

IQ INNOVATION QUARTERLY

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Going With the Flow

Curiosity inspires engineer
to build his own wind tunnel

**PLUS: Engineer Finds
Her Force for Innovation**
Passion for 3D modeling
propels career odyssey

AERODYNAMIC APPRECIATION

Sai Mudumba marvels at the structure of a
wind tunnel at the University of Washington.



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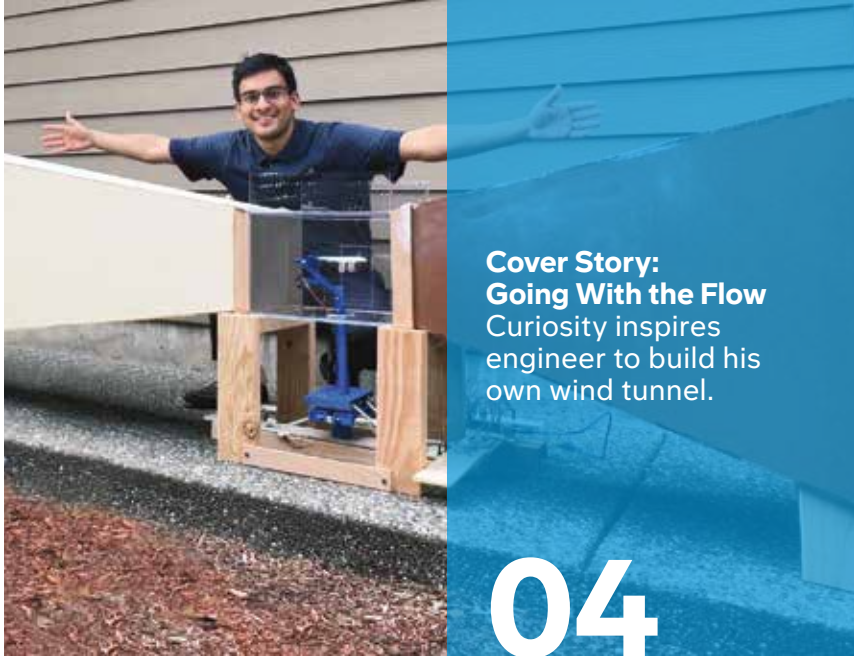
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Flying west to go east, flying
boat survives onset of war
and sets flight record.



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IQ IS ...

Innovation Quarterly invites readers
to go inside the future of aerospace
with the people who make it happen.



Compelling Curiosity

Keeping the wonder
in engineering

As I prepared to write this note, I was excited to learn about the story of Boeing engineer Sai Mudumba. Not only is he a fellow Purdue grad, he's a lifelong learner. His curiosity about aerospace concepts compelled him to build his own wind tunnel, leading him to discover new ways to collect airplane data.

I can relate. My passion for aerospace and engineering started early in my life. For my eighth grade science fair project, I attempted to build a low-speed wind tunnel. There were many technical shortcomings in my creation, the least of which was the house fan I borrowed from my parents to power the tunnel.

If I have noticed one thing during my career at Boeing, it's how personal interests and creativity fuel our professional passions.

This issue of Innovation Quarterly is full of inspiring stories about teammates who are transforming their knowledge from outside pursuits into new ideas for 3D modeling, autonomy and more. Their enthusiasm is driving technical excellence across the business, proving the power of intellectual curiosity and its unstoppable influence on innovation.

Let their stories challenge you to give thought to your greatest curiosity, and pursue a project of your own. Together, our discoveries will change the world. **IQ**

David Loffing

Vice President and Chief Engineer,
Boeing Commercial Airplanes



AERODYNAMIC ADMIRATION

Sai Mudumba looks inside a reproduction of Wilbur and Orville Wright's 1901 wind tunnel at The Museum of Flight in Seattle. Like the aviation pioneers, Mudumba's curiosity inspires his own wind tunnel experiments.

PHOTO: MARIAN LOCKHART/BOEING

Going With the Flow

Curiosity inspires engineer to build his own wind tunnel

BY MICK BOROUGHS, BOEING WRITER

Sai Mudumba's interest in all-things aviation soared each time he watched airplanes taxi and takeoff from Miami International Airport, near his childhood home. At 10 years old, he tried to grasp how enormous vehicles could become airborne and fly away.

"Living in Florida, I saw rocket launches at Cape Canaveral, like the Mars Curiosity rover. It lifted off in 2011 aboard an Atlas V rocket to travel to another planet millions of miles away," said Mudumba, still with a sense of awe. "It was inspiring for me to see what humans could achieve, and it was a pivotal moment for me to decide to become an aerospace engineer."

From launches to lift

Mudumba earned his bachelor's and master's degrees at Purdue University School of Aeronautics and Astronautics and a second master's degree in electrical and computer engineering. He joined Boeing in 2022 and is an aircraft design software developer with Boeing's Multidisciplinary Design, Analysis & Optimization engineering team in Everett, Washington.

In 2023, Mudumba reviewed his university notes and thought about airflow around simple shapes and airfoils. The idea of using a wind tunnel as a data source came to mind. At Purdue, he had used the campus's subsonic wind tunnel in his lab courses.

A wind tunnel is an environment to test the aerodynamic effects on objects in a scaled and cost-effective way. Boeing operates several wind tunnels, and Mudumba recently had the opportunity to check out the company's icing wind tunnel in Seattle.

"It was impressive to see the complexity of how they gather data and how it functions overall," he said. "I have so much respect for the wind tunnel designers and operators. Operating one is as complex as building one. It's like a beautiful orchestration of everything working together in sync."

Mudumba decided to design his own wind tunnel using off-the-shelf materials, online tutorials and 3D printing to craft some parts.

"I started looking at YouTube to see if there were any wind tunnels that used more than a simple force balance, but the majority I came across were very simple in nature with just lift and drag sensors and nothing else," he said. "I saw an opportunity to create something that could collect lift, drag and other moments like pitching, rolling and yawing, so it would be a five-component force balance."



