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PILOT REPORT
FALCON 8X

ALSO IN THIS ISSUE

EDITOR'S NOTE

Falcon 6X serial number five on Jan. 28 after flying from Dassault Aviation's production facility in Merignac, France to the company's completion center in Little Rock, Arkansas.

DASSAULT AVIATION

Flying The Competition

By Lee Ann Shay

James Albright has flown dozens of aircraft his career—but his first business jet type rating came in the Gulfstream III—and today he flies a GVII-G500. He likes Gulfstreams and knows a lot about them. So when Dassault Aviation offered a chance to fly the flagship Falcon 8X for a BCA pilot report, his curiosity piqued and he happily agreed.

The average equipped price of a new 8X is $57.5 million, according to the Spring 2022 Aircraft Bluebook.

Dassault has delivered 80 trijet Falcon 8Xs since the aircraft entered service in October 2016, according to Aviation Week Network's Fleet Discovery database. Amjet Executive, a charter operator in Greece, was the launch operator for the 6,450-nm-range jet.

Dassault is hoping to celebrate another first operator soon. It expects the Falcon 8X's sibling, the 5,500-nm-range Falcon 6X, to receive EASA certification in the fourth quarter, according to Carlos Brana, Dassault's executive vice president for civil aircraft. The fifth aircraft in the program, which will be the first delivered to a customer, arrived at Dassault's completion center in Little Rock, Arkansas, on Jan. 28. He says Dassault hopes "to deliver this airplane by the end of the year."

Then in 2025, Dassault plans to enter the Falcon 10X into service. The 10X is Dassault's entry into the ultra-long-range market, which will put it into

The Falcon 8X at the NBAA static display in October 2021.
Credit: Brett Schauff

competition with Bombardier's Global 7500 and Gulfstream G700. Brana says Dassault thinks the interior layout options and experiences distinguish it from the competition. The large windows and volume make it feel like "an apartment in the sky," he adds. It also includes low cabin pressure, low noise, enhanced technology and safety features, among other features.

The 7,500-nm-range aircraft is priced at "$75 million in economic conditions of 2021," Brana says. That range matches the Gulfstream 700's and is 500 nm shorter than the G800's, which Gulfstream expects to certify in 2022 and 2023, respectively.

But even for the Falcon 8X, which has a range of 6,450 nm, Brana says the average flight duration of Falcon 7X or 8X is "about 2.5 hr., even though you can fly 12, 13 or 14 hr." Just because it has a maximum distance doesn't mean you'll always use it. "But you do use the comfort of the cabin, and this is exactly what is selling the 6X," he says.

James Albright's pilot report doesn't address cabin comfort, but I think you'll find his insights interesting and helpful—especially given his flying background.

Enjoy this issue!

As always, I welcome your feedback. Feel free to contact me at bcaeditors@aviationweek.com.

Lee Ann Shay
Editor In Chief, BCA

AIRCRAFT

The Falcon 8X is a revolutionary aircraft when it comes to efficient design and innovative safety features

Pilot Report: Dassault Falcon 8X

The Falcon 8X is a revolutionary aircraft when it comes to efficient design and innovative safety features

DASSAULT AVIATION

AIRCRAFT

James Albright

At long last, the time has come for me to understand the magic behind the Dassault Falcon series of aircraft. All Falcons have been like a foreign language to me. The Falcon-fluent pilots that I've known over the years seemed like perfectly fine individuals, but they spoke a language we in the Gulfstream world just couldn't comprehend. For my full-time job, I fly a top-of-the-line Gulfstream, the GVII-G500. So, it only makes sense for me to dive right into Dassault's current flagship, the Falcon 8X.

First, a caveat. Dassault often compares the 8X to the Gulfstream G600, since their maximum range numbers are similar. I have been flying the shorter range G500 for two years now and will focus any comparisons on that aircraft since I know it better.

