DREAMLINER MAKES HISTORY WITH PLASTIC, OUTSOURCING, DESIGN — AND DELAYS

News / Manufacturer

By *Dominic Gates*

When Boeing announced its vision for the new 787 Dreamliner in 2002, it was no surefire winner. Aviation pundits and many company employees openly questioned whether Boeing management was fully committed to remaining a power in the airliner business.

Airbus was aviation's innovator then, pouring billions of euros into developing its new A380 superjumbo jet. Boeing seemed like a deer in Airbus' headlights.

The U.S. plane maker had already abandoned a plan to develop a bigger jumbo jet, the 747X, to go against the A380. Then, in December 2002, it dumped a more daring plan for a dramatically different-looking jet that emphasized speed over size, the Sonic Cruiser.

The replacement, first called the 7E7, seemed boring by comparison: a fuel-sipping, traditionally shaped airplane that would save airlines money.

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Some doubted that Boeing would follow through on this one, either.

They were wrong. Through all the criticism, Boeing's strategic planners kept their nerve and ultimately judged the market dead right: The 787's unprecedented sales success reversed Boeing's fortunes.

And the choice to make the jet out of plastic instead of metal, along with a bold, global manufacturing plan, repositioned Boeing as the lead innovator in aerospace.

Then, starting in 2007, supply-chain problems led to a series of morale-sapping delays costing billions of dollars, and the Dreamliner program shuddered to a standstill.

As the long-delayed first flight finally arrives, any sense of triumph has been dampened by repeated snarls in building the first few jets, compounded this year by a design flaw discovered at the wing-body joint.

And employees in the Puget Sound region, already worried about their future role because such large pieces of the jet are built elsewhere, in October learned they won't even keep all of the final assembly work: A second final assembly line is to be built in North Charleston, S.C., rather than Everett. And the tail fin, the only large piece fabricated here, will also be produced somewhere else, to ensure Boeing's independence from this region.

If the Dreamliner finally succeeds, the years of dithering over the go-ahead and the delays in production may be forgotten.

It's Boeing's new way of building the jet that could have the most lasting impact, particularly in the Pacific Northwest.

Here's what's different about the new plane.

The plastic airplane

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With the debut of the Dreamliner, the all-metal jetliner gives way to the plastic airplane.

The 787's outer surface is almost entirely carbon-fiber-reinforced plastic. The new material, a composite of what plastics experts jokingly call "burnt string and glue," dramatically changes the way airplanes are built.

The "burnt string" is carbon fiber, treated at very high heat and emerging shiny black. The glue is epoxy resin that's infused into the carbon thread.

The resulting composite plastic is tough, light and strong. It won't corrode and isn't subject to metal fatigue.

In the U.S., the Japanese firm Toray makes the carbon fiber from oil-based polymers in Alabama and ships bobbins of the black thread to its plant just across the street from the Boeing composites center in Frederickson, Pierce County. There, Toray impregnates the thread with the epoxy resin, then sends Boeing and its partners large rolls of material resembling black duct tape.

The airframe structural pieces are built up with layer upon layer of this carbon-fiber tape.

For the large, cylindrical fuselage sections, the tape is wound around a rotating, drumlike mold. A computer-controlled robotic arm lays a piece of tape, snips it off, then lays another, building it up in rhythmic, precise patterns like a spider spinning a cylindrical web.

The structure is cured to hardness in a high-pressure oven called an autoclave. Boeing's partners have built some of the largest autoclaves in the world, big enough to hold 40-foot-long fuselage sections.

It's a brave new world of automated manufacturing. The ability to bake these huge, one-piece plastic sections means much less final assembly work for Boeing mechanics, whether in Everett or in Charleston.

The Boeing marketing machine

The 787, even after some cancellations this year, has a record 840 orders before it flies.

The sales success is the fruit of a tortuous, years-long effort to establish exactly what new airplane the world's airlines needed.

In October 2002, at a two-day Sonic Cruiser planning meeting with about two dozen key airline customers in Seattle, Boeing's head of engineering, Walt Gillette, asked the fleet planners to vote on which mattered more to them — speed or fuel efficiency?

With the aviation world reeling from the Sept. 11 attacks the previous year, almost all opted for efficiency.

Less than two months later, on Dec. 19, Boeing announced it would abandon the flashy Sonic Cruiser design in favor of the 787.

What looked to the outside world like weak dithering was a flexible response to solid customer feedback.

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Still, to win its key launch order, Boeing had to convince All Nippon Airways' chief engineer, Shinsuke Maki.

In October 2003, Maki told Boeing's sales team that going with composite plastics was a mistake. With the new material, he thought the dings and dents typical on airplane loading ramps would be a nightmare to repair.