ROLL WITH IT

Mudumba's wind tunnel collects five force components, including lift, drag, pitching, rolling and yawing. The force balance, part of the blue structure in the middle of Mudumba's tunnel, measures the wind forces that act upon an airplane model.

PHOTO: COURTESY OF SAI MUDUMBA

LIVE AND LEARN

Mudumba appreciates the complexities of both building and operating a wind tunnel after designing his own.

PHOTO: SAI MUDUMBA



"It was impressive to see the complexity of how they gather data and how it functions overall. I have so much respect for the wind tunnel designers and operators. Operating one is as complex as building one. It's like a beautiful orchestration of everything working together in sync."

SAI MUDUMBA,
BOEING ENGINEER

Winds of Change

BY JAKE SCHULTZ, BOEING HISTORIAN

Wind tunnels have been used for aeronautical study for well over 100 years.

Among the pioneers were Albert Francis Zahm, who built and operated a wind tunnel from 1901-1908 at Catholic University in Washington, D.C. Gustave Eiffel — of Eiffel Tower fame — is among others who conducted early aeronautical research.

In the United States, brothers Orville and Wilbur Wright conducted some of the earliest wind tunnel experiments. While their original 1901 wind tunnel no longer exists, multiple museums exhibit numerous reproductions, including one at The Museum of Flight in Seattle.

In 1914, Jerome Hunsaker, an aeronautical engineer and engineering educator at Massachusetts Institute of Technology, partnered with his assistant, Donald Douglas, to build MIT's first modern wind tunnel. Douglas later founded the Douglas Aircraft Company, a Boeing heritage company.

The Boeing Company used the early MIT tunnel to test the first Boeing airplane, the B&W, which was also the first airplane to be tested in a wind tunnel prior to its construction and flight. Later, Boeing tested the Model C in the MIT tunnel as well.

Shortly thereafter, William Boeing provided funds for a wind tunnel to be built on the campus of the University of Washington. Boeing was an early advocate of education and collaboration with universities for the advancement of the aerospace industry and for academic research benefiting society.

In 1943, Boeing constructed the Boeing Transonic Wind Tunnel in Seattle. Still in use today, the wind tunnel provides early information to engineers on the effectiveness of aircraft designs and collects data that is crucial for future flight tests.

"Wind tunnel testing is critical to be able to manufacture and fly any airplane," said Andrew Mosedale, a Boeing test engineer who ran wind tunnel testing for the B-52 Commercial Engine Replacement Program in 2022. "It's one of the reasons the wind tunnel here was originally built, to be able to design aircraft. Today, we're just continuing that work."



PHOTO: MARIAN LOCKHART/BOEING

WOOD WIND

Inside the Wright Wind Tunnel replica behind Mudumba, a wing is mounted on a balance that measures its lifting capability, which is expressed in a number called the lift coefficient. The Wrights tested more than 200 wing shapes and collected nearly a thousand data points during their wind tunnel experiments in 1901 and 1902.



PHOTO: BOEING ARCHIVES

DEBUT REVIEW

Victor Ganzer, chairman of the Department of Aeronautics and Astronautics, checks UW's first wind tunnel circa 1953.



PHOTO: MARIAN LOCKHART/BOEING

IN THEIR FOOTSTEPS

Jake Schultz (left) and Mudumba visit the first UW wind tunnel building. William Boeing provided funds for the building's construction in 1918. The university replaced the original tunnel (previous photo) with this one in the 1980s, and students still conduct research in this building today.



PHOTO: BOEING

MODERN MACH

Boeing tests a B-52 with replacement engines in the Boeing Transonic Wind Tunnel, using a 4% model and reaching a maximum speed of Mach 0.92.

"It was a great learning experience to think of what tools I could use to cut the wind tunnel into the shape I wanted. The other challenge was operating it. There's a lot of complexity in learning how to operate a wind tunnel and understanding how it behaves."

SAI MUDUMBA,
BOEING ENGINEER

"Half the challenge," Mudumba explained, "was building it with a limited selection of tools. It was a great learning experience to think of what tools I could use to cut the wind tunnel into the shape I wanted. The other challenge was operating it. There's a lot of complexity in learning how to operate a wind tunnel and understanding how it behaves."

Put together with polycarbonate sheets, wood and an attic fan, the 10-foot-long (3-meter-long) wind tunnel came together inside Mudumba's living room.

The tunnel is portable and comes apart in five segments: the converging section, the test section, the diffuser, the fan, and the force balance, along with a small model airplane.

Mudumba laughs, recalling one curious neighbor who asked him, "What's a wind tunnel?"

Like his neighbor, Mudumba's teammates and his manager, Brent Robbins, took an immediate interest in the do-it-yourself project.

"I was blown away at how cool it was," Robbins said. "I always planned on building my own wind tunnel but never figured out how to measure anything but lift and drag forces. I wanted to know moments, and Sai figured that out and implemented it."

"What impressed me most was the mechanisms he developed using sensors for the test stand. Now I know who to talk to regarding my own project."



TUNNEL VISIONARIES

Inspired by Mudumba's ideas, Brent Robbins (right) is considering his own wind tunnel project.

PHOTO: MARIAN LOCKHART/BOEING

“Boeing is at the forefront of innovation. I’m excited about the future of airplanes, and I’m excited to be a small part of this great company.”

SAI MUDUMBA,
BOEING ENGINEER

As for Mudumba's next goal, he is pursuing a ground school course at a local community college to help him earn his private pilot's license. He plans to take his first solo flight in 2024. In addition to paying for the coursework, Boeing's Learning Together Program will provide an incentive payment to Mudumba when he obtains his license.

In the meantime, he's gaining more experience in his current role in aircraft configuration and integration so he can help design the next generation of Boeing airplanes.

“Boeing is at the forefront of innovation,” Mudumba said proudly. “I’m excited about the future of airplanes, and I’m excited to be a small part of this great company.” **IQ**



INSIDE IQ
Look inside
Sai Mudumba's
wind tunnel.