When I started my career as a business jet pilot in 1991, I was typed in the Gulfstream III, the finest business jet of its day. (Part of our initial type training was the attitude that refused to listen to any contrary opinions on that statement.) The Dassault flagship then was the Falcon 900. The Falcon 900 is about 17 ft. shorter than the GIII and tips the scales at just over 45,000 lb. maximum takeoff weight (MTOW) compared to the GIII's

Credit; Dassault Aviation

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nearly 70,000 lb. And yet the Falcon 900 could carry eight passengers farther. What kind of science is behind that magic?

A Falcon driver back then would tell you that a Gulfstream is an over-powered beast that flies like a tank. And back then I would say we were guilty on both charges, but at least we had those sexy winglets! The Falcon 900 crowd would say our winglets were meant to compensate for inefficient wings and nothing flies better than a Falcon. Did I mention our sexy winglets?

Now here we are, 30 years later and much has changed, or maybe nothing has changed. Dassault long ago adopted winglets, but the emphasis on efficient design remains. The Falcon 8X is 80 ft., 3 in. long, has a wingspan of 86 ft., 3 in., a tail height of 26 ft., 1 in., and a MTOW of 73,000 lb. (Compared to the G500, the 8X is about 10 ft. shorter and 7,000 lb. lighter.) If you need to carry eight passengers a very long distance, the Falcon 8X will go 6,450 nm at Mach 0.80, much farther than the G500's 5,300 nm at Mach 0.85. The magic continues. I needed to learn more.

When Dassault invited me to fly the Falcon 8X, I asked for everything they could provide about the digital flight control system (DFCS) and anything else that could explain the aircraft's ability to extract so much performance from every drop of fuel. After a few months of study, I felt comfortable with everything except the DFCS. Dassault says that with their latest DFCS, you fly a "trajectory rather than an attitude." They call this a "flying path" in much of their literature and I've also heard that it is a "path stable" aircraft. No matter what you call it, it appears to be a major shift away from how most aircraft are flown: "In the more advanced, trajectory-based control system (closed loop), the pilot merely sets the desired path, and the DFCS monitors the resulting path, and using the logic built into the control laws, moves whatever surfaces are necessary to have the result match the desired path." Path stable? Closed loop? I spoke with several Falcon 8X pilots, and none of their answers clicked with me. The language barrier again! Clearly, I

A Falcon 8X at Hanscom Field (KBED) on a clear New England day.
Credit: James Albright

needed to fly the airplane.

Dassault Falcon Jet Chief Pilot Franco Nese brought the primary demonstrator aircraft to Hanscom Field (KBED), in Bedford, Massachusetts, and invited me to learn more. The aircraft's ramp presence is misleading; it is indeed smaller than any other ultra-long-range business jet in terms of length and fuselage height. But upon entering the cabin all preconceived notions of diminutive size evaporate. At a 74-in. height, 92-in. width, and 42-ft., 8-in. length, the Falcon 8X's cabin nearly equals that of the G500.

The Cockpit

Of course, my attention was drawn to the cockpit and the EASy III avionics. As the name would imply, the avionics draw from previous Honeywell Primus Epic systems, which are similar to those used by other

Falcon 8X cockpit includes the Honeywell EASy system.
Credit: Dassault Aviation

manufacturers but tailored for Dassault as the Enhanced Avionics System (EASy). Thanks to my experience with Gulfstream Primus Epic systems, I was immediately comfortable with much of the cockpit. Many of the panels and controls looked identical to those found in the Gulfstream G450, G550 and G650 aircraft. The four 14.1-in. displays are arranged in a “T” configuration--an integrated primary flight display (IPFD) for each pilot, with two multifunction display units (MDUs) stacked vertically in the center. Each pilot has access to onside and the center displays through dedicated cursor control devices with trackballs and multifunction keyboards.

