Tech That Connects

CTO explains how technologies enhance air travel and advance aerospace innovation

Across product design, development, delivery and sustainment, technology drives aerospace innovation.

Chief Technology Officer Todd Citron shares the strategies and priorities behind the big ideas at Boeing, and why each is important for the future.

TALKING TECH

Boeing Chief Technology Officer Todd Citron leads Boeing's research efforts around the world.

PHOTO: BOEING

IQ&A

IQ | What are the greatest technical challenges facing the aerospace industry?

TC | Challenges are really opportunities, and it's exciting to be in a period where there are so many opportunities.

The current industry environment is reflected in Boeing's technology focus areas: sustainable, producible, autonomous and digital. All are essential to address current industry needs — such as the rapid resurgence in air travel following the pandemic — with safe, high-quality products and services.

Regarding sustainability, we're evolving technologies to help the industry achieve net-zero carbon emissions by 2050:

- First, we're driving more efficient operations. One example of this is our work demonstrating trajectory-based operations for aircraft routing, which will decrease emissions by about 10% and increase airport capacity.
- Second, we're developing alternatives in renewable energy. Boeing airplanes will be compatible with 100% sustainable aviation fuel by 2030. Unblended, or "neat," SAF, which is totally free of fossil fuels, can reduce life cycle carbon emissions up to 84% when compared to conventional jet fuel and offers the industry's largest potential to reduce carbon emissions over the next 30 years in all aviation segments. While we're helping to improve the SAF supply, we're also studying a range of alternate energy technologies, including hydrogen, for the longer term.
- And third, we're maturing technologies that improve efficiency and reduce waste. The most visible is the X-66 Sustainable Flight Demonstrator. Its extra-long, thin wings show promise of improving aerodynamic efficiency. When combined with expected improvements in propulsion, structures and systems, we believe the transonic truss-braced wing configuration could reduce emissions by up to 30% compared with today's best-in-class aircraft.

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ELECTRIC EVALUATION
At Wisk, leaders Brian Yutko, left, and Jim Tighe, right, discuss the airframe of Wisk's 6th Generation air taxi with Boeing engineering director Ramy Mourad and Citron. Before flight testing and production, engineering teams evaluate the structure components and materials for safety and quality.

PHOTO: WISK

IQ | What about the other technology focus areas?

TC | We're advancing producibility by employing autonomy in our factories. For example, cameras and robotics automate manufacturing inspections and yield more consistent results. Teams use technology to analyze manufacturing data, while machine learning analyzes data from fabrication tools. These technologies spot degradation much earlier, resulting in tighter manufacturing tolerances that enhance safety and quality.

Globally, we're developing material and automation technologies to improve production quality and increase rate production.

Underpinning it all, model-based engineering is enabling rapid iteration and enhancing engineering quality on multiple platforms, including the MQ-25 Stingray and the T-7A Red Hawk advanced trainer.

And we're on the verge of safe, certified autonomous flight with Wisk, a Boeing subsidiary in Mountain View, California. Numerous technologies are driving the design of the vehicle, known as an electric vertical takeoff and landing air taxi.

URBAN SKY

Wisk teams simulate how eVTOL vehicle operators manage air taxi traffic in large metropolitan areas.

PHOTO: WISK

IQ&A

IQ | How does Boeing determine its technical priorities?

TC | Technology only adds value when there's a need. We must determine the probability any technology will transition to a product, service or business operation.

First, we objectively define the need. For example, "advanced structures" have no defined use, but structural technology that improves strength to weight by 50% is a well-defined need.

Next, we identify the date by which the need must be satisfied. After that, we assign the technology need to a specific product.

By defining the business need, the timeline requirements and the transition product, we can create an executable plan to satisfy the need. We use this structure to prioritize technology projects based on the timing of the need dates and the ranking of the need in the overall business strategy.

IQ | How do technological advances affect safety?