Months of shuttling composites experts to Tokyo failed to convince All Nippon Airways (ANA) of the material's viability.

"We just weren't closing the credibility gap," said Joe McAleer, Boeing's sales director for ANA. "Something else was needed."

So in February 2004, Boeing flew a 6-foot by 3-foot composite panel over to Tokyo and invited a team of ANA engineers to beat on it with hammers as hard as they wanted.

They barely managed to scratch the panel. Then Boeing offered a live demonstration of how to repair the minor damage.

A month later, ANA signed for 50 Dreamliners.

Outsourcing design and assembly worldwide

In 2003, the state of Washington passed tax breaks worth around $3 billion over 20 years to win final assembly of the 787 for Everett.

Despite this, the Dreamliner production plan has taken outsourcing to a new level.

The only piece of the 787 built in Boeing's Washington factories is the vertical tail fin. And, to

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ensure 787 production can continue in the face of any future strike by the Machinists union, Boeing this month announced plans to duplicate the fabrication of that part somewhere else.

Mitsubishi, Kawasaki and Fuji make the wings, a fuselage section and the structural "wing box" of the center fuselage in Japan.

Alenia makes the horizontal tail and two big mid-fuselage sections in Italy.

Spirit AeroSystems makes the nose and forward fuselage in Wichita, Kan.

And Boeing makes the aft fuselage in Charleston, S.C., having acquired the facility from Vought last summer.

The entire midsection of the airplane is put together in Charleston by Global Aeronautica, a 50/50 joint venture between Boeing and Alenia.

And Boeing will build a second final assembly line in a new facility beside the two existing fuselage plants in Charleston.

In addition, Boeing's major partners did the detailed design of the Dreamliner sections that they build.

All this is entirely new. Previous Boeing jets had pieces made around the globe, but they were designed solely by Boeing and assembled wholly in its Puget Sound-area factories.

Yet with all the global resources thrown at it, the vision of a quick, snap-together jet hasn't materialized yet.

Boeing belatedly pulled back in-house some of the engineering design work when its partners proved incapable. And the partners failed to finish their pieces of the first planes on time.

Hundreds of Boeing staff flew out on months-long assignments to help overcome manufacturing paralysis caused by inexperienced assembly mechanics, fastener shortages and work done out of sequence.

The final assembly line in Everett was overwhelmed by unfinished or wrongly built sections of airplanes that had to be meticulously disassembled and rebuilt.

In November 2007, a month after he was ousted as head of the program following the first six-month delay announcement, Boeing vice president Mike Bair vented his frustration at the global network of suppliers.

"Some of these guys we won't use again," Bair said.

Yet Boeing is sticking to its basic strategy.

In an interview last month, Bair, now vice president for business strategy, insisted that the concept of outsourcing both design and build responsibility is "the right thing to do."

"The model is not wrong. We were just too generic in how we applied it," Bair said. "We need to be more thoughtful about really assessing [supplier] capability."

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So far, Boeing's response to its Dreamliner problems — the buyout of Vought's 787 operations and the planned expansion in South Carolina — provides no solace to Washington state.

Delays unprecedented at Boeing

The Dreamliner is set to fly almost 28 months later than originally scheduled.

And with a slowed production ramp-up, many customers will get their airplanes more than 2 ½ years late.

For Boeing, it's an unprecedented outcome.

From factory rollout to first flight took precisely two months for Boeing's last new airplane, the 777, in 1994.

For the Dreamliner, with its bungled outsourcing of design and assembly, that transition took 2 ½ years.

Supplier partners bear the blame for most of that, along with poor project management by Boeing.

The Machinists union strike in 2008 added two months of further delay.

And Boeing engineers must answer for the design flaw at the wing-body joint that extended the wait this year.

The lag will be very expensive, since Boeing must pay contract penalties to both suppliers and airline customers. Joe Campbell, a financial analyst with Barclays Capital, estimates that the extra cost of the delays and the increase in manufacturing expenses for the first few hundred Dreamliners will be more than $10 billion.

Fortunately for Boeing, the economic downturn has taken the sharp edge off the delays for Dreamliner customers. In the current climate of falling air traffic worldwide, airlines are clamoring to defer deliveries rather than complaining about not getting planes.

Virgin Atlantic, for example, originally ordered 15 of the planned 787-9s, larger than the initial 787-8s, for delivery in 2011. The new delivery schedule has not yet been determined, but those jets will be at least two years late.

"We don't regret ordering the 787," said Edmond Rose, in charge of fleet planning for Virgin Atlantic, in an interview this month. "It has the potential to be a game-changer for our industry, both in reducing our costs and our environmental footprint. We expect it to be the right aircraft, hitting the right sweet spot for us."

Still, Boeing will have to work hard to recover its reputation.