The cockpit feels spacious, owing to the wide fuselage width and the absence of control yokes in front of each pilot. The layout is designed to minimize pilot workload, with all flight avionics directly in front of each pilot and a guidance panel for flight director and autopilot controls on the center eyebrow panel. Each pilot has an electronic flight bag (EFB) mounted outboard of their main display. The EFBs are Windows tablet computers that can be loaded with the usual approach chart applications and whatever other programs the pilot desires, including the FalconSphere II suite of performance calculation, dispatch, documentation and planning apps, so long as they are compatible with the Windows Operating System.

Other than the EFBs, none of the displays are touchscreens. Most systems are accessed through physical switches and controls, and most of these adhere to the “dark cockpit” concept. If they are not illuminated, they are in a good flight mode. The final distinguishing components of the cockpit are the dual “smart sticks” on each side and the very large head-up display in front of the pilot. There are plans for a dual HUD installation later this year.

Exterior Preflight

The leading edge slats run the entire length of the wing.
Credit: James Albright

The "S-duct," which moves air from above the fuselage aft and down to the center engine. Credit: James Albright

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The Falcon 8X was ready for engine start when I arrived, but I asked for a quick walkaround to see what checks were needed on a typical preflight. The inspection is typical, clockwise around the aircraft starting at the nose. Besides checking for the general condition, various covers need to be removed, the nosewheel torque link pin installed, and landing gear pins need to be removed.

The flight control surfaces looked perfectly conventional to me at first: ailerons, spoilers, elevators, a rudder, a trimmable horizontal stabilizer and flaps. I asked to see the slats and was told, "You're looking right at them." In the retracted position they look just like the polished bright work of a conventional wing, but when extended, they increase the camber of the entire wing from root to winglet.

The ailerons, elevators, rudder, spoilers, slats and flaps are each powered by hydraulic power provided by one or two of the three hydraulic systems. System A is powered by engine-driven pumps on the No. 1 and No. 3 engines. System B is powered by pumps on the No. 2 and No. 3 engines. System C is powered by an engine-driven pump on the No. 2 engine. Hydraulic system redundancy is provided to systems A (ground only) and B by an electrically powered backup pump. Further redundancy is provided by an electrical pump providing hydraulic power to the spoilers. The horizontal stabilizer is driven by one of two brushless motors in normal operations, or a brush motor in the event of multiple failures.

The fuel panel is located on the right side of the fuselage, aft of the wing. The fuel quantity can be set on the panel to automatically upload the desired amount. The upload rate is about 1,000 lb. per minute. The fuel system comprises three independent groups of tanks, each dedicated to one of the three engines. Fuel is transferrable from any tank to any other tank and the tanks are pressurized to provide for positive pressure during takeoff. Total usable fuel capacity is 35,141 lb. (5,244 U.S. gal.). We already had 10,058 lb. loaded.

Most of the aircraft is easily inspected from ground level with the notable exception of the third engine, which is mounted in the fuselage but includes an "S-duct" to channel intake air from above. Only that engine is equipped with a thrust reverser, which also can be used for "power back" operations. As is true with many business jets, the thrust reverser is a "bonus" in the performance charts, since all computed data assumes it isn't used.

There are distinct advantages to having three engines rather than two, beyond the obvious. Yes, if you were to lose an engine in the three-engine aircraft you only lose a third of your thrust instead of half. But you also have less adverse yaw when losing No. 1 or No. 3 and no adverse yaw at all with No. 2. The third engine also provides bleed air, and another location for accessories, such as generators and hydraulic pumps, furthering aircraft systems redundancy.

Of course, as a denizen from the land of overpowered beasts, I was more interested in the thrust output of three engines versus the two I normally have at my disposal. The three Pratt & Whitney Canada PW307D turbofan engines on the 8X are rated at 6,722 lb. thrust at sea level up to ISA+17C, for a total of 20,166 lb., which is substantially less than what the heavier Gulfstreams have. The G500, for example, has a total of 30,288 lb. of thrust; that's about 50% more thrust for an aircraft with 10% more maximum gross weight. Is the 8X design that much more efficient? Is the G500 that much more overpowered? Or is there something else going on here?

