Airbus and Boeing spar for middleweight title

by **John Croft**
Contributing writer

In choosing between the 787 and A350, customers will weigh cost factors as well as improvements in performance, comfort, and environmental effects

There is no doubt that Airbus will be the commercial aviation world's new heavyweight champion when the A380 takes to the skies next year. With seating for more than 550 people, the 560-metric-ton (1.2-million-lb) behemoth will dwarf Boeing's 416-seat 747-400, the reigning champ's jumbo.

But Airbus did not stop there. In December the European aircraft manufacturer jumped into the ring to defend its title in the 200-300-seat category as well, a "middleweight" crown Boeing was all but sure to win back with its high-tech 787, due out in 2008. This new aircraft, due in 2010, is called the A350.

The contest promises to raise the ante a notch in the transatlantic rivalry between the two companies, spurring designers and engineers to one-up the competition's innovations. In either case, the airline industry will benefit from a new line of aircraft optimized for a growing number of environmental, performance, and human comfort design drivers.

Gauging the markets

In deciding whether to design and develop a new aircraft, manufacturers look to market forecasts, which are not carved in stone. Boeing continues to believe the 200-300-seat sector will be the largest growth market, hence the 787, or Dreamliner (originally called 7E7). But Airbus, which for years has focused its efforts on the over-400-seat market with the A380—a niche its forecasts deemed the most promising—now believes both segments are favorable for a new offering, hence the A350.

Airbus decided to introduce a direct competitor to the 787 relatively late in the bout. For Boeing officials, this is vindication of the game plan they have had all along. "Airbus has now recognized they can no longer ignore the 787," Randy Baseler, Boeing's vice president of marketing, likes to say in his sales pitches to airlines. "It's easy to see why [they] scrambled to offer the A350."

Boeing is planning to offer two long-range variants and one shorter range version of the 787. First to arrive will be the 787-8 in 2008, with 223 seats and an 8,500-n.mi. range, followed by the 296-seat, 3,500-n.mi. 787-3 in 2010 and the long-range, 259-seat 787-9 by 2012, if not before.

The 200-300-seat market is currently dominated by Boeing's 757-300 and 767, and Airbus' A330/A340 aircraft families, though Airbus is the leader with a 60% share. While Airbus continues to build both the A330 and A340, Boeing ended its 757 line in October and may do the same with the 767 later this year. Over-

all, Airbus delivered more aircraft than Boeing in 2003, for the first time in the manufacturer's 33-year history. It did so last year as well.

In announcing the go-ahead to begin offering airlines the A350, Airbus parent company BAE Systems said in December that its customers—not Boeing's challenge—fueled the decision to launch the product. "A detailed analysis and intensive discussions with Airbus customers have confirmed strong market demand for an aircraft of the size and design and with the high level of efficiency proposed by Airbus with its A350," the company wrote in a press release. BAE Systems owns 20% of Airbus; EADS owns the remainder.

Airbus is considering two versions of the aircraft: a 245-seat, 8,600-n.mi.-range model called the A350-800 and a 285-seat, 7,500-n.mi.-range version called the A350-900. Each is meant to augment the current A330 fleet as a longer range sister aircraft.

At 19 in. tall and 10.3 in. wide, the windows on the 787 are larger than those on any other commercial aircraft. The electrochromatic windows require no shades and can be darkened at the touch of a button.

Material differences

Although both manufacturers are putting the best spin possible on their prospective champions, the pedigrees of the contenders are quite different: The A350 is a derivate, though improved, version of the A330; the 787 is a clean-sheet design.

"I think there's a marked difference between the two product offerings," says John Walsh, president of Walsh Aviation, an aerospace consulting service based in Annapolis, Md. In particular, Walsh says Boeing's decision to build an all-composite structure will prove to be a change agent for the industry as a whole. The 787 is about 50% composites by weight, with most of the primary structure—including the fuselage and wings—made from graphite and epoxy resins. These are the same materials used in much smaller doses (about 10% of the structure) in the Boeing 777 and the A380 (about 25%).

