The 787 Dreamliner Difference

Technical Fellows calculate the contributions of composites

BY KAITLIN STANSELL, BOEING WRITER

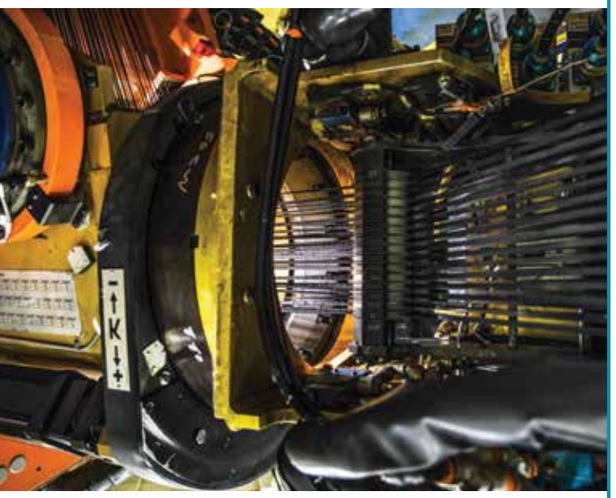
Twenty years ago, Boeing engineers predicted the use of composite materials in the design of the 787 Dreamliner would improve efficiency, durability, and even passenger comfort. Seeing the results after more than a decade in service, Boeing Technical Fellows count the promises made as promises kept.

SPOOLS OF INNOVATION
Boeing Technical Fellow Karin Anderson looks into the carbon fiber tape dispensing system of an automated fiber placement machine at Boeing South Carolina.
PHOTO: KAITLIN STANSELL/BOEING

FIBER FEEDER

Carbon fiber tape feeds through an automated fiber placement machine to layup precise patterns and layers around the circumference of the 787 aftbody fuselage section.

PHOTO: JOSHUA DRAKE/BOEING



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> **PATRICK ENJUTO,**
> **BOEING TECHNICAL FELLOW**

Dreamliner by design

Boeing’s introduction of the 787 Dreamliner in 2004 signaled a significant departure from traditional commercial airplane manufacturing. With an airframe comprised of 50% carbon fiber reinforced plastic and other composites, the 787 entered history as the Boeing commercial airplane with the most extensive use of composite materials. Designers believed composites would offer numerous advantages over conventional aluminum designs, and they have since proven the advantages of composites are real.

“We have learned that composite structures can result in an unprecedented combination of efficient and robust structure design,” said Boeing Technical Fellow Patrick Enjuto. “Some of our earlier 787s are currently undergoing their first major maintenance inspections with excellent results. Operators are going in all the way to the bones of the airframe to get an extensive look at how the airplane is performing in service.”

Extensive testing has proven the durability of the Dreamliner’s composite airframe, Enjuto said. To date, about 700 in-service airplanes have undergone routine maintenance checks, revealing zero evidence of composite airframe fatigue.

On average, each 787 operates about 600 flights per year.

Thanks to the material properties of composites and their use on the 787 fuselage structure, passengers enjoy the view from the largest windows available for commercial jets. Beyond the open-cabin aesthetic, Enjuto said composite materials offer more options in cabin design, contributing to lower cabin altitude pressurization and increased cabin humidity.

According to 787 Chief Engineer John Murphy, composite materials reduce airplane weight and provide aerodynamic benefits, contributing to the 787 Dreamliner being up to 25% more fuel-efficient than previous-generation airplanes. Since entering service in 2011, the 787 has avoided more than 170 billion pounds (77 billion kilograms) of carbon emissions.

BREAKING THE MOLD

Composite materials are more shapable and flexible than most metals, enabling engineers to design airplane wings that are as beautiful as they are efficient.