Let's keep some heads in the clouds

Curious minds are wired to wonder. They venture away from what's known toward what's possible. Boeing is proud to champion the next generation's inspiring discoveries.
Learn more at [boeing.com](https://www.boeing.com)



**FAST CLIP**

One of a dozen Boeing-built Model 314 Pacific Clippers flies over the Golden Gate Bridge in San Francisco.

PHOTO: BOEING ARCHIVES

Long Way Home



Flying west to go east,
flying boat survives onset of
war and sets flight record

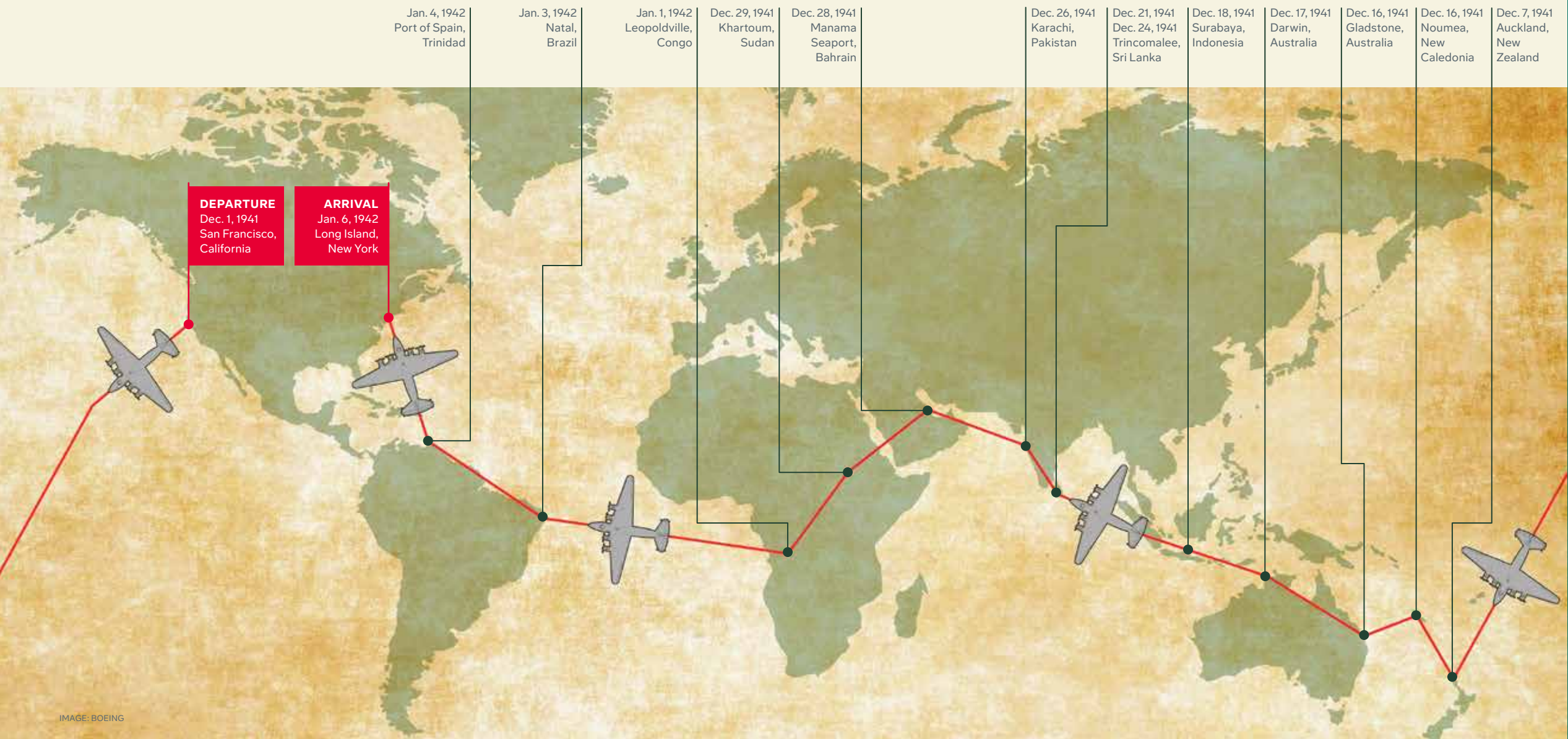
BY KEVIN KELLY, BOEING WRITER

On Dec. 7, 1941, Pan American Airways had three Pacific Clippers in flight over the Pacific Ocean when the attack on Pearl Harbor occurred.

One of the flying boats had just two hours left on its five-stop, weeklong flight from San Francisco to Auckland, New Zealand, when radio operator John Poindexter received news of the attack. Fearing an assault on Pan Am facilities in the Pacific region, Poindexter passed the message to the plane's captain, Robert Ford.



IMAGE: BOEING



FOLLOWING THE STARS

The crew charted a westward course from Auckland to New York using a paper atlas and celestial navigation.

Directives without directions

On Dec. 1, before departing San Francisco, Ford had received a top-secret letter from Pan Am. If war broke out during the flight, the letter directed Ford to:

- Safely deliver the passengers and cargo.
- Deliver the aircraft to a Pan Am facility in the United States or to the U.S. military.
- Destroy the aircraft if it was in imminent risk of capture or under attack.

Ford, a certified master of flying boats, safely landed the plane in Auckland on Dec. 7, 1941, marking the fifth stop of the trip from San Francisco. There, the crew spent a week at the American embassy, stripping the aircraft of unnecessary items, removing identifying markings as best they could, and loading gas, oil, spare parts and provisions for the 10-person crew.

No radio, no maps

In Auckland, Ford received orders to fly west from New Zealand to New York. He was to maintain radio silence throughout the flight, and the crew had no maps to guide their long westward route.

Navigator Roderick Brown bought an atlas from a library in New Zealand. His celestial navigation skills and the coordinates from the atlas provided the only data for the flight path.

