All Hands on Deck: Updates Up Front Appeal to the Senses

Flight deck innovations keep data within reach

BY QUEENA JONES, BOEING WRITER

When passengers board an airplane, they pass by the pilots' seats and marvel at the myriad levers, switches, knobs and glowing lights in the flight deck. Pilots walk into the flight deck and see their office for the day. And thanks to the Boeing Flight Deck team, it's a space in which pilots will feel increasingly at ease.

Here are five flight deck technologies in development for the 777X, Boeing's newest commercial airplane family member.

PILOT'S-EYE VIEW

A 777-9 simulator, also known as an engineering cab, is ideal for testing and training.

PHOTO: JIM ANDERSON/ DJ & COMPANY

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PED Mounts: Keeping Data at Pilots' Fingertips

PERFECT PLACEMENT
The mount in the center can accommodate many types of PEDs, which conveniently tuck into the recessed opening, as in this 777-9 rendering.

GRAPHIC: BOEING

Just a decade ago, pilots carried hefty notebooks of paper maps and charts and kept pertinent flight data on a clipboard in the flight deck window. Now, crew members keep this ever-changing information at their fingertips via a personal electronic device (PED).

Since pilots had begun to increasingly use PEDs for current information, airline customers asked Boeing to design a holder that would keep the device safely within reach of the pilot and in a stable position. Senior design engineers Brandon Boekelman and Chris Haus worked together to design a prototype that would fit the most commonly used devices.

The Flight Deck team worked with a diverse group of pilots, engineers and human factors specialists to gauge the usability of the design. They tested the location of the holder in the flight deck to make sure it wouldn't be in the way or be cumbersome to access, and they evaluated different designs, fabrication materials and mounting styles.

Then they asked the airline customers which styles best met their needs. Multiple airlines have embraced the usage of mounts, and Boeing now offers a variety of options.

"Listening to the customer is essential to ensure we deliver the right products," said Boekelman. "We work to understand what they want, then we figure out how to do it."

After 15 years with the Flight Deck team, Boekelman said working with so many different people to find new solutions keeps the design process interesting and rewarding. "We've figured out ways to make customers happy, and we've come up with functional, elegant designs."

BRANDON BOEKELMAN
Senior design engineer, Flight Deck

PHOTO: KATIE BOEKELMAN

CHRIS HAUS
Senior design engineer, Flight Deck

PHOTO: DEE DEE VASQUEZ

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Touch Screens: Cutting the Clutter and Making Way for Future Improvements

SCREEN TEST
Pilots can directly interact with electronic checklists with the touch of a finger.

PHOTO: JIM ANDERSON/ DJ & COMPANY

Boeing began working on introducing touch screens into the flight deck about 10 years ago.

While it's hard to believe in today's touch-screen world, they were initially deemed a fad that had no place in the flight deck. But soon, flight crews preferred the technology that mirrored how they were already using personal phones and other electronic devices.

"Touch screens are everywhere," said engineer Pamela Pulla, recalling that pilots would get frustrated with other displays if a screen did not respond to touch.

"Crews performed much better with the touch screens," said Pulla. "The old devices could respond only to bare fingers, but the touch screens respond if a pilot is wearing gloves or using a stylus."

They are also less likely to be damaged by accidental liquid spills.

Pulla believes touch screens are a steppingstone to future innovations to further reduce visual clutter, lessen the environmental footprint of the flight deck and improve crew efficiency.

TOUCH UP
Engineer Pamela Pulla interacts with a touch screen on a 777-9 simulator in Seattle.

PHOTO: JUSTICE OFOSU/BOEING

PAMELA PULLA
Engineer, Flight Crew Operations

PHOTO: STEPHANIE SU

FORE CAST

A PED hosts the Jeppesen FliteDeck Pro EFB application, which is cast onto the forward display.

PHOTO: JIM ANDERSON/ DJ & COMPANY

3 Crew Information Gateway: Gathering All Flight Data in One Place

Touch screens are integral to the Crew Information Gateway (CIG), which collects Electronic Flight Bag (EFB) data from a pilot's portable device onto the main flight deck displays, right in front of the pilot.

"The CIG helps the pilot see the EFB information together, and it really helps improve overall crew situation awareness," said human factors engineer Peter Batsakes.

He and teammates have been testing the integrated gateway for about two years and are continuing to improve its overall look and feel. Other engineers are working with software developers to create original software applications for aviation — for example, apps that suggest shorter routes and thus reduce fuel consumption.

Batsakes said the gateway minimizes a crew's actual handling of a separate electronic device and keeps all the information in front of them. All members of the flight crew see the same information on the forward display, and they can cross-check performance data easily.

In addition to the convenience of having all the information in a single display, the CIG offers safety benefits. Crew members don't need to move to see or access a second display, touch or handle another device, or risk dropping an unmounted PED.

