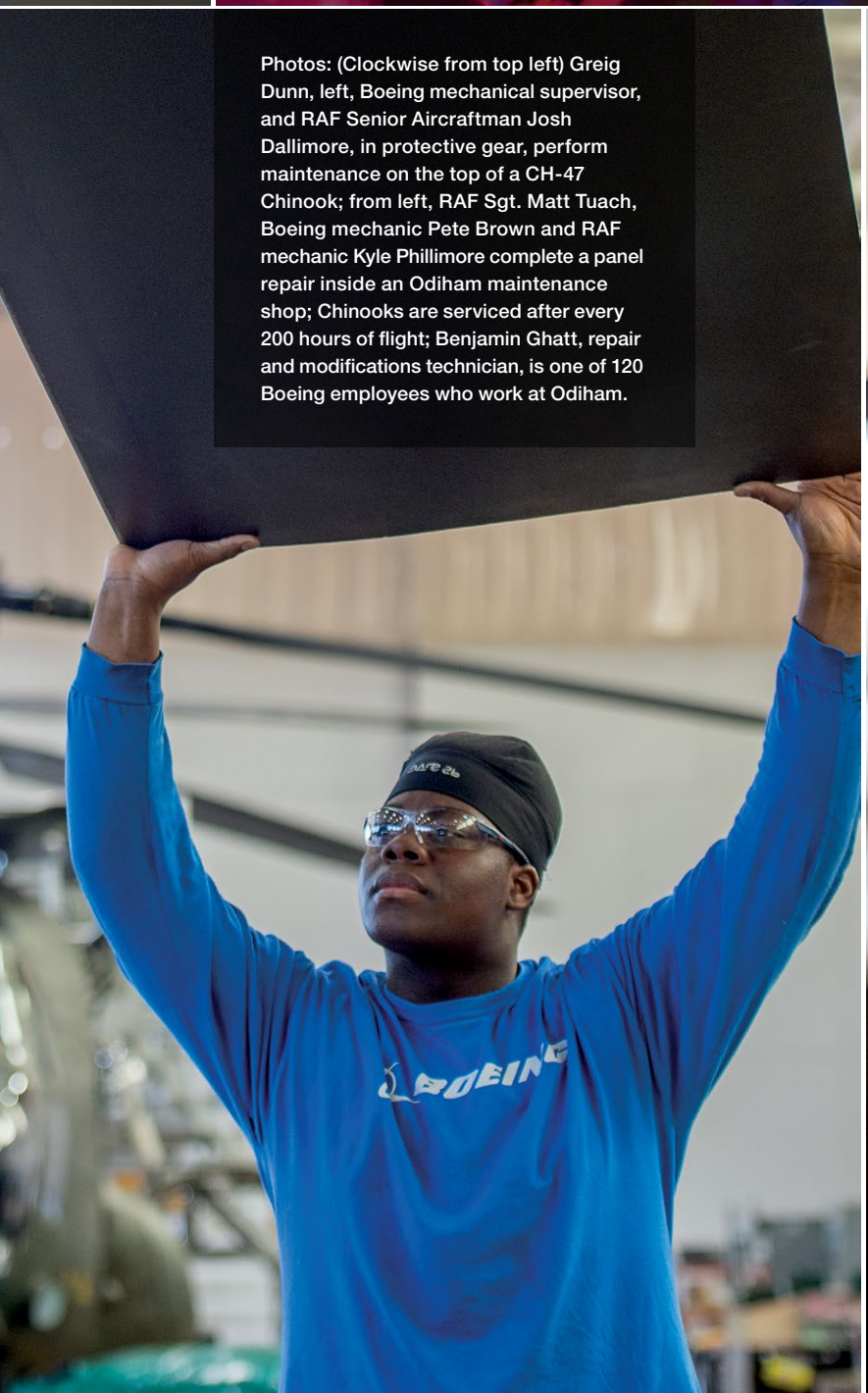
"There's a lot of passion for the Chinook in the UK," said Robert Grant, Boeing operations manager at Odiham. "There's a huge investment in the Chinook. They want Boeing here."