Cockpit Preflight and Engine Start

The Falcon 8X's overhead panel. Credit: James Albright

The flight plan presentation on the top MDU. Credit: James Albright

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The cockpit pre-start checks begin with a scan of left and right consoles, the center instrument panel, the pedestal and the overhead panel. Since the Falcon 8X employs the "dark cockpit" concept, whereby most lights are off in a normal flight mode, the scan is easily accomplished. After the APU is started, electrical and air-conditioning systems automatically come online within 2 min.

Nese downloaded the flight plan using the aircraft's airborne flight information system (AFIS). The system uses either VHF or satellite data link, automatically prioritizing VHF if available. The downloaded flight plan is displayed in the center top display unit in a large waypoint list window. The flight plan can be modified directly by using the cursor control devices to select the desired waypoint and the keyboard to make the necessary changes, or the changes can be made directly on the map display.

The engine start is accomplished by moving the selected engine's fuel switch from OFF to ON and rotating another switch to START. The selected engine's full authority digital engine control (FADEC) handles the start from that point on. Aircraft electrical and pneumatic systems switch automatically to engine electrical and air outputs. The aircraft's electrical system is primarily 28-volt DC, powered by two batteries and three 12-kw, 400-amp, engine-driven generators. The APU is capable of powering all systems on the ground and a 9-kw ram air turbine is available in flight to power essential buses without time or altitude limits, down to 140 KIAS, below which speed the load is shared with the batteries down to 98 KIAS.

After all three engines were started, Nese quickly untied the electrical bus, shut down the APU, and completed several systems checks. The flight

The flight plan and electrical system synoptic prior to engine start.

Credit: James Albright

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control check is conventional except it is accomplished by each pilot in turn, and then by the FBW system itself. The sidesticks are not linked mechanically and do not actively move in response to inputs from the other pilot, the autopilot or air loads on the control surfaces. They are called "SMART sidesticks" because they "Safely Manage Along Route Trajectory." I

Credit: Dassault Aviation

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asked to see what happens when both pilots move their sidesticks in opposition. Nese moved his stick to the right stop and asked me to move mine left. When I did so, a voice announced, "dual input" and the stick vibrated.

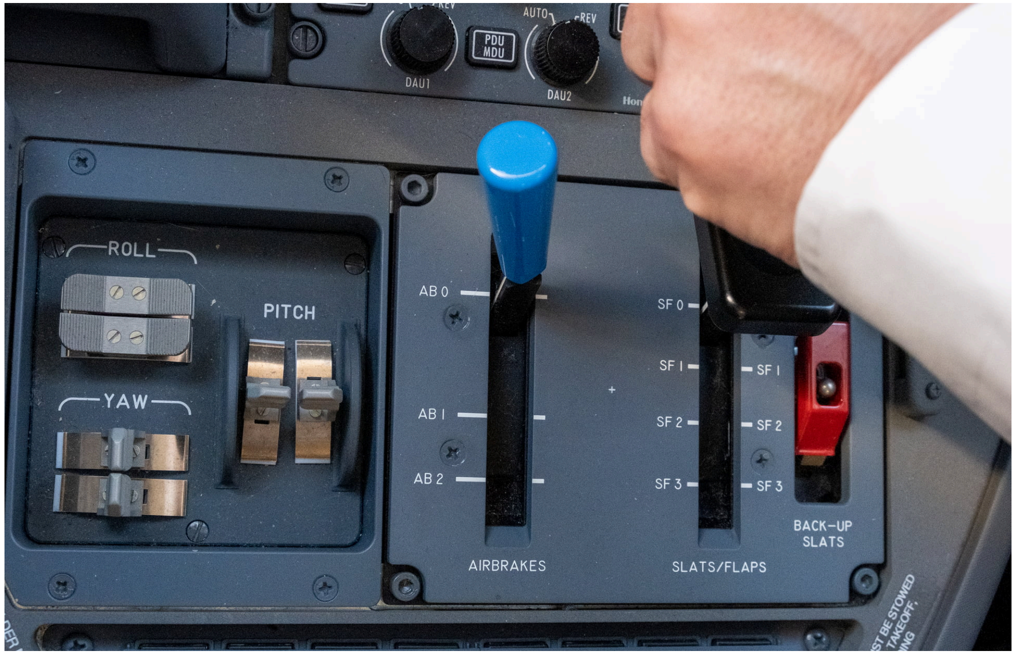
How to best alert pilots of a dual input has been a hot topic ever since the crash of an Air France Airbus A330 in 2009. In that accident, the right-seat pilot was pulling his stick full aft, causing the aircraft to stall. The left-seat pilot took priority with his stick, but the right-seat pilot took priority back without announcing that he had done so. The left-seat pilot was pushing his stick full forward, attempting to recover, but the right-seat pilot had priority. Neither pilot was aware of the dual input situation. The crash wasn't caused by the sidesticks but could have been prevented had the left-seat pilot understood he wasn't in control.

