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FINANCIAL TRENDS IN COMMERCIAL AVIATION

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Passing the Value Test The Boeing Technology Advantage

Technological advances are always exciting to aviation enthusiasts. Yet new technology is not an end in itself at Boeing. “Ultimately, our goal is not to develop new technologies,” said Walt Gillette, retiring vice president of Airplane Development for the 787 program. “Our goal is to use technological advancements to develop new sources of value for our customers, financiers, and the passengers.”

The real value of technology springs from the innovative application of the latest advances to create new ways for airlines to earn revenue and conduct business, and to help passengers rediscover the joy of flight. Such innovation may show up as new airplane capabilities and features, or it may take the form of better ways to produce the airplane in the factory. Both types of innovation focus on reducing the cost of owning and operating the Boeing 787 Dreamliner.



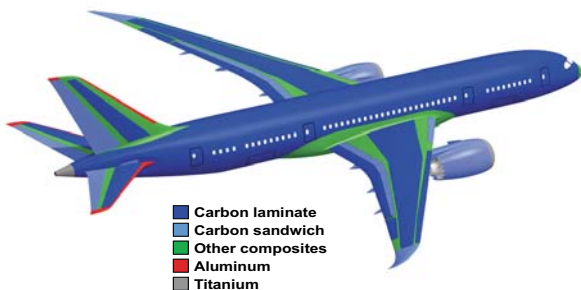
Walt Gillette in front of the composite fuselage barrel

Technology builds value aboard the airplane

The Dreamliner introduces major advances in four areas of airplane design: use of composite materials for primary aircraft structure, replacing pneumatics with electrically powered systems, increased commonality and interchangeability through open systems architecture, and enhanced aerodynamics.

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Composites Serve as Primary Structural Material



Airplane Value Provides a Firm Foundation for Financing

By Walt Skowronski

Aircraft financiers are increasingly basing airplane financing decisions on the long-term value of the airplane asset as opposed to the credit of airline operators. A commercial jetliner is one of the most mobile assets in the world. It can fly to any point on Earth where demand is strong and market values are high. The long economic service life of a commercial airplane gives aircraft financiers and investors the flexibility to address cyclical market challenges over time.

The recent ratification of the Cape Town Treaty demonstrates the global desire to enhance the financing infrastructure to better protect airplane value and liquidity. The Treaty formalizes and improves financier rights to the value of a financed airplane, bringing airplane assets in line with international custom and agreement on other types of real assets.

The resulting confidence in the ability to use the airplane’s value as security for a loan gives financiers greater flexibility to develop innovative financial arrangements. This, in turn, removes political and economic obstacles that have traditionally made it difficult for some airlines to qualify for favorable financing.

The Boeing product strategy reinforces the notion of airplanes as assets. Long-lasting composite structure, increased component standardization, engine interchangeability, flexible interior designs, and open systems architecture—aggressively developed by Boeing—all directly enhance the liquidity and asset value of Boeing airplane products.



Walter E. Skowronski, President Boeing Capital Corporation

Boeing technology leadership and innovation reduces ownership costs, cuts the cost of transitioning airplanes between customers and regions, and keeps residual values strong by ensuring operational flexibility with low operational and maintenance costs. The Boeing focus on designing, producing, and supporting airplanes that meet airline operational requirements—and on delivering superior asset performance and liquidity—allows Boeing customers and partners to count on airplane products and services with the highest value and the lowest risk. This is one area where Boeing Capital Corporation is leading innovation in financing infrastructure to gain the full benefit of Boeing’s technological developments. ■

Composite Materials: Unlike any other commercial airplane, 50% (by weight) of the Dreamliner's structure is made of advanced carbon composite materials. Carbon composites are strong, yet lightweight. They are resistant to the fatigue that eventually causes metal structure to weaken and crack. And 30 years of aerospace use shows that carbon composites are immune to corrosion.

The 787 uses composites where the material's superior damage resistance provides everyday operational benefits, simplifying service and maintenance and eliminating inspection requirements. This makes the Dreamliner more valuable to airlines because it costs less to operate and is available for more hours of revenue service.

More-electric Systems: Recent advances in electric motor technology provide another opportunity to create value. In the 787, most onboard mechanical systems are powered by electric motors. Conventional airplanes rely on bulky and complex pneumatic systems, powered by hot, high-pressure air diverted from the airplane's engines.