Low fuel, food and funds

Late in the evening of Dec. 16, Ford left the harbor at Auckland and flew in blackout conditions to Noumea, New Caledonia, picking up Pan Am staff who were stranded there and taking them to Gladstone, Australia. A local banker gave Ford a \$500 advance to cover food and fuel expenses for the long trip home. That was the only assistance and support the crew received. From there, the Pacific Clipper flew west to Darwin, in Australia's Northern Territory, and on to Surabaya, in the Dutch East Indies (present-day Indonesia).

FLOAT AND FLY

Boeing Model 314, NC18602, the Pacific Clipper, was built to navigate open seaports and calm waters, not rivers.

The next stop was Trincomalee, Ceylon (now Sri Lanka), for refueling. Aviation fuel was in short supply, as it was reserved for military use. Flight engineers Swede Roth and Jocko Parish transferred all the remaining aviation fuel to the two main fuselage tanks, then filled the reserve tanks with lower-octane automobile gasoline. Each 5-gallon (19-liter) can of gasoline had to be carried over the wing and emptied into the reserve tanks by hand. The crew would use the aviation fuel for takeoff and to climb to altitude, then use the automobile gasoline while cruising.

Engine fire

The Clipper departed Trincomalee on Christmas Eve morning. Less than an hour into the flight, the No. 3 Wright Cyclone engine burst into flames due to a broken piston, likely the result of excess heat from the automobile gasoline.

The aircraft returned to Trincomalee, where the crew made all the repairs in a single day. On Dec. 26, the plane was airborne again and headed for Karachi, India (now Pakistan). After making a stop in Bahrain, Ford landed the flying boat on the Nile River in Sudan.



PHOTO: BOEING ARCHIVES

FOR THE RECORD

The final landing at LaGuardia marked the completion of the 37-day, 18-stop, 31,500-mile (50,694-kilometer) west-to-east flight from San Francisco and New Zealand to New York. The Clipper had flown for nearly 210 hours, crossed the equator four times, flown over five continents and three oceans, and stopped in 12 nations.

No denying the Nile and the Congo

Clippers were designed to land on calm waters near populous seaports. The narrow banks, swift currents and debris of the Nile River posed dangers to the 84,000-pound (38,102-kilogram) aircraft with its 152-foot (46-meter) wingspan.

But the crew pressed on. Ford reached Leopoldville (now Kinshasa in Congo), docking at a rudimentary aircraft service facility on the Congo River.

After the crew had rested and the plane had been replenished, it was time to face two of the biggest obstacles of the journey home. First, the flying boat had to get in the air quickly to avoid nearby rapids and waterfalls in the Congo River. Next would come the nonstop, 20-hour, 3,583-mile (5,766-kilometer) flight across the Atlantic to Natal, Brazil.

Following that, the crew would stop at Port of Spain, Trinidad, before making the final leg of the flight to New York.

Unannounced arrival

In the early morning hours of Jan. 6, 1942, the radio operator at LaGuardia Airport received the following message: "Pan Am Pacific Clipper, inbound from Auckland, New Zealand. Ford reporting. Due arrive Marine Air Terminal LaGuardia seven minutes."

There was nothing on the day's manifest about this flight, so the unexplained transmission created confusion and concern. The Clipper circled the airport for an hour waiting for permission to land.

The final landing at LaGuardia marked the completion of the 37-day, 18-stop, 31,500-mile (50,694-kilometer) west-to-east flight from San Francisco and New Zealand to New York. The Clipper had flown for nearly 210 hours, crossed the equator four times, flown over five continents and three oceans, and stopped in 12 nations.

Upon landing, Pan Am transferred the crew to the airline's Atlantic division, prohibiting their return to San Francisco and preventing a full circumnavigation of the globe. Regardless, more than 80 years later, the record still stands as the longest commercial flight by mileage. **IQ**



INSIDE IQ
Watch a Pacific Clipper
fly before World War II.

Lightening the Launch Load

Satellite structures lighten up with inventive use of additive manufacturing

BY ED MUIR, BOEING WRITER

INNOVATION EXCITATION

Boeing engineer Michael D'Olio monitors vibration testing of additively manufactured satellite antennas.

PHOTO: BOEING

Principal Senior Technical Fellow Rich Aston leads a team of engineers always trying to build the proverbial better mousetrap.

"We always strive to find new and better ways to innovate," said Aston. "Learning and teaching are core values of our team."

Applying their knowledge and creativity to inventions, Aston's team created a fully additively manufactured, or 3D-printed, metallic satellite spacecraft structure. The structural panels are lighter, require less labor and dramatically reduce cycle time compared to the design and manufacture of previous structures.

ADDITIVE ASSEMBLIES

Boeing engineer Emily Woods prepares a 3D-printed satellite panel for assembly. Producing the panels with additive manufacturing reduces structure assembly time to less than one hour.

PHOTO: BOEING

OUTSIDE THE BOX

Rachel Zilz, Woods, Nicole Schoenborn and Rich Aston team up to assemble an additively manufactured satellite that they designed. The 3D-printed construction eliminates secondary labor operations.

PHOTO: BOEING

Benefits of this 3D-printed product

- The fabrication lead time for the high-strength aluminum used on the structure is days rather than months for traditional honeycomb composite panels, enabling engineers to respond faster and with more agility if a customer requests changes.
- The 3D-printed construction eliminates secondary labor operations such as match drilling and match bonding.
- The design features a roughly 99% part count reduction, reducing potential supply chain strain.
- Structure assembly time is dramatically reduced to 53 minutes, compared to weeks for a traditional composite design.

"Our team is often focused on the next project, so it's nice to step back and realize what we've accomplished," said engineer Nicole Schoenborn.

The team earned the 2023 Boeing Special Invention Award, which recognizes technical innovations that have brought new and improved capabilities to aerospace and realized significant benefits for the company and its customers. [IQ](#)

Space to Sea: Low Earth Orbit to Ocean Expertise

After years commanding satellites,
an engineer dives deep

BY ELAINE BRABANT, BOEING WRITER

Off the California coast, divers drop into the ocean. They stay mostly hidden, like the underwater vehicles they design and now test.

