

Otto Sees Market-Disrupting Potential In Drag-Reducing Laminar Flow

Graham Warwick October 05, 2026



The Phantom 3500 is designed to fly at up to 51,000 ft. with a maximum speed of Mach 0.80.

Credit: Otto Aerospace

In a sector known for steady, incremental progress and intense brand loyalty, upstart Otto Aerospace is attempting the seemingly impossible: to disrupt a mature market by offering much more for much less.

The market is business aviation, and the disruption is not about offering a slightly bigger cabin or slightly longer range. It is a niche-defying proposition: a super-midsize experience at light jet expense. The challenge: Accept an unproven newcomer into your midst.

- Target is 60% lower fuel burn in cruise at 51,000 ft.
- Windowless cabin reduces drag, weight and cost

Fractional ownership operator Flexjet has already made its choice. It placed a firm launch order with the newcomer in September 2025 for 300 Phantom 3500 business jets, plus options. Now Otto must deliver on its promises.

And they are eye-opening promises. Otto is pitching the Phantom 3500 as a competitor to super-midsize business jets, such as the Bombardier Challenger 3500, on cabin size and range but with a midsize purchase price and a light jet's operating costs.

The Challenger 3500 lists at \$29.5 million, offering 3,400-nm range with four passengers, cruise speed up to Mach 0.82 and a maximum operating altitude of 45,000 ft. It is a successful formula—Bombardier has delivered more than 1,000 of its super-midsize-family aircraft.

The Phantom is being designed to fly a maximum of 3,500 nm at Mach 0.76 and 51,000 ft., with a maximum Mach number of 0.80, a list price “significantly lower” than current super-midsize jets and 50% lower operating costs, Otto says.

The statements are based on the Phantom's extensive use of natural laminar flow (NLF) aerodynamics to reduce drag and carbon-fiber composites to minimize weight. Otto is targeting a maximum takeoff weight of just 19,000 lb., compared with more than 40,000 lb. for the Challenger 3500.

This would allow the Phantom to be certified as a Part 23 single-pilot aircraft, while the lower weight and drag would enable it to be powered by a pair of Williams International FJ44-4 turbofans. Combined, these would reduce development, manufacturing and operating costs.

Enabled by the composites, the aerodynamics require a different approach to design. The aircraft is exceptionally smooth in shape and finish, lacking even the interruption of cabin windows. Passengers will view the world in high resolution via external cameras and digital displays lining the 6.4-ft.-tall cabin—something Otto calls SuperNatural Vision.

Key to the Phantom's performance is maintaining smooth laminar airflow over as much of the airframe as possible, delaying the transition to turbulent flow and reducing skin friction drag, which accounts for 45-50% of the overall drag on a conventional subsonic aircraft.

"A big part of what Otto is achieving with the Phantom 3500 is transonic natural laminar flow," Chief Technology Officer Kyle Heironimus says. "The challenge with transonic laminar flow is there's multiple different mechanisms to potentially transition the flow early if you're not careful."

The Phantom has a modestly swept, 67.7-ft.-span wing with a slotted NLF airfoil section designed to maximize the drag reduction in high-altitude cruise. "Because we can climb direct to Flight Level 510 above the jet stream, we expect to achieve North American coast-to-coast range at the typical cruise speed of Mach 0.78," Heironimus says.

The airfoil has forward and aft sections separated by a slot that runs almost the full span of the wing. Air flows up through the slot from the higher-pressure lower surface of the airfoil, reenergizing the flow over the aft part of the wing.

Flow from the slot stabilizes the boundary layer over the forward section of the airfoil and restarts the boundary layer over the aft section, which has a much shorter chord. That confines turbulent flow to a much smaller percentage of the total airfoil.



A smooth, step-free surface finish is essential to sustaining drag-reducing laminar flow. Credit: Otto Aerospace

Most conventional airfoils on subsonic business jets maintain laminar flow to 5-20% of wing chord. NLF designs such as the HondaJet's wing can extend this to 40% on the upper surface and 60% on the lower surface.

"We have a transonic swept wing that has 85-90%-plus laminar flow coverage on the top and bottom surfaces," Otto CEO Scott Drennan says. In addition, the slot allows a simple hinge mechanism for the ailerons and flaps, which comprise the aft section of the airfoil.