I think your auditory senses are the first thing to go in a highly stressful situation and an audible alert is insufficient. The "haptic feedback" in the 8X stick is better, in that the vibration in your hand is hard to miss. Another solution is to have one stick move in response to the other, as with the Gulfstream "active" sidestick. I prefer that solution, but I was still learning the 8X's "hands off" approach to flying. More on that later.

Once we completed our flight control checks, Nese prompted the FBW system to complete its own check. While the check is only required once every 24-hr. period, he activated the check for my benefit. The minimum number of flight control computers required by certification rules is two, a primary and a secondary. Most manufacturers have opted for three, adding a backup. The 8X employs a total of six: three main and three secondary, as well as an additional backup computer.

Taxi

We were ready to taxi in just a few minutes. Because our parking position required an immediate 180-deg. turn, I added just enough thrust to start us rolling and then applied full right rudder pedal to initiate a right turn. The nosewheel steer-by-wire is electrically controlled through transducers in the rudder pedals and hydraulically actuated for a maximum of 60-deg. turning authority at low speeds, decreasing as speed increases. Once we were



The airbrakes and slats/flaps handles. Credit: James Albright moving at a fair pace, idle thrust was more than sufficient to maintain taxi speed.

Nese selected Slats Flaps 1, or "SF1" in Falcon-speak, which means all six leading-edge slats and the trailing edge flaps extended to 9 deg. SF2 is also available for takeoff, increasing the flap angle to 20 deg. The slats and flaps are selected through a four-position handle (SF0, SF1, SF2, SF3) or can be deployed automatically by the flight control system if necessary to reduce the angle of attack (AOA).

We then reviewed our performance numbers, which were generated by the avionics and displayed on the bottom MDU. The aircraft had just under 10,000 lb. of fuel added to our basic operating weight of 36,100 lb. and three pilots, bringing our takeoff gross weight to 46,400 lb. The weather was clear, temperature around 20C and we had a right-quartering headwind, giving us performance numbers of 104 V_1, 111 V_R, 116 V_2, 146 V_{FR}, 164 V_{FT}, and a takeoff distance of 2,813 ft. Of these speeds I was unfamiliar with V_{FR} and V_{FT}, which are not used in U.S. certification rules. V_{FR} is flap retraction speed and V_{FT} is the final takeoff speed, which is the speed after the loss of an engine with the aircraft cleaned up to the en route configuration.

Takeoff

Once cleared for takeoff, I aligned the aircraft with the runway and moved all three throttles to their forward limit, the TO detent. The aircraft accelerated nicely and in a matter of a few seconds we reached V_R and I

The Falcon 8X taking off. Credit: Dassault Aviation

pulled back on the sidestick to increase our pitch to about 20 deg. With a positive rate of climb, Nese retracted the landing gear and, passing 400 ft., the slats and flaps.