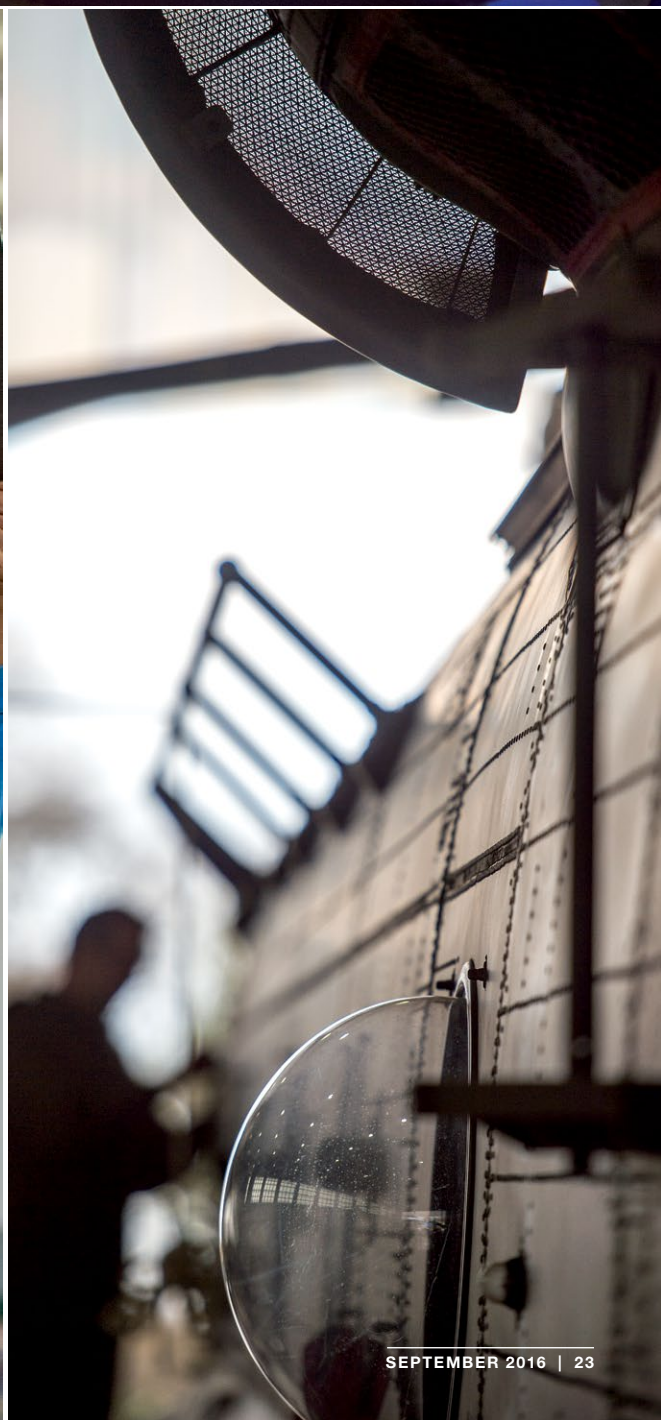
Chinooks are serviced after every 200 hours of flight because of the operational stress encountered, especially in harsh environments. A close watch is kept for structural fractures caused by high vibration or surface corrosion created by saltwater or desert sand. The Chinook can withstand a lot, though, according to RAF maintenance crews.

"I like working on it," said Sgt. Howard Hague, an RAF mechanic and team leader. "What you see is what you get. You can test it in all environments. It's a good bit of equipment for what it does, for what we need it to do."

Odiham has a work bay devoted to blade maintenance. Made of metal and composite materials, Chinook blades are 30 feet (9 meters) long, 60 feet (18 meters) when measured in tandem and 99 feet (30 meters) tip to tip when putting the dual rotors together. The two sets of blades rotate in opposite directions. Another bay is set aside for Chinook panel repair. Pete Brown has worked there for 18 years, first as an RAF technician and now for Boeing. The shop has a crossover of military and Boeing personnel.