A full-scale slotted NLF wing has never flown. Otto plans to fly its slotted wing for the first time on the FTV-1 performance-conforming prototype in 2027. To reduce risk, significant wind-tunnel testing has been completed, including in the European Transonic Windtunnel. "That tunnel runs up to 2 bar at -170F in a full nitrogen environment," Drennan says. "So you're on condition there even with a 10th-scale model."

Otto also conducted icing tunnel tests on a full-scale wing section in the aileron area to look for ice accretion in the slot, "which we did not have an issue with," Heironimus says. Tests were conducted in Cox & Co.'s LeClerc Icing Research Laboratory in Plainview, New York. One more high-speed tunnel test campaign is planned for early 2027 to clear the safety of flight requirements for FTV-1 from a high-speed handling qualities standpoint, he says.

Founded in 2008, Otto is not starting from scratch. The company's Celera 500L full-scale technology demonstrator accumulated more than 50 hr. of flight testing in 2018-21. In May, Otto completed DARPA-related test flights of a laminar-flow uncrewed aircraft.

The Celera demonstrated 80% lower fuel consumption than a comparable light business aircraft thanks to a small fuel-efficient, diesel-cycle piston engine; a low-drag, high-aspect-ratio wing; and extensive drag-reducing laminar flow over the wing, fuselage and tail.

The one-off Celera and long-endurance drone, both of which feature pusher propellers on the tail, are quite different configurations from the twin-turbofan Phantom, but they have provided flight data to validate Otto's laminar-flow prediction tools.

"The Celera 500 kind of gets swept into the background because it uses a different wing technology and flies at a different speed," Heironimus says. "But the fact is, it was a great data point that we looked at through our [computational fluid dynamics (CFD)] lens to make sure our tool was functioning OK. It was."

Tests of the drone at White Sands Missile Range in New Mexico provided a second data point. "Using our tools, we predicted the laminar flow performance on that drone and nailed it again," he says. "We're using that data to scale up and respond to various Department of War opportunities for the intelligence, surveillance and reconnaissance mission."

"We've got a pretty heavy empirical data set from the tunnel and flight that has allowed us to tailor our CFD tools," Heironimus adds. Otto uses a modified version of NASA's Overflow CFD solver for laminar flow transition prediction and partners with Luminary on accelerated CFD analysis using machine learning.

FTV-1 will be heavily instrumented to measure the extent of laminar flow and resulting drag and fuel-burn reductions. "We call it a performance-conforming prototype because we have three more aircraft—FTV-2, -3 and -4—that will be conformed through the FAA from a type design standpoint to take certification credit," Heironimus says.

FTV-1 will have the same shape, design and materials as the later aircraft. "There are certain areas where we are going a little faster on some of the systems to get in the air quicker, and we're not seeking formal conformity on that aircraft," he says.

"We're minimizing our investments a little bit on the initial tooling because, on FTV-1, you can do some soft tooling here and there," Drennan says. "You have hard tooling where you need it, and you don't have that sunk cost if you need to make some changes."

As on the Celera 500, FTV-1 will use thermal imaging cameras to map the extent of laminar flow. "First and foremost, it's about getting up to altitude and speed and demonstrating the fuel burn," Heironimus says. "It's also about how robust that laminar flow is at those high altitudes. [FTV-1] will let us go explore . . . the edges of the laminar flow envelope to see how reliable and robust it is."

On the Phantom 3500, the largest contributors to the laminar flow drag reduction are the wing and forward fuselage, but Otto expects runs of laminar flow on the engine nacelles and pylons as well as the vertical and horizontal tails. The wing-to-body junction is not a laminar flow zone, but the fairing is designed not to disrupt laminar flow over the wing.

Laminar flow over the fuselage does not extend past the entry door, but the benefits of the windowless cabin include a reduction in drag due to fewer excrescences, structural weight savings from fewer and smaller holes in the pressurized fuselage, and cost savings from eliminating transparencies, Heironimus says.

Two 3,600-lb.-thrust-class William FJ44-4QPM light-jet turbofans power the Phantom 3500. Credit: Otto Aerospace

Designing to achieve laminar flow is one issue; sustaining laminar flow in operation is another. Otto is working to ensure the Phantom 3500 can be manufactured and operated in a way that robustly maintains the promised drag-reduction benefit. A driving requirement in manufacture and in operation is to minimize steps, gaps and waviness on the surfaces of the wing, tail and other critical areas to avoid tripping turbulent transition.