Before the 787, Airbus had been the leader in bringing composites to commercial aircraft. The company first introduced these lightweight materials on the A300 in 1972, using glass-fiber-reinforced polymers for the radome and vertical-fin leading and trailing edges. In the 1980s, Airbus began using long-carbon-fiber-reinforced polymer matrix materials for moving surfaces (spoilers, airbrakes, rudders, flaps) and as primary structures for vertical fins on various models. In 2002, it converted the fuel tanks, rear pressure bulkheads, and keel beams on the A340-600 and A318. Most recently, the company used composites for the center wing box and rear fuselage of the A380. The A350 will further expand the limits with a carbon-fiber-reinforced plastic wing design.

A quantum increase in composite use on the 787 is just one of many design improvements that Boeing hopes will work in unison to make the whole function as more than the sum of the parts. This synergy, says the company, will differentiate its product. "Just picking one of the technologies and using it on another airplane won't lead to the full improvement you see on an airplane designed to take full advantage of these advances," says Baseler.

Cabin comfort

In the cabin, composites and other advanced technologies will make for a better ride, says Boeing, starting with the internal altitude. While metal-made commercial aircraft are typically limited to cabin pressurization altitudes of 7,000-8,000 ft in order to reduce cyclic fatigue on the structure, the 787's more robust composite cabin allows for a 6,000-ft altitude on every flight.

For passengers, that should make for a more

relaxing long-range experience. In a recent joint study with Oklahoma State University, Boeing says participants in a 20-hr altitude chamber test simulating an airline cabin at five different altitudes reported feeling "less achy, more relaxed, and more comfortable" with a 6,000-ft cabin altitude compared with higher levels.

The air quality at altitude should also be better with the addition of a gaseous filtration system along with legacy HEPA (high-efficiency particulate air) filters in the 787's cabin air recirculation system. Boeing says the combination will scrub the air of particulates down to the bacterial and viral level. Low humidity levels, known to be a source of irritation on long flights, will also be boosted by the lower cabin altitude and a new constant humidity controller. Corrosion, long the partner (and enemy) of higher humidity in metal cabins, is also less of a concern with composites.

Boeing is also going to great lengths to make the 787 cabin a desirable destination in and of itself, with 14 in. more cabin width than the Airbus contender. The 787 also has LED lighting that the company says will simulate natural light. Its windows are 30% taller than those of Airbus and have almost double the viewable area. Its seats will be the same size as the 777's, and it will have wider aisles.

Ride quality too should be improved with a new active gust alleviation system similar to what Boeing built for the B-2 bomber. Airbus uses such systems in its digitally controlled aircraft, the A320 family included.

Compared to the numerous cabin improvements Boeing is proposing for the 787, the A350's advances seem to reflect a minimalist approach. Beyond the existing cabin amenities will be solid-state lighting "and full compatibility" with the latest generation in-flight entertainment systems controlled through an Airbus-designed interconnect system.

Environmental enhancements

In the area of good-neighbor improvements, Boeing would appear to be in the lead as well. Its Dreamliner's combination of advanced engine technology and optimized airframe/engine interaction analysis and design, according to Boeing, has minimized the noise "footprint" at airports. This is an increasingly important factor as nearby communities, particularly in Europe, demand quieter takeoffs and landings.

The new higher bypass GEnx 72A1 engines will provide quieter operation.

According to Walt Gillette, Boeing's 787 vice president for engineering, manufacturing, and partner alignment, the 787's 85-dBA noise contour falls within airport property boundaries for every facility the company has analyzed.

While that estimate makes the 787's footprint 60% smaller than that of the A330, the A350's new higher-bypass engine—the GEnx 72A1—will no doubt make for quieter operations as well. Boeing is offering the GE engines in addition to the Rolls-Royce Trent 1000.

Other environmental improvements for both aircraft include lower emissions by virtue of more efficient engines and airframes, and fewer wasted raw materials. By using more composites, both manufacturers will increase what Gillette calls the scrap-to-usage ratio. According to Gillette, only 10-15% of the aluminum bought to build a metal airplane ends up flying on the plane after the milling process is complete. For a composite aircraft, that percentage is up around 90%, he says.