"It works really well as a mixed





Photos: (Clockwise from top left) Greig Dunn, left, Boeing mechanical supervisor, and RAF Senior Aircraftman Josh Dallimore, in protective gear, perform maintenance on the top of a CH-47 Chinook; from left, RAF Sgt. Matt Tuach, Boeing mechanic Pete Brown and RAF mechanic Kyle Phillimore complete a panel repair inside an Odiham maintenance shop; Chinooks are serviced after every 200 hours of flight; Benjamin Ghatt, repair and modifications technician, is one of 120 Boeing employees who work at Odiham.

team," Brown said. "You wouldn't know we're civilians and RAF. It doesn't matter. We work together."

Chinooks typically fly with two pilots and two crew members. Each is outfitted in body armor and has a personal weapon. The helicopter can be armed with mini-guns and machine guns. The pilot has several radio channels available to speak to air traffic control, a military controller, ground troops and other aircraft. Levers and buttons deal with everything from night lighting to the cargo hoists. The Chinook actually requires a key to operate.

Each engine on the Chinook starts up separately and moves from ground to flight power. Functional checks are performed before liftoff, making sure everything is working properly. In flight, "It feels very robust," said Flight Lt. Matt Holloway, RAF pilot and now a 27 Squadron Chinook training captain. "The aircraft isn't going to let you down."

Chinook crews train throughout the UK and off its coastline, as well as in mountainous terrain in Scotland. They regularly transport British army

Photo: Royal Air Force Odiham, an hour's drive southwest of London, is home to two Chinook squadrons on alert for overseas deployment or emergency response.

and navy personnel. To experience a harsh desert environment, however, RAF Chinook crews are sent to a U.S. military base in El Centro, Calif., for certification. They work with American troops and no shortage of dust.

Nearly 850 Chinooks are in use today in 19 countries. The double-rotor helicopter keeps evolving and won't easily give in to time. New engines, blades and lift capabilities are in development. The U.S. Army publicly has stated it wants new helicopters through 2065. Dabundo, the Chinook program manager, expects production of the storied aircraft to extend well into the 2070s. Those who operate and maintain it at RAF Odiham share a similar vision.

"The Chinook is going to be around when my kids are flying—and they're not born yet," Flight Lt. Chris W. Dodd said. "It's going to be the next B-52. It'll be flying for 100 years." ●

DANIEL.W.RALEY@BOEING.COM

Root

Photo: In Abu Dhabi, United Arab Emirates, Boeing has partnered with Etihad Airways, the Masdar Institute of Science and Technology, and others on producing biofuel from saltwater-loving plants. BOEING

cause

Boeing and partners around the world team for a cleaner future—with biofuels

BY ERIC FETTERS-WALP

A potential future fuel for airplanes is growing out of saltwater sand near the shores of the Arabian Gulf.

Close to the Abu Dhabi International Airport in the United Arab Emirates, rows of salt-loving salicornia plants sit amid ponds of seawater. Boeing and local partners—Etihad Airways, Masdar Institute of Science and Technology, and jet-fuel company Takreer—are showing that plant oils from the salicornia seeds can be processed and refined into biofuel for the aviation industry.

The biofuel project, in a nation that has been one of the world's top oil producers over the past half-century, signals the growing shift away from fossil-based jet fuels toward cleaner, more efficient energy sources.

Boeing is a partner on numerous fuel processing and feedstock-growing projects around the globe, striving to be at the forefront of efforts to create large-scale supplies of such fuels. At the same time, the company is an active supporter of creating standards and regulations that help reduce aviation emissions and provide incentives for the transition to cleaner fuels. While Boeing does not intend to become a biofuel producer, the company and its customers can benefit from encouraging the biofuel industry.

"It's very simple: You can have a great airplane with powerful engines, but without fuel, your airplane is not going anywhere," said Darrin Morgan, director of Business Analysis and Environmental Strategy for Commercial Airplanes. "We're one of the few sectors that can't move away from using liquid fuels in the foreseeable future."

Environmental concern about carbon dioxide and other emissions from jetliners that crisscross the skies around the globe and around the clock is propelling the move away from petroleum-based fuels. Sustainable aviation biofuel can reduce carbon-dioxide emissions by more than 50 percent on a life-cycle basis compared with fossil-based jet fuel, according to Boeing Research & Technology. That includes the absorption of carbon dioxide by plants that are then used for biofuels. Using biofuel also reduces sulfur emissions, soot and particulates. Biofuels have other advantages as well, Morgan said.