What these engineers do is so progressive, so impactful to U.S. security that much of their work is secret. Yet these teammates are openly developing and producing the U.S. Navy's Extra Large Uncrewed Underwater Vehicle (XLUUV), known to the U.S. Navy as Orca. The development program will produce the world's largest autonomous submarine. Boeing self-funded a proof-of-concept vehicle, the 51-foot-long (16-meter-long) Echo Voyager.

SURFACING AUTONOMY

Boeing's prototype, Echo Voyager, undergoes testing off the coast of Southern California.

PHOTO: BOEING



DEEP CONVERSATION

Ann Stevens (red vest) discusses logistics before ocean testing in Long Beach, California, with fellow Boeing engineers (from left) Dutch Williams, Brian Phelps and Meghan Guerrero.

PHOTO: PAUL PINNER/BOEING

A force of nature

The vessel must independently navigate the ocean for months at a time, withstanding forces more extreme than air or space. It's a responsibility that self-described "space geek" Ann Stevens couldn't resist.

"I've always liked to solve really hard problems," said Stevens, who spent the first of her two decades at Boeing working on satellites.

Now she leads Boeing's Maritime & Intelligence Systems business.

"I love to hear, 'No one has done that before,'" Stevens said. "The idea of making undersea warfare a differentiator for our service members was compelling to me. It's rare to work on something that is a true game-changer."

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**ANN STEVENS,
BOEING MARITIME &
INTELLIGENCE SYSTEMS**

A product without wings

Shock often registers on people's faces when Stevens or her teammates explain they're building a submarine. Even though Boeing has developed underwater vehicles for 60 years, most of the company's products fly. The relatively small Maritime Undersea team specializes in solving a unique set of challenges.

Underwater vehicles must endure highly pressurized, corrosive ocean water. Plus, unlike airplanes or spacecraft, undersea vehicles don't have a communications link.

"You can't talk to something underwater," said Stevens, who once monitored satellites and recalls the need to "talk" to them, giving commands 24/7. "Our maritime vehicles need to do their missions perfectly without any human intervention. That's the headset of this team. That's the way we think of autonomy."

"You can't talk to something underwater. Our maritime vehicles need to do their missions perfectly without any human intervention. That's the headset of this team. That's the way we think of autonomy."

**ANN STEVENS,
BOEING MARITIME &
INTELLIGENCE SYSTEMS**

ALONE AND UNAFRAID

This is the second and latest XLUUV developed and built by Boeing. Known as Orca, it uses advanced autonomy to operate for months at a time without human intervention.

PHOTO: BOEING



XLUUV deep dive

Boeing's XLUUV delivers unprecedented endurance, capacity, mission flexibility, reliability and autonomy. This game-changing combination expands strategic and tactical options for previously unattainable missions, allowing operators to reexamine their approach to undersea and seabed warfare.

Key features

- **Advanced autonomy:** Operates for months at a time in open, congested and contested waters on its own.
- **Obstacle avoidance:** Enabled by sonar and proven autonomous algorithms.
- **Resilient and redundant:** Provides unmatched mission assurance.
- **Payload:** Offers unprecedented internal and external volume.
- **Independent of host ship:** Swims from the pier to simplify labor and logistics.
- **Reduced cost:** Enabled by in-water maintenance through a blend of endurance, host-ship independence and novel design features.



IMAGE: BOEING



DIVE-READY

The main mast houses communications and snorkel capability during littoral-/surface-level operations. (Left) Capt. Jason Weed, U.S. Navy Commodore of the Unmanned Undersea Vehicles Squadron ONE, stands with retired Boeing engineer Dan Tubbs, who played a crucial role in the development of Boeing's XLUUV.

PHOTO: BOEING

In some ways, the team operates like a startup. Customers bring them problems. Then, engineers and technical experts in Huntington Beach, California, and Herndon, Virginia, propose, debate and provide solutions. Their products can go from concept to design, development, assembly and deployment in just a few years.

"To do things that fast, you have to be super-tightknit and dedicated," Stevens said. "This team knows the platform and environment better than anyone else. They trust that together they can solve anything that comes their way."

"To do things that fast, you have to be super-tightknit and dedicated. This team knows the platform and environment better than anyone else. They trust that together they can solve anything that comes their way."

ANN STEVENS,
BOEING MARITIME &
INTELLIGENCE SYSTEMS

XLUUV in the numbers

- 1 Advanced, trusted autonomy
- 2 Multi-spectrum communications
- 3 Redundant sensor/snorkel masts
- 4 Independent field-replaceable pressure vessels
- 5 Redundant battery and diesel generator
- 6 Modular multi-mission payload bay
- 7 Multi-sensor situational awareness capability
- 8 Multi-source integrated navigation
- 9 Integrated mooring system
- 10 Precision forward/downward sonar