Pneumatic systems on conventional airplanes require a complex system of manifolds, valves, and ducts to power secondary systems located throughout the airplane. These systems require constant monitoring and frequent maintenance.

On the other hand, the Dreamliner uses wires with simple plugs and sockets to distribute electrical power from generators to electric motors that are compact, efficient, and reliable. These electrical systems are monitored automatically by the airplane's central maintenance computer.

As an added bonus, going to more electric systems will actually allow the Dreamliner's engines to produce thrust more efficiently. Pneumatic systems that divert high-speed air from the engines rob conventional airplanes of some of their thrust and increase the engine's fuel consumption.

On the Dreamliner, all the high-speed air produced by the engines goes to thrust. So, more of the airplane's fuel goes to flying and less goes to heating the coffee, keeping the cabin comfortable, and all the other things that electricity does more efficiently than pressurized air. And, because electrical systems are inherently easier to service, upgrade, and relocate, owners and leasing companies can quickly reconfigure an airplane for a new owner or operator.

Open System Architecture: The way onboard systems are installed to interact with each other is yet another major area where innovative use of technology creates value on the 787.

Traditionally, systems manufacturers and suppliers customized their products for each airplane type. Boeing and its partners have adopted an "open" systems architecture for the 787, based on industry-wide standards. This will make it easier for manufacturers to upgrade information systems, such as radios and displays on the flight deck, and even entertainment systems in the passenger cabin. Airplane owners will be able to simply plug in a new component and installation software will integrate the new equipment with the airplane's central computer system. This is also a boon to an airplane owner preparing

to sell or lease an airplane to another operator.

Aerodynamics: New computer design tools and analytical software allowed engineers to refine the airplane's shape to get the most aerodynamic advantage from the extremely smooth surfaces and graceful curves that composite materials make possible. Boeing has also worked with engine manufacturers to make sure the airplane's wing and aerodynamics gain maximum benefit from new engine technologies and capabilities.

Technology transforms the production floor

To build a 50% composite airplane required a breakthrough in production technology. High-volume composite production is easy for small, simple items. Low-volume production of large, more complex parts has also been mastered. Something new was required to meet the production rates necessary to support a very popular commercial airplane.

Boeing brought together an international team of composite manufacturers to tackle the problem. The team developed tools that allow large sections of the fuselage barrel to be built as a single piece. Robotic tools apply layers of epoxy-impregnated carbon fiber fabric over precisely configured forms to build up the precise thickness required for the airplane's skin.

The cylindrical section is then baked under pressure to create the finished fuselage section, ready for the installation of wiring, systems, and interior provisions. Fully assembled fuselage sections will then be joined in final assembly.

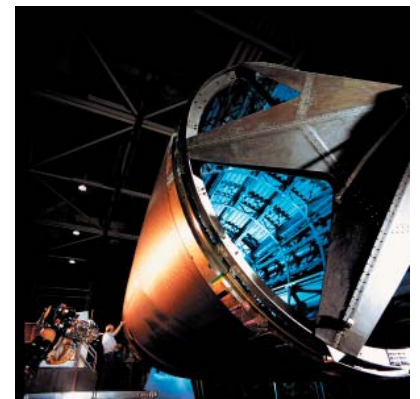
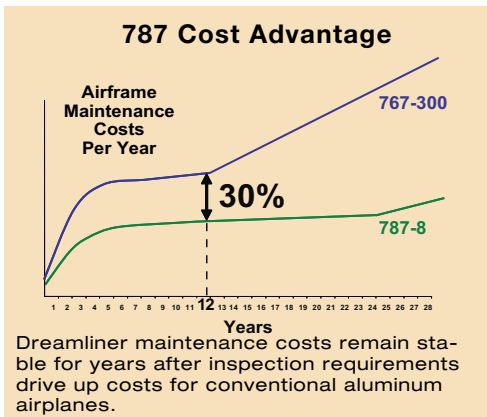
Breakthroughs such as these are helping Boeing shrink production times dramatically. Shorter production times reduce the time lag between airplane order and airplane delivery. This, in turn, can help acquisition planners match fleet requirements more precisely and forecast finance and interest costs more confidently.