Since 2011, when biofuel was

approved for commercial aviation, more than 2,500 commercial flights using biofuels have shown they perform as well as or better than traditional jet fuel, said Bill Lyons, director of Global Technology for Boeing Research & Technology.

"You're not sacrificing performance with these fuels," Lyons said. "Engines and airplanes have evolved over time to take advantage of biofuels better than before."

But a lack of infrastructure is a big obstacle to replacing jet fuel with aviation biofuels on a large scale. Over the past century, the petroleum industry has built vast production, refining and distribution infrastructure, which doesn't yet exist for biofuels, according to Morgan. That is why Boeing has partnered with companies and research institutes on six continents in recent years for a variety of research studies, testing, and demonstrations on everything from feedstock farms to fuel refining and logistics. That regional approach allows Boeing and its partners to test different potential sources for large-scale biofuel production, Morgan said.

In addition to the project in the UAE, Boeing and South African Airways, SkyNRG of the Netherlands and Sunchem SA are developing sustainable biofuel from an energy-rich tobacco plant called Solaris. In China, Boeing and a variety of partners are trying to make sustainable biofuel from agricultural waste materials, such as corn husks, as well as used cooking oil. In Canada, researchers are looking at wood waste and sawdust as a potential fuel source in studies that involve Boeing as a partner. In Southeast Asia and Brazil, Boeing supports biofuel research and efforts to grow feedstocks. And Boeing is contributing toward Japan's goal of using biofuel for flights to and from the 2020 Olympics and Paralympics in that nation.

"If produced sustainably, aviation biofuel can reduce carbon emissions 50 to 80 percent compared with conventional fossil fuel," said Dong Yang Wu, a Technical Fellow and managing director of Boeing Research & Technology–China. "This can help reduce the environmental footprint of the entire industry and promote the sustainable growth of the local commercial aviation market."

Boeing and its partners also are pursuing approval for "green diesel," which already is being produced in significant amounts, notably by Finland-based Neste Corp. Jim Kinder, a Senior Technical Fellow in Propulsion, said Boeing is working with companies in the U.S. and China, the U.S. Department of

Photos: (Far left) Boeing and two airlines completed Africa's first flights powered by biofuel in July. The 737-800 engines used a blend of 30 percent aviation biofuel produced from Solaris, a nicotine-free tobacco plant, refined by AltAir Fuels and supplied by SkyNRG. YANDISA MONAKALI
(Below) An airport worker pumps fuel into a 737 operated by Alaska Airlines. The all-Boeing airline is involved in expanding the use of aviation biofuel through several projects, including a partnership between Alaska, Boeing and the Port of Seattle. ALASKA AIRLINES

Photos: (Below) A worker checks machinery at a refinery in northeast China where agricultural waste is turned into biofuel. Boeing is a partner in the project. BOEING (Right) Raw material enters an ethanol manufacturing plant in Brazil, another country where Boeing supports biofuel research. SHUTTERSTOCK

Defense and the U.S. Federal Aviation Administration toward approval of green diesel for aviation uses. Production of green diesel, which is made from plant oils and cooking waste fats, has reached more than 1.2 billion gallons (4.5 billion liters) annually, Kinder added.

While growing biofuel production to a scale that supports thousands of daily commercial flights is still not a reality, all these efforts build toward that goal, Morgan said.

"If you don't get it to 1 percent, you don't get to 10, 50 or 100 percent. At this point, we're working on getting biofuel production and use to the highest percentage possible," he said.

In Seattle, Alaska Airlines, the Port of Seattle and Boeing are working together to support biofuel production in the Pacific Northwest and use at Seattle-Tacoma International Airport, making it the first airport to create a long-term road map for incorporating aviation biofuel into its fueling infrastructure.

"Biofuel infrastructure will make Sea-Tac airport an attractive option for any airline committing to use biofuel and will assist in attracting biofuel producers to the region as part of a longer-term market development strategy," said John Creighton, a commissioner for the Port of Seattle, which oversees the airport.