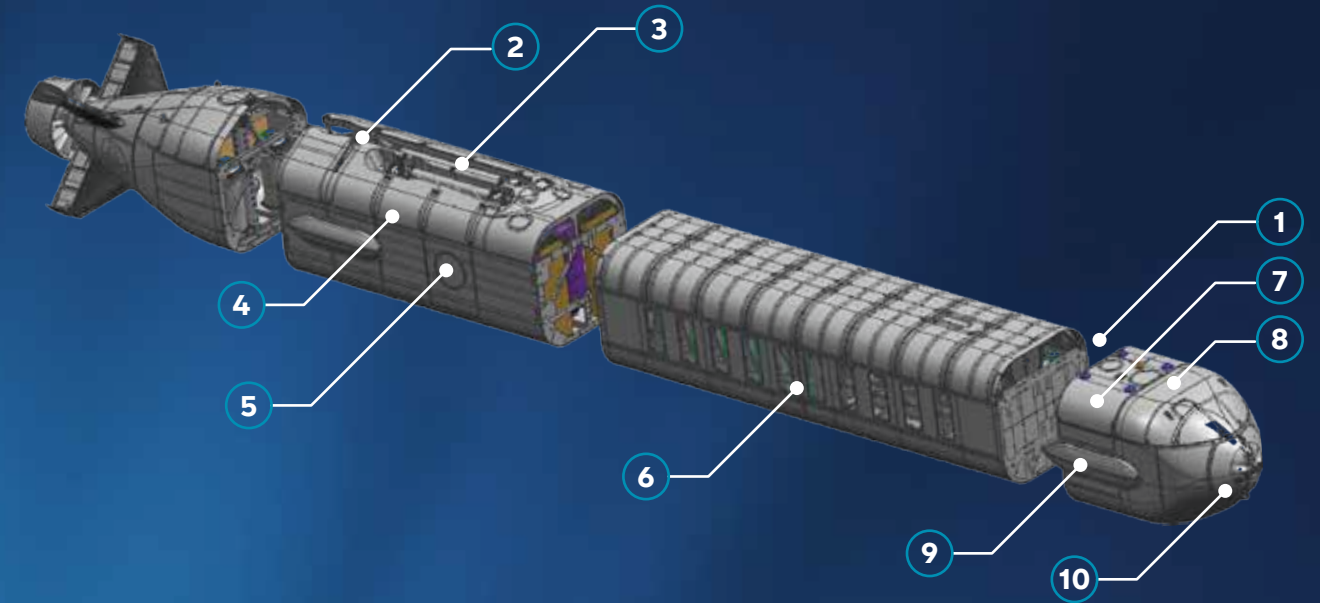


IMAGE: BOEING

Tough talk yields transparency

Though sea challenges differ from those Stevens encountered putting satellites into space, she notices a common thread. Tough problems require tough conversations. Stevens doesn't back down from either.

Teammates say they never have to guess what she's thinking. That thing no one wants to talk about? She'll go there. But she has learned to do so thoughtfully.

"If people are talking around a problem, I could be blunt and say exactly what's on my mind, but that may not be well received," said Stevens, who studied human and group behavior, earning a master's degree in organizational management.

"As I've matured as a leader, I haven't grown less transparent, but I have learned how to read a situation and be mindful of how I deliver that transparency," she said.

"As I've matured as a leader, I haven't grown less transparent, but I have learned how to read a situation and be mindful of how I deliver that transparency."

ANN STEVENS,
BOEING MARITIME &
INTELLIGENCE SYSTEMS



WATER ONCE-OVER

Engineers enter the ocean to inspect the vehicle and adjust equipment.

PHOTO: BOEING

That philosophy also applies to how she develops people.

“My job is to make my team the best they can be,” Stevens said. “I tell them when I think they’re right or wrong, and I give them the help they need to grow.”

She and her leadership team talk weekly about talent. They spotlight individuals’ achievements and career goals, as well as identify ways to expand skills through on-the-job experiences and mentorships.

“There are so many opportunities at Boeing,” Stevens said, pointing to her own journey from space to sea. “I’m proof that you can have more than one career here. It’s an incredible place to be if you are an ambitious engineer, and you want to do really meaningful things.” **IQ**

DRIVE-BY

A Boeing team member evaluates Echo Voyager during sea trials.

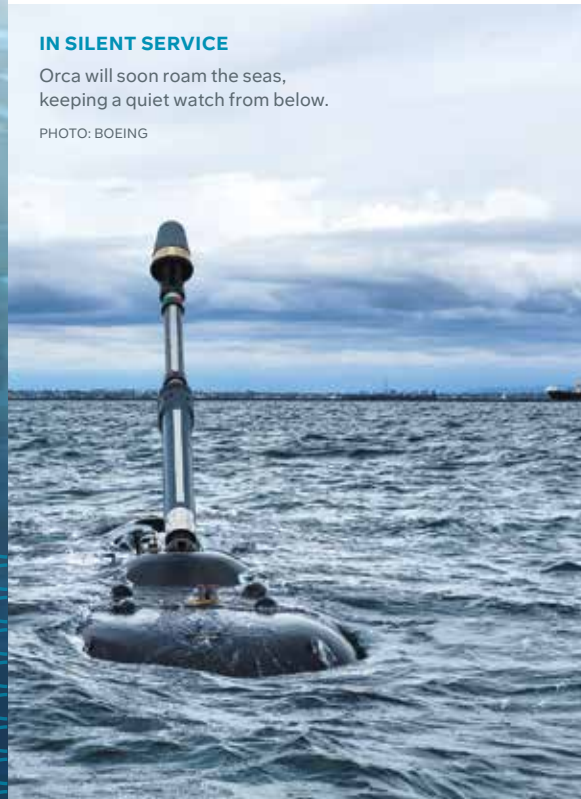
PHOTO: BOEING



IN SILENT SERVICE

Orca will soon roam the seas, keeping a quiet watch from below.

PHOTO: BOEING



“There are so many opportunities at Boeing. I’m proof that you can have more than one career here. It’s an incredible place to be if you are an ambitious engineer, and you want to do really meaningful things.”

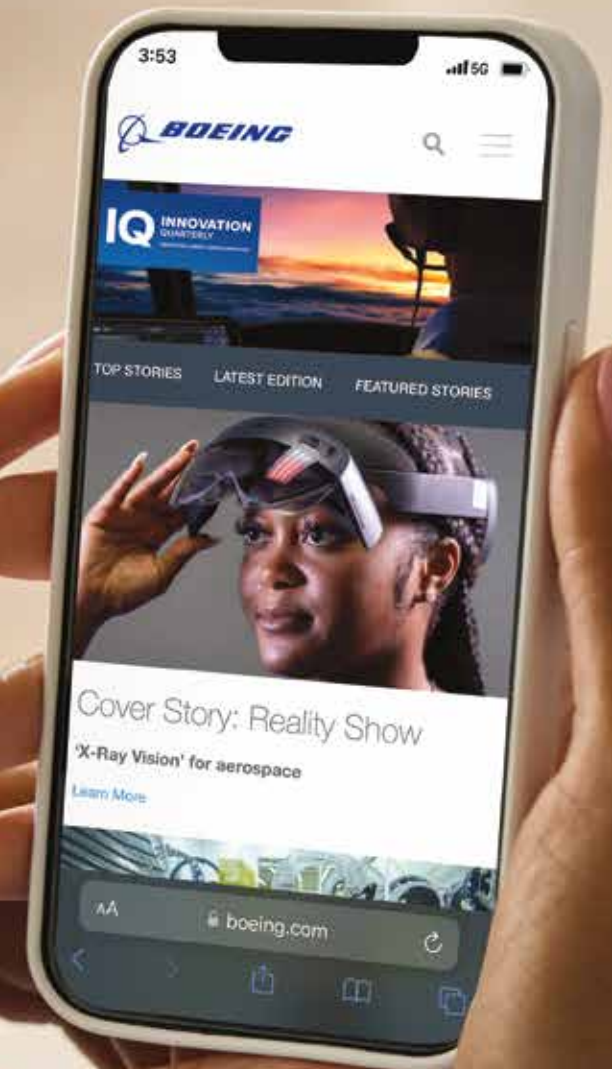
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PHOTO: INSTA_PHOTOS/GETTY