The pull on the stick took more force than I was expecting, just a little more than I would expect from a Gulfstream GVII. Falcon 8X instructors teach their students to move the stick until the path of the aircraft is as desired, then release the stick and guard it. Climbing through 500 ft. I was satisfied with our climb and released the stick and watched as the nose stayed right

Credit: Dassault

where I had left it. The DFCS is designed to maintain the pilot-commanded bank angle “hands off” up to 35 deg. of bank unless disturbed. If, for example, the pilot rolls into 15 deg. of bank and turbulence increases it, the flight control system counteracts the disturbance. If the system stopped the roll at 17 deg., that will be the new maintained bank angle. As for the pitch, the “flight path stable” aspect of the DFCS adjusts the necessary flight controls to maintain the desired flight path angle, which was something I needed to explore further.

I selected the “Climb” mode of the flight director--something other manufacturers call “Flight Level Change”--and the flight director displayed a magenta bar that showed me the path needed to maintain our desired climb speed. The autospeed climb schedule starts at V_2+10 until cleaned up, 200 kt. until out of the airport traffic area, 250 kt. until 10,000 ft., 260 kt. until Mach changeover, and then Mach 0.78.

Speed Run

A new litmus test for what makes a business jet fast is having a published maximum operating speed of at least Mach 0.90 (M_{MO}) and the 8X doesn't disappoint. Since the maximum range numbers are based on a more-economical Mach 0.80, I wanted to evaluate the differences in flight characteristics, noise levels and fuel burns. The aircraft's maximum operating altitude is 51,000 ft., but I opted for 41,000 ft. to avoid having to don an oxygen mask. (I've always been a bit of a germaphobe, even before COVID-19.)

We made it to 41,000 ft. rather quickly, in about 17 min., climbing at the recommended climb speed of Mach 0.78. In a few seconds, we stabilized at Mach 0.80. The aircraft was light at 44,700 lb. and the outside air temperature was nearly at standard, ISA+2C. The cockpit was very quiet, and the fuel flows were 750, 750 and 770 pph, for a total fuel burn of 2,270 pph. For comparison, I've flown a G500 in similar conditions at Mach 0.80 with a slightly higher total fuel burn of 2,300 pph.

I then pushed the engines up to maximum continuous thrust and watched the airspeed obediently climb to Mach 0.878 but no further. We were at 44,500 lb. and the temperature had climbed to ISA+3C. The fuel flows settled in at 950, 970 and 960 pph for a total fuel burn of 2,880 pph. Most notably, the cockpit was still quiet. For comparison, I've flown a G500 in similar conditions and easily made it to Mach 0.90 with a fuel burn of 3,050 pph. The G500's cockpit, however, becomes noticeably noisier when above Mach 0.85.

The 8X does have lower fuel flows, but its vastly superior range appears mainly due to its higher fuel capacity of 35,141 lb. compared to the G500's maximum of 30,250 lb.

Steep Turns

Nese then arranged for a block of airspace between FL390 and FL410 and asked me to complete a left 360-deg. turn at 60 deg. of bank. The normal simulator exercise in most aircraft for a type rating dictates the maneuver at a much lower altitude and only 45 deg. of bank. (This makes the aircraft easier to control and ensures you can maintain speed with an excess of thrust.) But he clearly had something in mind, so I dutifully rolled into 60 deg. of bank and applied whatever back pressure was needed to nail the altitude. Placing the flight path vector (FPV) on the zero pitch reference line (ZPRL) made quick work of that and the altitude indication remained glued to 40,000 ft. Up to 35 deg. of bank I didn't need any back pressure at all, but above that the FPV started to nudge downward and I needed aft stick to hold altitude. As we approached 60 deg. of bank and 2Gs, the aft force was considerable. Even with my altitude and bank angle rock steady, the airspeed needle hardly moved. Of course, the autothrottles were responsible for that precision, but the fact we had enough thrust to do that at 40,000 ft. was impressive. I asked Nese what kind of lead I would need to roll out and he suggested 10 deg. would be ample. I thought that wouldn't be enough but waited until 10 deg. off heading and then rolled. It was more than enough, due to the 8X's nimble roll response.