Meanwhile, Boeing also is helping create international standards and regulations for aviation biofuels, which is a necessary step to move forward, said Brian Moran, vice president of Government Affairs for Boeing Europe.

"As an industry, we have set some pretty ambitious targets," Moran said, noting that the international goal is to reduce the carbon footprint of commercial aviation to just 50 percent of 2005 levels by 2050, even as the number of airplanes increases. "The technology is ready. Airlines and regulators recognize the advantages, but the regulatory framework is not there yet. That is why we engage policymakers to make our case."

In addition to supporting the eventual widespread use of biofuels, Boeing is active in efforts to create more immediate solutions, including the use of carbon offsets, in which airlines and others can invest in carbon-reduction projects to "offset" the carbon emissions created by the use of aviation fuel. Boeing, Airbus and others also are attacking emissions with new and innovative commercial jetliners. The 787 Dreamliner and 737 MAX, for example, are significantly more fuel-efficient than the generation of airplanes that came before them.

But better airplanes alone won't get Boeing, the airlines and their increasingly environmentally minded passengers to the emission-reduction goals being negotiated by nations around the globe, Lyons said. That's why it's worthwhile to invest in biofuel development, which can also support farmers and regional economies around the world in addition to creating cleaner air, he said.

"Aviation is fundamental to global economic prosperity and progress," Lyons said. "But at the same time, we have to realize there are finite resources, and if we want to grow, we have to confront that." ●

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Octopus of the sky

Insitu's innovative multi-copter provides more options for the unmanned ScanEagle

BY DAN RALEY | PHOTOS BY BOB FERGUSON

The device resembles an octopus, with mechanical tentacles reaching in all directions, wrapping up others when necessary.

Yet FLARES—or Flying Launch and Recovery System—was meant for the sky rather than the sea. It's the latest innovation in the rapidly evolving world of unmanned aerial systems, or UAS.

Built by Boeing subsidiary Insitu in Bingen, Wash., FLARES is an autonomous multi-copter that complements the ScanEagle, the company's flagship and original unmanned aircraft, by dispatching it and catching it in flight.

"When we first started, it had never been done before—dropping a UAS from a UAS," Insitu flight-test

Photo: Insitu's FLARES, or Flying Launch and Recovery System, is a multi-copter that carries another unmanned aerial system, ScanEagle, before releasing it into flight. FLARES also can capture ScanEagle at the end of its flight.

Photos: (From top) From left, Insitu software engineers Ben Triplett, Ehsan Nasroullahi and Chris Griffis prepare FLARES for a test flight in Oregon; Nasroullahi inspects FLARES before it goes airborne; Tyler Sibley, demonstration team UAS operator, uses a handheld controller to direct FLARES during testing.

engineer Amy Arbeit said.

The airplane-shaped ScanEagle, first flown in 2002 and autonomous as well, has been used by the U.S. military and some allies for surveillance missions for a nearly decade. It has also become a favorite for a growing number of commercial and civilian purposes. ScanEagle is currently catapulted by a launcher from a trailer and retrieved by the SkyHook, which is on a separate trailer, dealing with limited launch and landing zones. It requires a clear space for operation, according to Insitu officials.

FLARES, with ScanEagle tethered below it, provides options, said Andrew Hayes, Insitu director of advanced development. It climbs to 500 feet (150 meters) and releases its fellow UAS. The process takes less than five minutes. A ground operator presses a button on a handheld controller and a freed ScanEagle simply flies away from FLARES.

On retrieval, the multi-copter hovers in one place and catches the returning unmanned aircraft with a 300-foot-long (100-meter) cable and gently sets it on the ground. The ScanEagle flies into the cable, which slides down the leading edge of the swept wing until a wing hook engages.