PETER BATSAKES

Human factors engineer, Flight Crew Operations

PHOTO: JIM ANDERSON/ DJ & COMPANY

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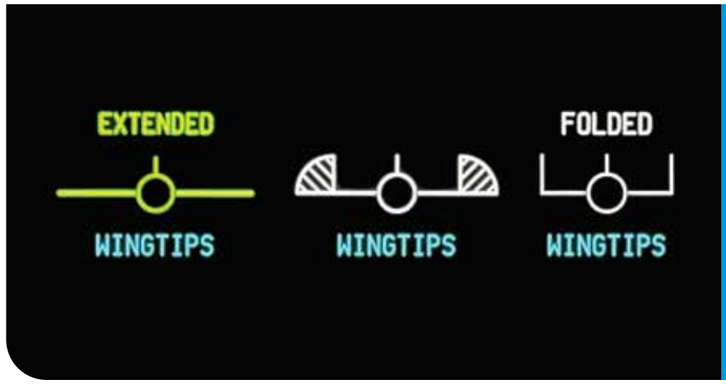
TIP SWITCH

Engineer Paul Burkhead shows the folding wingtip control. It is intentionally shaped like a wingtip to provide a visual cue.

PHOTO: SARA CHANEY/BOEING



ABOVE THE FOLD

Simple, clear indicators on the flight deck forward displays show the status of the wingtips: extended, in motion or folded.

Folding Wingtip Control: Indicating Position of Unique Design

The 777X is the first commercial airplane with folding wingtips. When extended, the wingtips increase the wingspan to further enhance aerodynamic efficiency, thereby reducing fuel use, emissions and engine thrust. After landing, the wingtips fold automatically so that the airplane can fit into the same gates as its predecessor, the 777-300ER (Extended Range), providing an operational advantage for customers.

During development, airlines requested that Boeing evaluate automating the wingtips to reduce crew workload. But pilots still needed the ability to control the wingtips in certain situations. Human factors engineer Paul Burkhead worked with dozens of test pilots, airline customers and regulators to understand standard flight procedures, asking questions to learn when and how pilots could most safely and efficiently operate the wingtips.

“We were open to every suggestion and eager to be creative,” Burkhead recalled. “As the only airplane manufacturer of a commercial airplane with folding wingtips, it was fascinating to begin with a blank slate.”

From the flight deck, crew members can’t see the wingtip position, and visual confirmation isn’t sufficient. An indicator is the only way to verify that wingtips are both extended and locked into position.

Burkhead and teammates created a first-of-its-kind control that is safe and easy to use. Test pilots asked for an indicator that signals when the wingtip is extended or folded. A color-coded display does just that and is visible to the pilot from the flight deck seat.

PAUL BURKHEAD

Human factors engineer, Flight Crew Operations

PHOTO: THE HIDDEN LENS PHOTOGRAPHY

PHOTO: JOEY JETTON/BOEING

5 Contemporary Pilots' Seats: Enhancing Safety, Comfort

Like passengers, pilots are required to wear seatbelts during taxi, takeoff and landing, but they must be able to reach every control and see every display in their forward field of view. A secure yet comfortable seat is a necessity.

Starting with a request for the 777X, senior design engineers Mark Wolf and Jonathan Knopp worked with supplier Ipeco to develop a better seat for pilots. Wolf and Knopp adapted a standard seat design to allow adjustments for lumbar support, seat tilt, side bolsters and thigh supports. With plush upholstery, the new seats have wider, extendible armrests and sculpted headrests that crew members can adjust vertically and horizontally.

"I don't recall any other seat design project having this much customer input," said Wolf, who has been with the Flight Deck team for most of his 33 years at Boeing. Having pilots in his family and working closely with customers and test pilots, Wolf has heard many requests for a softer seat cushion.

"Pilots spend an enormous amount of time in these seats," he said. "Anything we can do to make their experience more comfortable is worth the effort upfront."

The redesigned seats went through rigorous safety, quality and environmental testing, including 16 G-force (16 times the force of gravity) testing, which requires the seat to withstand significant lumbar loads without compressing the seat cushion. A cushion that is too soft will "bottom out," or cause the occupant to press upon the rigid seat structure underneath the cushion.

By layering the improved cushions instead, the new seat meets the stringent 16 G-force requirements and is about two times softer. The softer cushions relieve pressure on the tailbone, and the adjustable seats and extendible thigh pads alleviate discomfort in the upper back, hips and thighs. Additional lumbar support relieves lower back pain as well.

FRONT-ROW SEAT

Considering the hours crew members spend in them, flight deck seats are designed for maximum comfort and safety in the 777X.

PHOTO: IPECO

"Boeing listened to the customers' concerns and devoted great effort to incorporate everything the customers wanted," said Wolf, who reviewed the final design with customers.

Seat development and certification includes rigorous structural and occupant injury testing, environmental testing, life-cycle testing, multiple design reviews, ergonomic assessments and numerous flight tests.

"While we strive to meet all the schedule commitments, safety is always our No. 1 priority," Wolf said.