PASSION PRINT

Seeing endless tooling possibilities in additive manufacturing, Alexis Khalil's creations blur the lines between art and engineering.

PHOTO: KAITLIN STANSELL/BOEING

Engineer Finds Her Force for Innovation

Androids and cosplay ignite passion for 3D modeling that propels designer's fantastic career odyssey

BY KAITLIN STANSELL, BOEING WRITER

Alexis Khalil is wielding the force of 3D printing to create tooling solutions for the 787 program.

Galactic inspiration

The equipment and tooling engineer says her passion for additive manufacturing started with her love of the "Star Wars" film series.

"Growing up watching the movies, the details in the galaxy fascinated me," she said. "Androids in particular were so fun and an interesting addition to it all, to imagine a bunch of mechanical parts having personalities."



AFT APTITUDE

Boeing South Carolina engineers Alexis Khalil, Adekunle Samuel and Christopher Bleyer collaborate on tool design by getting close to the airplane structure in the 787 Aftbody factory. Hands-on learnings inform their 3D-modeling and 3D-printing solutions for greater tooling capabilities.

PHOTO: KAITLIN STANSELL/BOEING

Eager to make her own androids, Khalil realized she could apply the basic principles of 3D modeling and 3D printing to design detailed robots inspired by her favorite big-screen characters. Her passion for her projects intensified as she began to understand the tooling process and how to design with relational modeling.

Starting with a basic model, then advancing to more intricate designs, Khalil began showcasing her technical skills in her creations. Now she's exploring how to bring her robots to life through motion and expanding her interests to create body armor-type costumes.

FORCE TO RECKON WITH

Khalil works hard to play an armored soldier.

PHOTO: COURTESY OF ALEXIS KHALIL





Not child's play, but cosplay

"I learned how to scale 3D-model designs to fit to my body, manipulating design files to adapt character designs to my 3D-printing setup," Khalil said.

Now Khalil sports her costumes at cosplay events like MegaCon Orlando and Dragon Con, sharing her passion for pop culture and performance art with cosplay enthusiasts and welcoming the annual events as a collaboration venue.

"The cosplay world is a community of incredible artists, many of whom are practicing engineering whether they realize it or not," Khalil said.

"Meeting other cosplayers is a way to collaborate and learn new ways to push 3D-modeling software to be more artistic, or to use different features and materials in unconventional ways."

CREATIVE GIG

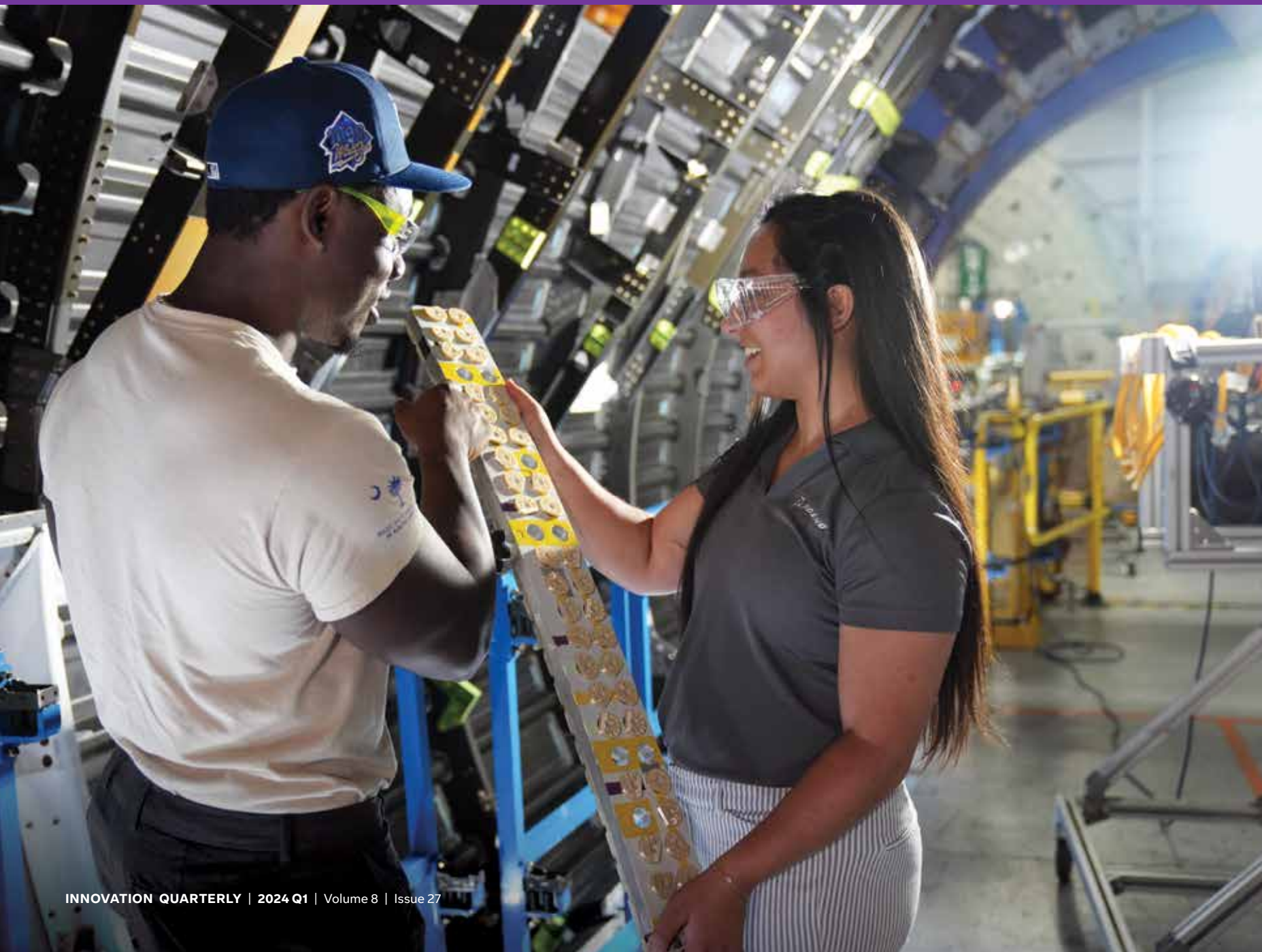
Using 3D printing, Khalil and her teammates create standard tools that have applications for other airplane programs. Above, Samuel and Khalil assess a drill jig plug, which fills specific holes in a drill jig that no longer require manual drilling, aiding first-pass quality.