Summary: At Boeing, technology is serious business. The technologies that earned their way aboard the Dreamliner and onto the factory floor have passed the value test. Every one of them will contribute to the Dreamliner's performance and capabilities, to the owner's balance sheet, and to the passenger's enjoyment of flight. ■

Walt Gillette, vice president 787 Program Development, announced his retirement, effective July 31, 2006, after 39 years of service to Boeing and the commercial aviation industry. Scott Strode, currently vice president of Airplane Production, will succeed Gillette.

Dreamliner Technologies Provide Value to New Airplane Programs

The GENX engine core, developed for the Dreamliner's advanced engines, will be shared by the new 747-8. The Dreamliner's highly efficient wing inspired the improved aerodynamics and greater fuel capacity of the 747-8 wing. The 747-8 flight deck and passenger cabin also benefit from Dreamliner technologies. While the 747-8 SkyLoft is unique in commercial aviation, wireless technology developed for the Dreamliner will give airlines the option to outfit the large space above the main passenger deck as a high-tech business center, with wireless computer and communications stations—or to create a passenger lounge with wireless multimedia entertainment. ■



A robotic mandrel makes possible the high-volume production of composite aircraft structure.

Technology Redefines Joy of Flight

Revolutionize flight—That is the lofty goal that the Dreamliner design team set at the beginning of the 787 development process. The team studied commercial flight from every viewpoint to identify how an airplane could strengthen the aviation business and help the world rediscover the joy of flight.

For the first time in history, the financial community was invited to help airplane designers address the value of the airplane as an asset. This teamwork kept financier value at the forefront during design. The result is a highly innovative design that makes the 787 a solid long-term investment. Among the innovations are some revolutionary changes in the airplane interior.

Breathe Easy on Long-Distance Flights Improving passenger comfort enhances market demand

Ever feel dried out at the end of a long airplane flight? One reason is that the air conditioning system aboard conventional airplanes gradually replaces cabin air with the much drier air from the high-altitude atmosphere outside. The cabin atmosphere, which starts out with the same humidity as the city where you boarded, becomes increasingly dry as the flight progresses.

In aluminum airplanes, cabin humidity is kept low intentionally, in order to prevent condensation on the airplane's interior surfaces. Condensed moisture can build up in insulation materials and eventually contribute to corrosion of the airplane's metal structure.

The Dreamliner's composite structure does not corrode when exposed to moisture. What's more, the Dreamliner's insulation is designed to resist the buildup of moisture. This allowed Dreamliner engineers to design an air conditioning system that retains a comfortable

level of humidity throughout the flight.

But Boeing studies revealed that humidity is only part of the key to feeling good after a long flight. Volunteers in one study spent 10 to 15 hours sitting in a simulated airplane environment, just to pinpoint the real source of the itchy eyes and dry sinuses that passengers often report.

The studies found that gases and vapors coming from objects and materials around us—as well as from clothing and our fellow passengers—are the main culprits in causing that dried-out feeling. So, the Boeing 787 adds air purification to the airplane's environmental control system, which already filters out microscopic particles and even viruses. Removing irritating vapors is a big advance in promoting passenger comfort.

The Dreamliner's composite structure contributes in yet another way to a comfortable cabin atmosphere—a richer mixture of oxygen in the air at cruise altitude.

While cruising at an altitude of 30,000 or 40,000 feet, the air in a conventional airplane cabin is pressurized to the equivalent of an 8,000-foot mountain peak. Over many years of repeated pressurizations, the structure of an aluminum airplane becomes fatigued.

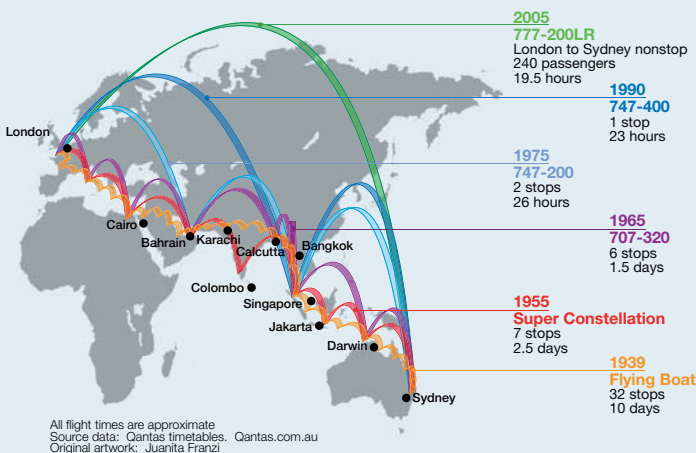
Composites do not suffer fatigue from this repeated stress. Consequently, the Dreamliner can be pressurized to the equivalent of 6,000 feet of altitude—more reminiscent of an elegant resort than a lofty mountain spire.