“The mantra for laminar flow is: Design it in, build it in, keep it in,” Heironimus says. This involves not only shaping, tolerancing and tooling, but deciding where to locate access panels, which systems they provide access to and how often they need to be checked.

“So the mantra is that even with a perfect design, if you can’t build it, you can’t keep it,” Hieronimus says. Historically, laminar flow has not caught on because people could design for it but did not think about the manufacturing and maintenance needed to count on it, he says.

“We have high confidence that the airfoil shape is correct,” Heironimus says. “A lot of the risk reduction we’ve been doing in preparation for FTV-1 is ensuring we can build and finish that shape to the tolerances that we want.”

“We’ve been making samples of our leading-edge join to understand that from installation and maintainability viewpoints,” Drennan says. “We have no moving elements in the leading edge, and a simple motion in the back for the ailerons and flaps—no Fowler motion.”

Achieving a smooth finish begins with the substrate materials, tooling sequences and manufacturing processes, “but we’re using millimeter-precise robots to do sanding, polishing and painting to get that really smooth finish to support the laminar flow,” Drennan notes.

Maintaining the surface quality in service is critical. “We’ve been doing real finishing samples,” he says. “We worked with Sherwin-Williams on a unique paint and repair methodologies for it, so when you abrade it or take a ding here or there, you can fix those laminar flow areas. We are pushing the boundaries there to get the right finish spec.”

Laminar flow will have to be robust if operators are to be able to claim the performance benefit reliably in service. There is a certification framework in place for this, Heironimus says. The Piaggio P.180 Avanti has some laminar flow, and the aircraft flight manual (AFM) includes “dirty-aircraft” knockdowns on speed and range—performance penalties for surface contamination that the crew must apply when planning a flight.

“They handle it as either the aircraft is clean or it’s not—it’s kind of binary,” he says. “This is not something we’ve finalized with the FAA, but on the Otto side, we’re thinking about how we can handle that from a continuum standpoint.”

Data from the aircraft's integrated health monitoring system will allow Otto to watch fuel burn in real time and provide performance predictions. "Both we and our operator will know how the airplane is flying, but it will also give Otto an opportunity to help those operators with either cleaning the aircraft or restoring laminar flow where necessary," he says.

Otto has developed a predictive model that, for example, looks at the performance impact of opening an access panel on a laminar flow zone, then not properly restoring the surface tolerances. "How we pull that into the AFM is still in work, but it's not going to be a situation where we don't get credit in the AFM for laminar flow," Heironimus says.

Laminar flow does not come for free, and Otto faces higher costs for materials and manufacturing processes that must be offset by the benefits.

"People say you can't have a full composite aircraft in this class of aircraft," Drennan says. "But that's not true when you're doing laminar flow from a clean-sheet design. Yes, we have a premium on some of our manufacturing processes, but those are paid for by laminar flow. Our empty weight is half our competition; our fuel burn is half our competition."

Laminar flow has opened up new trade spaces beyond performance and economics. "One of my favorite examples is we have the most amazing cabin you've ever seen—even in the super-midsize class—on a 19,000-lb. aircraft because laminar flow allowed us to put a little extra weight and size into it," Drennan says.

Production will employ the same determinant assembly used to meet the surface step, gap and waviness tolerances on stealth aircraft. Tooling will control waviness. Some critical areas will use same-qualified resin transfer molding (SQRTM), an out-of-autoclave composite manufacturing process using a three-dimensional closed mold with tooled inner and outer part surfaces.

SuperNatural Vision is Otto's name for the virtual displays that replace the cabin windows. Credit: Otto Aerospace

"The part comes out of the tool with a little flash on it," Drennan says. "You basically soft-tool it, knock the flash off, and the edge you have is exactly where you thought. It's a net-shaped composite part that comes out. Your upstream assemblies all match up, and you know what you get from a step, gap and waviness standpoint.

"Everybody loves autoclaves, but there's a lot of black magic going on inside there to get the recipe right [and] then maintain it at a high production rate," he says. "Whereas the conformance and repeatability of a three-dimension tool out-of-autoclave is a godsend, not just for the initial yield but all the secondary operations you normally have to do."

Otto looked at a metallic wing, but this required large, hard-tooled surfaces to achieve the step, gap and waviness tolerances, Heironimus says. A composite wing also offers a weight saving from using the latest carbon-fiber materials.

"But what's really important is the engineering team is able to design in features—spars and ribs and things that would traditionally have been mechanically fastened and would then put fasteners through the outer mold line on the wing" to disrupt surface smoothness, Hieronimus says.