PHOTO: KAITLIN STANSELL/BOEING

TOOL TEAM

Khalil joins forces with teammates like Samuel to support tooling needs using 3D printing.

PHOTO: KAITLIN STANSELL/BOEING



Creative forces at work

"I have endless excitement for the ability to have an idea in my head and then just make it a part of my reality," Khalil said. "Passion is a special type of magic when learning."

At a college networking event, Khalil met her future Boeing manager, who helped her realize that her affinity for 3D-printing androids could translate to a career in aerospace engineering.

"I showed him my portfolio, and after seeing my passion for 3D modeling and 3D printing, he suggested I would probably love tooling," Khalil said. "Spoiler, he was right."

Khalil supports the 787 Aftbody assembly and integration by creating new tools and addressing emergent needs on existing tools.

Using her 3D-modeling and 3D-printing skills, she helped design part of a drill jig that mechanics use to precisely drill dozens of holes around a passenger door in the aft section.

"My favorite part of the tooling process is the 3D modeling and manufacturing with 3D printing. It involves a lot of collaboration within engineering, with the Innovation Cells and with the mechanics," Khalil said. "And being creative makes for innovative solutions."

She enjoys every opportunity she has to help teammates sharpen their 3D-modeling and 3D-printing skills, and she's a willing mentor to interns and other team members at Boeing South Carolina.

She believes 3D printing can allow anyone to create practical solutions, solve complex problems and unleash their creativity. From fixing equipment to crafting intricate models, the possibilities — as Khalil sees them — are as vast as the galaxy itself. **IQ**

Novel Network

Field test proves readiness of new radio services

BY GLYNNIS RICHARD, BOEING WRITER

Connecting sites from Hawaii to Florida, Boeing's radio as a service (RaaS) successfully completed a field test with the U.S. Army, showcasing the capabilities of the extended network.

The 2023 field test was the first demonstration of the network's use for real-time monitoring of live fire training events.

"When a soldier made a successful shot on a target, a sensor from the acquired target sent a signal through the RaaS tactical mobile network to all the other sites simultaneously," said Bob Worsham, Boeing program manager for Command, Control, Computers, Communications, Cyber, Intelligence, Surveillance and Reconnaissance (C5ISR) Services.

RaaS provides deployable, secure 4G/5G, Wi-Fi and radio mesh networks, connecting service members during expeditionary operations and battlefield deployments and on both cyber and training ranges.

Military units can integrate the technology on existing radio assets and infrastructure.

During the field test, the network included an array of mesh radios, cellphones, SIM cards, vehicle kits, manpacks, and a private 4G LTE/5G extended network. Boeing also demonstrated the long-range capability by using satellite communications (SATCOM) integrated with RaaS.

"This extended network has the potential to greatly improve military readiness and battlefield command," said Eric Esposito, Boeing training specialist.

Boeing has plans to continue supporting the U.S. Army's training strategy for the Indo-Pacific region, where battlefield communications are particularly challenging across mountains, jungles and the Pacific Ocean. Expanding the RaaS network and extending SATCOM capabilities will provide new solutions for soldiers, sailors and airmen.



SATELLITE SYNERGY

Boeing teammates Hector Marin and Corey Holmstrom position a SATCOM terminal to connect the RaaS network to a Boeing training site in Florida.

PHOTO: BOEING



"This extended network has the potential to greatly improve military readiness and battlefield command."

ERIC ESPOSITO,
BOEING TRAINING SPECIALIST



ASSEMBLY REQUIRED

Marin and colleague Eric Esposito raise a mast assembly to outfit radios for the experiment, connecting field test sites in Hawaii and Florida.

PHOTO: BOEING





WONDERFUL WHIRL

After competing in the U.S. Air Force Marathon 10K, Devin Soffy watches an MH-139A Grey Wolf (right) and UH-1N Huey land at Wright-Patterson Air Force Base in Dayton, Ohio. Replacing the Huey, the Grey Wolf will patrol intercontinental ballistic missile fields and transport U.S. government officials and security forces.

PHOTO: ORLY SOFFY/BOEING



INSIDE IQ
Watch the
Grey Wolf land.

As the MH-139A begins production, Boeing Global Services is partnering with Leonardo to develop custom training devices and courseware for the U.S. Air Force. In 2023, the team delivered the cockpit procedural trainer to Malmstrom Air Force Base in Montana. Additionally, the Air Force will receive a full crew simulator, an integrated aircrew system trainer, and 3D-image-based courseware that will give the crew an inside look at the aircraft.

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