Passenger preference for the Dreamliner's improved comfort will give operators a competitive advantage that can only bolster the already extraordinary demand for the 787. The airplane's value as an asset can only be enhanced by such enthusiastic airline and passenger acceptance.

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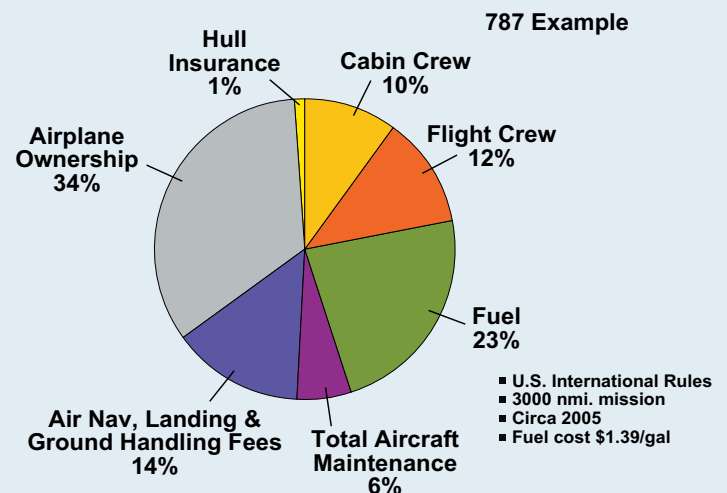
Industry Reference Points

Evolution of Point-to-Point Flight – Technology Made it Possible



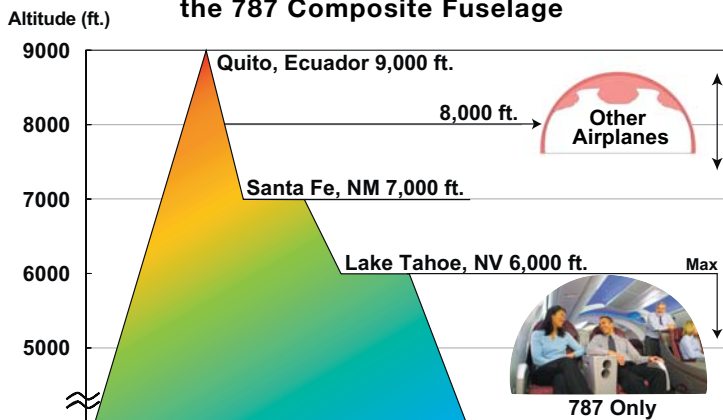
The reliability of jet aircraft allowed airlines to offer nonstop flights between distant city pairs. The 747 was the first jetliner large enough to carry the fuel needed for the longest nonstop flights. The 777 introduced twinjet economics to very long distance flight, allowing airlines to increase nonstop frequencies and serve smaller point-to-point markets.

Source of the Cost of a Flight



Building on the success of the Boeing 777 family, the 787 Dreamliner makes it economical for airlines to increase nonstop service in existing markets and to create new point-to-point markets where larger airplanes would not be profitable. In addition to reducing fuel consumption, maintenance costs, and weight-related airport fees, which together account for 43% of the cost of a 787 flight, the Dreamliner design team engaged the financial community to reduce ownership costs, traditionally the largest segment of the cost of a flight.

Comfortable Cabin Pressure Made Possible by the 787 Composite Fuselage



Cabin pressure in today's intercontinental airplanes is equivalent to what you would find on an 8,000-foot mountain peak. That's about 1,000 feet higher than the city of Santa Fe, New Mexico, in the United States, and about 1,000 feet shy of the altitude of Quito, Ecuador. Alpinists may find this altitude exhilarating. Most people, however, find greater comfort with the oxygen mix at 6,000 feet—about the same as a vacation resort, such as Nevada's Lake Tahoe in the United States or Switzerland's St. Moritz.