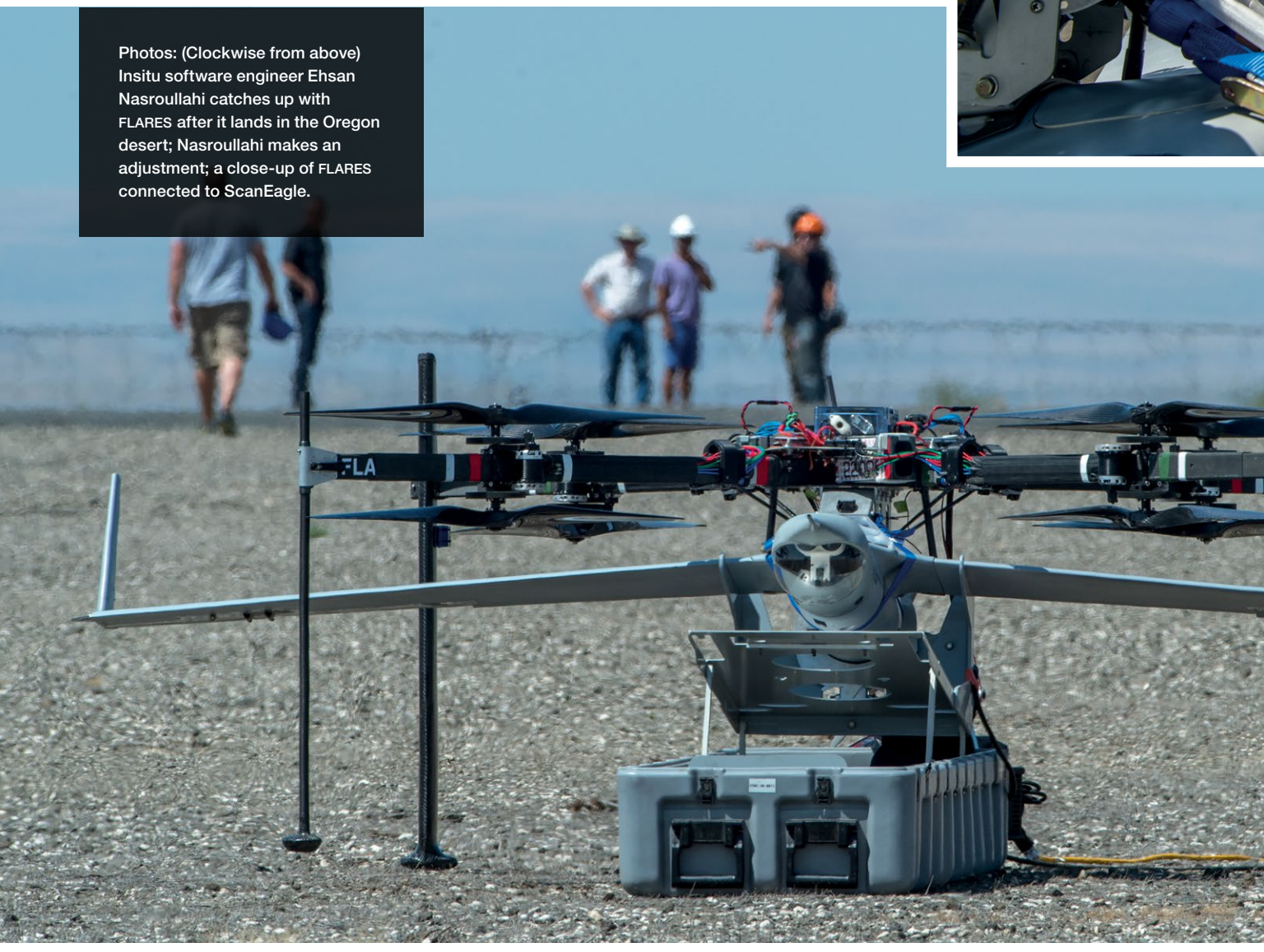
"With FLARES, we can launch anywhere," Hayes said. "This opens up a lot of different places."

The multi-copter can enhance a military mission by lifting off from the middle of a dense jungle or by navigating tight spaces around buildings, trees or power lines to release ScanEagle, according to Hayes.

Commercial customers will find many uses, too. With Insitu's multi-copter and unmanned aircraft working in concert, Hayes noted, a railway can monitor thousands of miles of track to enhance safety, on the constant lookout for boulders or washed-out areas; miles of farmland can be maintained with precision agriculture by an operator working from the back of a truck; or an advancing wildfire can be assessed and dealt with more expediently by authorities if a multi-copter and ScanEagle are launched on the edge of the blaze, Hayes said.