For the 787 to be judged a success, the jet has to attain its advertised range and fuel efficiency. Boeing also must meet the new schedule for initial deliveries toward the end of next year, then ramp up to building 10 Dreamliners a month by late 2013.

Air and light provide passenger appeal

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Boeing hopes the Dreamliner will restore some of the long-lost magic of flying — promising a smoother ride, fresher air and a passenger cabin that feels light, airy and spacious.

Boeing director Blake Emery, who's in charge of marshaling design efforts to ensure that passengers see the Dreamliner as different, said the design is based on extensive research assessing "the deep psychological needs that people have inside an airplane."

Entering a full-size 787 cabin mock-up at Boeing's Renton customer center, a would-be passenger immediately has a great sense of space overhead, subtly enhanced by ceiling lighting.

Curved luggage bins set high on the sidewall eliminate most of the usual hunching under bins necessary in today's airplanes. And bigger windows allow the passenger in the aisle seat to see outside without contortions.

The little plastic pull-down window shutters have been replaced with windows that dim electrically, transitioning smoothly from clear to dark at the touch of a button from the passenger at the window seat.

The bigger windows are possible because of the lightness and strength of the new plastic material the fuselage is made from.

And the absence of corrosion or metal fatigue allows Boeing to provide greater humidity and to set the cabin pressure at a lower altitude level — equivalent to about 6,000 feet, compared to today's planes that are pressurized to between 6,000 and 8,000 feet during a flight.

That, plus a new air-filtration system, should mean the cabin air is less dry and irritating on long flights.

In addition, onboard technology will detect wind gusts and tweak the flight controls to dampen any turbulence.

Still, it's the airlines, not Boeing, that decide what size seats passengers will squeeze into. And the Dreamliner seats won't be different from those on other jets.

Will this jet really be that much more comfortable?

It will likely be 2011 before the first passengers, flying a light and airy Dreamliner operated by ANA of Japan, find out if psychology trumps legroom.

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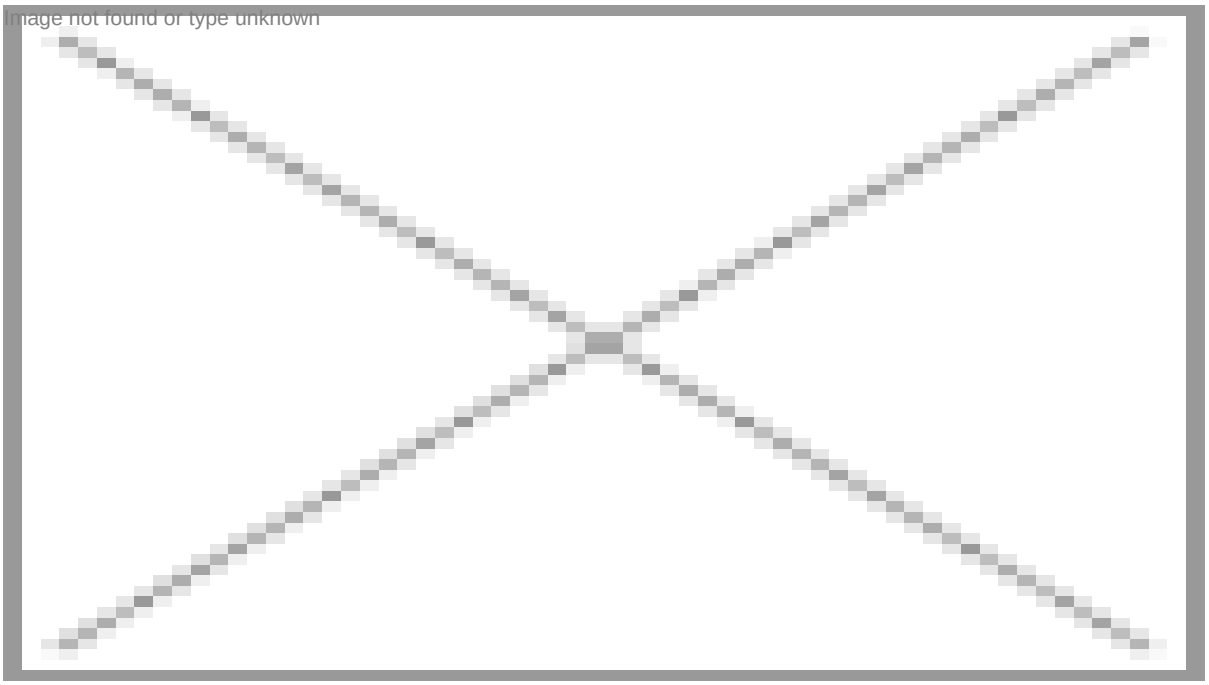

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