Passenger-Friendly Features

The Dreamliner focuses on improving passenger experience

It may seem like a paradox, but sometimes reducing the number of choices can actually increase flexibility. As a case in point, airlines have traditionally been faced with a bewildering number of choices when they configure an airplane.

If you have ever wondered whether to push or pull the latch on an overhead stowage bin, you have encountered one of these choices that the airline must make.

The Dreamliner design team analyzed the passenger cabin from one end to the other to identify the places where airline choices add confusion to passengers rather than value to the airline. Places like these, where passengers actually touch the airplane with their hands, were designated "passenger touch points." The team then developed standards to ensure that airline choices of interior features do not become sources of confusion that distract passengers from enjoyment of the flight.

Consequently, when you reach your seat on the Dreamliner, you won't have to puzzle out whether the latch on the stowage bin pushes or pulls—or whether it works from the right or left, top or bottom. Just go with your intuition. Your every choice is the correct one.

Once in your seat, you'll notice the large windows, even if you are seated on the aisle. A touch point below the window allows you to control how much light shines through. At your command, the window darkens electronically, allowing you to choose the most comfortable of five settings. The world outside remains visible to those who enjoy the view, yet the light doesn't disturb passengers who wish to watch movies or sleep. And, to ensure that the lighting level is appropriate for the activity in the cabin, flight attendants can control window tint for the whole airplane from a central panel.

Later in the flight, you won't need a telescope to see if the little panel above the lavatory reads occupied or available. Illuminated accent trim, visible from every seat and complementary to the cabin

décor, glows green or red, to let you know which lavatory is free.

Upon approach to the lavatory door, you will have no difficulty figuring out how to get in—or out. Just turn the knob as you would on any door and the door will pivot open and slide out of the way. Closing the door is similarly intuitive.

Design standards like these help passengers enjoy the flight experience. But just as importantly, standards make many interior components interchangeable.

Interchangeability is a big economic advantage for commercial jetliner owners and operators. The Dreamliner is designed to carry passengers for at least 30 years. During that period, interior styles will likely change several times. Seats, lavatories, galleys—and especially in-flight entertainment systems—will be upgraded or replaced several times as well. When an airplane is sold or leased, the new operator will want to redo the cabin in the colors and patterns of the airline's brand identity.

The Dreamliner design team worked with cabin component suppliers to develop standard mounts and interfaces that will make such modifications quick and economical. As a result, airplane owners can expect higher lease and resale values throughout the 787 Dreamliner's life cycle, and will find a larger pool of potential lessors and purchasers when the time comes to transfer the airplane to another owner or operator. ■

Noteworthy Developments



Cape Town Update

- Angola becomes the 10th country to ratify the treaty.

Boeing Customer Experience Center

Customer Experience Center Grand Opening on March 16, 2006

The customer viewpoint is the entire focus of the Customer Experience Center.

- Airplane interior mockups showcase product advancements that create value.
- Life-cycle business solutions are highlighted in the Customer Solutions Studio.
- State-of-the-art conference rooms provide teleconference and virtual meeting capability.

Boeing Delivers Final 717s on May 23, 2006:

- Concludes Boeing commercial airplane production in California.

Boeing Appraisers Conference Held on June 20-21 in Seattle

- More than 20 aviation industry appraisers attend the conference, which addresses Boeing technology leadership, market and product updates, maintenance programs, and Boeing's commercial product strategies.

Boeing Program Update:

737-900ER:

- 1st 737-900ER rolls out of factory on June 9 for delivery to Lion Air, Indonesia.
- Announced orders and commitments from GECAS, Sky Airlines, SpiceJet and Lion Air.

747-8:

- Boeing concludes first round of wind-tunnel tests for the 747-8 family.
- GE-Aviation finalizes the architectural design of its GENx engine that will power Boeing's 747-8. The engine will now enter the detailed design phase.

787:

- Fabrication begins for the wing center section at Fuji Heavy Industries (FHI) and Korean Aerospace to support first major assembly, scheduled for the end of June.
- On May 21, the 787 Program reaches a major milestone by completing 25 percent of the design releases required for the program.

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