In 2013, Insitu teamed with nearby Hood Technologies to come up with a multi-copter concept based on launch and recovery, building a prototype to prove it could work. Program manager Jim McGrew and his team collaborated with Boeing engineers in Huntington Beach, Calif., who have expertise

Photos: (Clockwise from above) Insitu software engineer Ehsan Nasroullahi catches up with FLARES after it lands in the Oregon desert; Nasroullahi makes an adjustment; a close-up of FLARES connected to ScanEagle.



in motor speed controls and power systems. Rotor adjustments were made to increase lift and better match ScanEagle's propulsion. Possible failures in the multi-copters were singled out, addressing safety concerns.

"Big airplanes have lots of redundant systems," said Raul Ramos-Schulze, FLARES electrical engineer. "We're trying to merge hobbyist design with commercial flight that leads to safety and robustness and reliability."

FLARES uses a one-gear transmission because it's in the air only briefly, at the beginning and end of each ScanEagle flight. Engineers continue to develop with different types of autopilot, attempting to lower cost, according to Ramos-Schulze.

While Insitu pursues Federal Aviation Administration certification over the next year to operate the multi-copter, the company is setting up classes and training simulators in a remodeled school in nearby White Salmon, Wash. Operators and maintenance technicians will take separate courses, comparable to what is offered for ScanEagle, according to Insitu. Technical writers are creating instructional manuals at the same site.

"It's really exciting that we get to be at the forefront of the FLARES program," said Kate Pinner, Insitu senior instructional design specialist, who has created the classroom setting. "It's really groundbreaking and motivating to know it's going to change the way the UAS industry is moving. It's that pivot point."

Testing is conducted more than an hour's drive away in an Oregon desert that offers restricted airspace and plenty of privacy. FLARES and ScanEagle are disassembled and transported in plastic cases, using a single truck.

While Insitu builds its unmanned aerial systems in the relative quiet of the Columbia River Gorge, its products have received mainstream exposure. A Hollywood film starring Tom Hanks demonstrated the unique capabilities of ScanEagle in a depiction of an international piracy incident that involved a U.S. cargo ship and the rescue of its captain from pirates.

FLARES is the next innovative

Photos: (From left) A flight operations team member untethers ScanEagle from a 300-foot-long (100-meter) cable used by FLARES to capture it; FLARES hovers over the Oregon landscape carrying a static weight.

step for Insitu, which also builds the bigger and more capable Integrator, in addition to ScanEagle, according to Hayes.

"*Captain Phillips*, that was us," Hayes said of the movie about the captain taken hostage by pirates. "If it's on CNN, we're probably flying it. It makes me proud to be part of this team. It's like being part of the Wright brothers—we're doing cool stuff." ●

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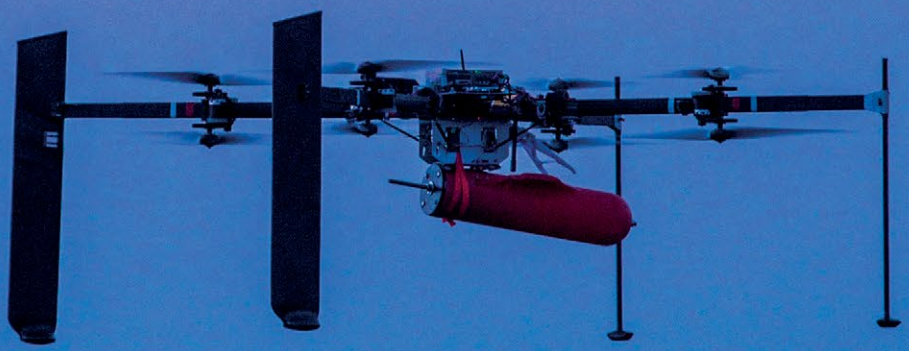

"As a boy, I picked up an extra paper round in Petersfield to save for flying lessons. I managed to get my pilot's licence before I could even drive a car. It's freeing to get up in the air and see the world from that perspective. Even though I left the British military I still feel like I'm part of it as a civilian test pilot. The data we gather proves the Chinooks are safe before the frontline fly them. We feel good about supporting the team overseas."

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