Efficiency and economics

Perhaps most important to airlines is how much it will cost to operate their next-generation aircraft, particularly with sustained higher prices for fuel. Gillette says the 787 will be 7% more efficient than the company's computer-designed 777, in part because of advanced computational fluid dynamics design work and wind tunnel testing in the aircraft design phase. Compared to its replacement, the 767, the Dreamliner will

A 787 model is prepared for a series of tests at the Boeing transonic wind tunnel facility to help verify the performance of the airplane design during the highest speed portions of flight.

be as much as 20% more efficient; 8% of the increase will come from engines, says Gillette, in part because of a higher bypass ratio and elimination of bleed-air systems.

Typically, a jet engine diverts high-pressure air from the compressor section of the engine to use for pneumatic services such as air conditioning systems, wing antiicing protection, and cabin pressurization, reducing the engine's output power and fuel efficiency. Instead of using bleed air, Boeing in this case will use distributed electrically powered systems throughout the aircraft to perform the same functions, leaving only the engine nacelle and cowl antiice systems powered pneumatically. An improvement of 3% comes from advanced materials such as composites, 3% from systems such as advanced controls, 3% from aerodynamic tailoring, and 3% from all of the improvements working together. The increase in efficiency means less fuel burned.

Airbus claims similar improvements for the A350. The company calls the -800 model the "smallest economically viable aircraft for long-range commercial operations" and puts the -900 as the winner for miserly seat-mile costs—the overall amount an airline spends to fly one seat for 1 mi. It attributes these gains to the new GE engines and to "significant" airframe weight savings resulting from "new technology and detailed aerodynamic tailoring."

Rather than totally redesigning the wing (which was developed for both the A330 and A340), Airbus will keep the suboptimal design but build it from composites and add performance-boosting features such as a "droop nose" device in lieu of a leading-edge slat on the wing, a technology developed for the A380. For the A350, Airbus says the droop nose will improve takeoff and landing performance without affecting high-speed aerodynamic efficiency. Other improvements coming from the A380 experience include laser-beam welding and the ability to make larger one-piece panels for the fuselage.

Heavier reliance on composites will help operators reduce maintenance costs for either aircraft. In the case of the 787, Boeing is working with the FAA to extend the time between heavy maintenance ("D-check") intervals to 10-12 years, as opposed to the normal six years for planes such as the A330 and 767. Composites also offer shorter term returns, because everyday ramp damage such as nicks and dents can often be fixed quickly with a composite patch kit rather than sending the aircraft back to the shop for sheet metal repair.

Deciding factors

Which of the two planes an airline chooses may depend on whether it desires the long-term benefit of lower maintenance and operating costs offered by Boeing's aircraft, or the shorter term gain of getting a more efficient derivative that has much commonality with the existing fleet. Though Boeing says the A350 by design will make the A330 obsolete, Airbus says carriers can profit from both aircraft by using the A330 for shorter hops and the A350 for longer. Whether a two-engine long-haul plane will make the four-engine A340 obsolete is open to debate, given the demonstrated reliability and payload of modern two-engine aircraft.

"The A350 should offer some benefits to airlines that figure they can stick with metal aircraft for awhile," says consultant Walsh. "It will take some sales from the 787, but no one knows how many." As of mid-May, Boeing had reported 255 orders and commitments for the 787; Airbus had not yet announced any orders since the program had not been officially launched. An Airbus spokeswoman said the timeline "is not definitive yet, though [the aircraft] shall enter service in 2010."

Regardless of how the A350 makes out, Walsh says Boeing has changed the very nature of the fight with the 787. "Boeing has set a new standard with this," he says. "I think the next move [for Boeing] will be to take this new technology and move it to a 737 replacement series." Once that happens, the two manufacturers will likely find themselves in another new battle, this one in the 100-200-seat category. That is because Airbus, in order to compete with the 737 replacement, would then have to modernize its A320 family, he says.

The action could change who is on top of worldwide jetliner sales for a long time. "In recent years, it's been Airbus leading and Boeing following," says Walsh, "That's taken a turn with the 787." ⩓