TC | Technology helps improve safety and quality in many ways, but one example is the use of digital twins in product development and testing.

Digital twins allow software developers, engineers and production teams to work on the digital design at the same time, reducing findings when testing the physical product. And digital twins allow us to simulate test conditions that would be unsafe to test with an actual aircraft. The outcomes are safer test programs and safer products.

In production, technology can automate strenuous or repetitive tasks and further enhance producibility, helping mechanics and quality professionals build, monitor and inspect the work more safely and efficiently.

For example, full-size determinant assembly eliminates the drilling of thousands of holes in final assembly and reduces the physical impact on mechanics. Exoskeleton vests support mechanics' shoulders and arms as they work overhead, alleviating fatigue. And robotics will reduce the need for humans to enter confined spaces, diminishing risk.

MAN AND MACHINE

Boeing developed the MQ-25 Stingray, the U.S. Navy's first carrier-based unmanned aerial refueler, with digital engineering. Early testing paved the way for successful demonstrations of the aircraft's deck handling capabilities aboard the aircraft carrier USS *George H.W. Bush* (CVN 77) in 2021.

PHOTO: BOEING

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IQ&A

IQ **How does Boeing Research & Technology build on Boeing's best-known technological achievements of the past 100 years?**

TC Boeing holds an unparalleled legacy of engineering firsts, and we keep building on those innovations to continually advance aerospace technologies.

In 1948, six Boeing engineers developed a B-52 concept that was so durable and flexible the aircraft is still in service today. The aircraft plays a pivotal role in the U.S. Air Force bomber fleet and is undergoing multiple modernization efforts that will provide it with new engines and radar to keep it viable and flying until 2050 and beyond.

As prime contractor for the International Space Station, Boeing teams have worked closely with NASA since 1993 to construct, then assemble the ISS on orbit. Boeing is integral in operating, maintaining and sustaining the orbiting laboratory, and those efforts are informing the next generation of low Earth orbit destinations.

And with the introduction of the Boeing 707, the world entered the Jet Age. Faster and more efficient than propeller-driven aircraft, jet-engine airplanes revolutionized aviation. Boeing then introduced the 747, which made global travel possible for people around the world.

Successive generations introduced technologies to enable extended operations and improve airplane efficiency. For example, the first primarily composite commercial airplane, the 787 Dreamliner, makes travel economically viable between more city pairs.

It's important to understand the system you are working on, down to the last detail, and to know how your work fits into the overall project.

You can't just follow the steps in a process. You must understand the "why," so if circumstances change, you're still able to achieve the objective.

A healthy paranoia about what can go wrong will drive you to work to prevent errors.

NEVER BORING

In 1969, Boeing began to test the first Boeing-built composite component, the boron composite wing foreflap, on a 707-320 Intercontinental. Flight testing confirmed the in-service reliability of the new high-strength, low-weight, structural material, which was fabricated from boron filaments. Design engineers said the boron foreflap was 25% lighter than an aluminum foreflap.

PHOTO: BOEING ARCHIVES

IQ **As an engineer and now Chief Technology Officer, what is the best career advice you've ever received?**

TC "Focus on excelling at the job at hand, and your career will manage itself." For me, it's all about technical excellence.

I was fortunate to have Dr. Harold Rosen, co-inventor of the geosynchronous communications satellite, as one of my mentors. He instilled in me that to achieve technical excellence, one needs an intuitive understanding of the work. Otherwise, how do you know your answer is correct?

It's important to understand the system you are working on, down to the last detail, and to know how your work fits into the overall project. You can't just follow the steps in a process. You must understand the "why," so if circumstances change, you're still able to achieve the objective. A healthy paranoia about what can go wrong will drive you to work to prevent errors.

Lastly, it's critical to understand the data coming off the system you're working on. To know the system is working properly, you need to be able to predict what you're seeing down to the last blip in the data.

It's a high bar, but that's what technical excellence requires. **IQ**