"Our methods are extremely robust, and that's how we prove the finished product will be reliable. It's essential for these designs to stand the test of time, because what we design today will be flying for decades to come."

JONATHAN KNOPP

Senior design engineer, Flight Deck

PHOTO: JONATHAN KNOPP/BOEING

MARK WOLF

Senior design engineer, Flight Deck

PHOTO: MARK WOLF/BOEING

GOT YOUR BACK

Engineer Jonathan Knopp leveraged his experience on the 777-300ER simulator (shown here) to help design the enhanced-comfort pilot's seat featured in the 777X.

PHOTO: STEVE SWEM/BOEING

Engineering Cabs: Bringing It All Together

As Boeing continually upgrades its airplanes, the team works regularly with pilots, regulators and airline customers to make sure each part of the flight deck looks and feels just right the moment pilots take their seat.

After months of development, testing and reconfiguration, all flight deck innovations and upgrades come together in an engineering cab, or e-cab, complete with all the flight controls, navigation instruments and display systems for each airplane.

These simulators are so realistic, they offer a dry run during development, in preparation for first flights and beyond.

Flight Deck vs. Cockpit: What's the Difference?

Engineer Justice Ofosu said it's simple: "You climb into a cockpit, whereas you walk into a flight deck." He added that a large commercial airplane has a flight deck, but a fighter jet has a cockpit.

And the flight deck itself is a Boeing original. In the 1930s, the XB-15 experimental bomber was the first airplane with a flight deck. A flight deck engineer joined the pilot and co-pilot in what was then called a "control cabin," later known as a flight deck.

BOEING HISTORICAL SERVICES

The Flight Deck team works with Boeing teams such as Avionics, Flight Controls and Safety, as well as customer pilots and regulators. It takes years to design, develop and plan each airplane's flight deck and customized e-cab.

Senior engineer Mark Henderson makes sure these next-level simulators can demonstrate standard and optional features of a Boeing airplane. He ensures that the e-cabs are ready to support system engineers, test pilots and human factors engineers as they assess all the prototype hardware elements and software systems that are under development.

E-cabs are used to evaluate and test new features, make design changes, prepare for flight tests and give an overall view of the flight deck without going on an airplane. The team determines if switches are too fragile or too rigid, if controls are too sensitive or too resistant, and if lights and indicators are bright enough.

They work through countless flight procedures and sequences to see how well the final designs will perform, allowing time for modifications and alterations before the airplane goes into production. After an airplane enters production, the e-cab is continually used for testing of new software updates, for development of new features and to support the airplane's production.

Justice Ofosu is one engineer who will never forget his first experience in an e-cab with Henderson. When Ofosu joined the Flight Deck team in 2021, he was fascinated by the e-cab's realism.

"Not only are the physical aspects of the e-cab realistic, the software systems actually simulate the sensations of flight," he said.

When asked how the e-cab systems rival movement, Henderson said, "It's all up here, in your mind." The user feels the e-cab turning, responding to airspeeds or other air commodities, but it's stationary; it's all a cognitive response.

As he's worked on e-cabs since 2013, Henderson appreciates how important they are to the airplane programs.

"The pilots practice different maneuvers in the e-cabs, and the system actually emulates the response of the systems to the pilots' input in a hard turn, for example," Henderson explained. "This realistic environment allows pilots to evaluate all the flight deck hardware and software before taking an actual test flight."

TESTING FOR TAKEOFF

Boeing engineers Brandon Boekelman (left) and Chris Haus are shown in a 777-9 simulator. E-cabs are identical to an actual airplane flight deck.

PHOTO: JIM ANDERSON/ DJ & COMPANY

After a year with the Flight Deck team, Ofosu is still impressed by the engineering expertise of his peers and the way they work through design challenges.

"I ask lots of questions to understand an issue, then I lean on my teammates to bounce around ideas and evaluate possible solutions," said Ofosu. "I'm constantly amazed by this team, at how they navigate issues and how they work. I know I can learn something from everyone."

The collaborative process pays off when the teams of engineers assimilate the various airplane systems into the e-cabs, which are large enough for about a dozen people to gather around at one time. A test director, aero stability and control expert, two test pilots and multiple flight test engineers can use the e-cabs to verify and validate the flight deck design and to rehearse for flight tests. **IQ**

Quick Turn: Engineer Origin Story

Thirty-three years ago, senior design engineer Mark Wolf took his last finals at Washington State University on a Friday afternoon. That same evening, he drove 75 miles (120 kilometers) from Pullman to Spokane.

After a cold night sleeping in his car, he took the Engineer in Training test the next morning. He passed. "Boeing asked if I could start on Monday," he said. "And I've been here ever since."

MARK HENDERSON

Senior engineer, Flight Crew Operations

PHOTO: JUSTICE OFOSU/BOEING

JUSTICE OFOSU

Engineer, Flight Deck Design

PHOTO: CYRUS MAJD/BOEING