“We’re able to do co-cure, co-bond and secondary bond in appropriate areas where we’re completely eliminating the fasteners in laminar flow critical areas,” he says. “Not only do you end up with a very smooth, net-shaped composite, but we’ve also eliminated all those joints you would typically need to fill and fair.”

Commonly performed on business jets, filling fastener heads and fairing panel joints makes the surface finish look perfect off the production line. “But in service, every one of those fastener heads is eventually gonna peel, every one of those joints is eventually gonna crack,” Heironimus says. “From Day 1, the team has been designing those features out, which you could never do with a metallic structure.”

Otto plans to use SQRTM net-shape composites wherever it can. “It’s most important on the aero surfaces, and it so happens the aero surfaces are the best candidates for that,” Drennan says. “You brought up the cost, but with the net-shape yield on a composite part, your secondary touch time is way down. The first-pass yield on our structures is a lot better, which helps win back some of the initial cost spent on tooling setup.”

Privately funded Otto is moving quickly. The startup completed the preliminary design review for the Phantom 3500 at the end of February and plans to fly the first flight-test vehicle, FTV-1, late in 2027. Three conforming prototypes are set to follow.

The company closed its G-1 issue paper with the FAA in June, setting the basis for Part 23 type certification. Closing of the G-2 issue paper, establishing the means of compliance, is expected soon, and the company is targeting entry into service in 2030.

Otto plans to begin construction of its new headquarters and manufacturing facility in Hangar 825 at Cecil Airport in Jacksonville, Florida, in 2028, backed by \$485 million in state and local incentives. Hangar 825 is a former U.S. Navy structure previously occupied by [Boeing](#).

For now, the company is based in Fort Worth. “We have an engineering flight simulator where we’ve loaded up the flight physics and can fly our data points,” Drennan says. “We have a mockup of SuperNatural Vision, so you can experience the digital window space in a realistic manner on a simulated flight.

“And then around those you’ll see a new [computer numerical control] machine, an autoclave, a revamping of our manufacturing capability to protect us inside the supply chain, to make sure that, if there is any slack in there, we have the ability to step up and make parts on our own,” he says.

Suppliers are already on board to build FTV-1, including Leonardo for the fuselage and Sonaca for the wing and empennage. “We purposely use the strategy of being a final assembly, integration and test house rather than a cocky vertically integrated startup,” Drennan says.

Otto's engineering simulator shows the Garmin G700 TXi flight displays selected for FTV-1. Credit: Otto Aerospace

Once the Phantom is up and running, Otto may bring some technologies in-house for future programs. “Probably mostly around the laminar flow and the composites because they are enablers,” Drennan says.

In addition to the Phantom 3500, Otto is working on two other programs: drones for the defense market and a yet-to-be-revealed commercial aircraft. The benefit of laminar flow is a function of scale. “There may be diminishing returns when you start to get huge, but anywhere under 100,000 lb., we think there’s great benefit,” Drennan says.

Otto acknowledges the challenge of breaking into the slow-growth, brand-loyal business jet market. “When you get stuck in that system, it’s hard to justify a full-blown clean-sheet aircraft with the requisite risks that come with the things we’re trying to do,” says Drennan. “We are backed by investors that expect those kind of results and expect a huge return from it.”

He cites the automotive market. “They could have made electric vehicles back in the 1940s but didn’t because they had a business model that worked and satisfied everybody that was interested,” Drennan says. “Then Tesla comes along with what the other guys could have done decades before and totally revamps the market. We plan on doing the same.”

To back this, he points to the numbers: “Fuel burn almost half, an engine that produces half the thrust, so the engine reserves are proportional, [and] single-pilot operation. The three biggest pieces of direct operating cost are now just plummeting.

“Then you have an aircraft where the empty weight—that which we have to produce—is half our competition,” Drennan says. “Labor, material all translates into a lower acquisition cost.” And Otto is designing for a commercial-airline level of aircraft availability, he adds, noting that availability for individual-owned business jets is typically 70-75%.

“Brand loyalty is huge, but our performance and our cabin experience are irresistible,” Drennan says. “It is inevitable you will pick this aircraft because you can’t choose otherwise when faced with the economics.”

—With Guy Norris in Colorado Springs

Copyright © 2026. All rights reserved. Informa Markets, a trading division of Informa PLC.