PHOTO: BOEING

787
The first decade by the numbers

Opened more than **410** new nonstop routes

Flew nearly half of the **15** longest routes in operation today

Made more than **4.4M** flights

Served over **900M** passengers

SOUND STRUCTURES

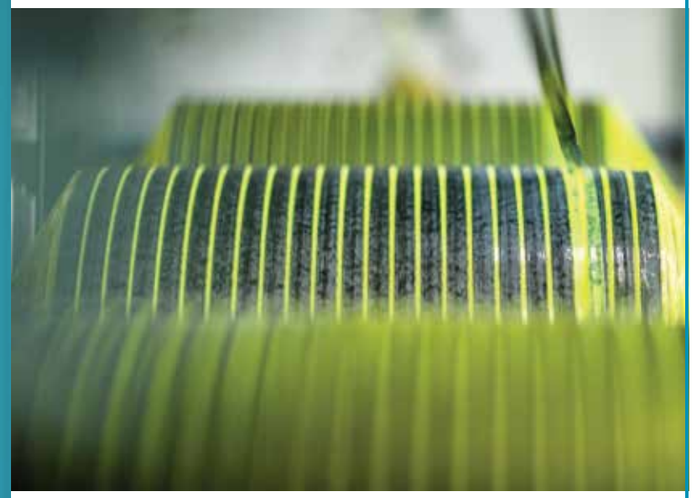
Boeing Technical Fellow Patrick Enjuto specializes in damage tolerance and advanced structural analysis methods for composite airplane structures. His work continues to inform innovations for the 787 Dreamliner, including advancements that will provide even more capability for 787 operators.

PHOTO: MARIAN LOCKHART/BOEING

FREEZER TO FLIGHT

Spools of carbon fiber material that will construct the aftbody sections of the 787 Dreamliner fuselage remain in a freezer until ready to use.

PHOTO: JOSHUA DRAKE/BOEING



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End-design in mind

Composites have transformed airplane design, offering several advantages over traditional materials:

- **High strength-to-weight ratio**
  Composites are often stronger than steel yet lighter than aluminum, making them ideal for airplane construction.
- **Corrosion resistance**
  Unlike metals, composites do not corrode, enhancing durability, especially in harsh environments.
- **Fatigue resistance**
  Composites can endure cyclic stresses without degradation, improving the life span of the airplane.
- **Design flexibility**
  Composites can be molded into complex shapes, allowing for more innovative and efficient structures.

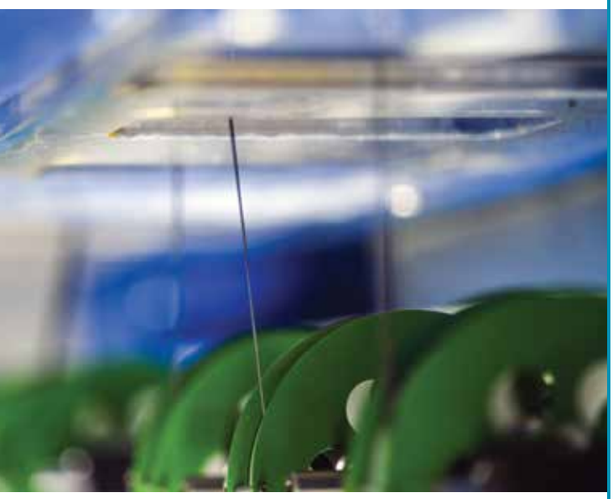
“One of the disadvantages to metals is they cannot be formed easily. Composites allow design engineers to take a more artistic, inspired-by-nature approach. You can soften the wing to look more like a bird’s wing for example, improving performance with a more aerodynamic and even elegant design,” said Boeing Technical Fellow Karin Anderson.

Boeing’s pioneering use of composites in the 787 Dreamliner set a precedent that continues to influence future products, most notably the 777X, which features an extraordinary composite wing design.

FINE-TUNED FORMS

Carbon fiber tape that is used in the production of the 787 Dreamliner fuselage is approximately the thickness of two strands of hair.

PHOTO: JOSHUA DRAKE/BOEING



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Flying forward

“The 787 Dreamliner has proven composite materials are durable, strong and efficient,” said Enjuto. “There will still be a place for metals in airplane structures, but composites are here to stay. Future developments will show more benefits in manufacturing processes, fuel efficiency and structural design advancements.”

The 787 has demonstrated the efficiency and quality of several advanced manufacturing techniques, including the use of automated fiber placement machines in fabricating fuselage sections. But there’s still more to learn to optimize producibility of composite parts.

“With a clear engineering focus on improving producibility, we’re documenting our best design practices to capture the lessons learned and understand the reasons for the approaches taken for using composites on the 787, the 777X wing and other products,” Anderson said.

“Additionally, there is a lot of work being done to improve Boeing’s analysis tools, including investments in smart testing, artificial intelligence and machine learning. We want to refine requirements for Boeing’s future products, and we know composites will be part of that future.” **IQ**

INSIDE IQ
Watch a machine layer carbon fiber tape to build the aftbody sections of the 787 Dreamliner fuselage.

IQR

MEASURE IN MILES

If the carbon fibers used in the 787 Dreamliner were stretched across the United States, they would span about 2,200 miles (3,540 kilometers) — from North Charleston, South Carolina, to Los Angeles.

PHOTO: JOSHUA DRAKE/BOEING