I tend to think of maneuverability and stability as inversely related: the more maneuverable an aircraft is, the less stable it tends to be, and vice versa. So far, the DFCS seemed to break that rule; the 8X was both maneuverable and stable at these speeds. I looked forward to the low-speed regime, but first we needed to push the high-speed numbers.

High- and Low-Speed Protections

We then got clearance for an unrestricted descent to FL230. With the autopilot engaged I pushed the nose down to about 20 deg. below level flight. As we approached the Mach 0.90 MMO/370 KIAS VMO, the

Nearing airspeed limits at 41,000 ft. Credit: James Albright

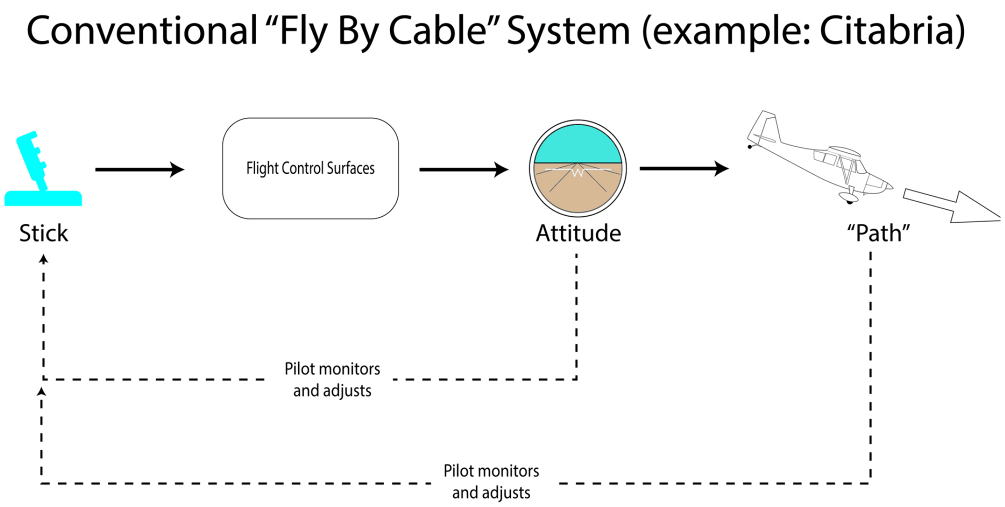
autothrottles pulled back to maintain the limiting speed. Nese explained that this was a function of the automatic flight control system (AFCS), which could be removed by disengaging the autopilot. So, I disengaged the autopilot and used the sidestick to push the nose farther down. The DFCS would have none of that and limited my pitch to prevent over-speeding the aircraft. The aircraft remained fully controllable in all axes and as we neared our target altitude, I pulled aft on the stick to reduce our descent rate and level us at FL230, then released the stick. Putting the FPV on ZPRL results in level flight, as it does with any aircraft with an FPV. What sets the Falcon 8X apart is that when you take your hand off the stick, it stays there.

Once we were level, with the autopilot and autothrottles still disconnected, I pulled the throttles to idle and watched as the aircraft maintained level flight while we configured with the landing gear and full flaps, SF3. Once the speed decayed to below around 110 kt., a warning voice commanded “Increase speed, increase speed,” the leading-edge slats automatically deployed and I was able to keep us level with added aft stick until I reached the aft stop. Once we reached about 90 kt., the aircraft started a gentle descent, between 400 and 500 fpm. The lowest speed I saw was 88 kt. before recovering with thrust.

Once level again, Nese negotiated our return to Bedford with Boston Center. As we waited, I played with the pitch and started to come to terms with the 8X’s “closed loop” fly-by-wire system. It had been a source of confusion since half the 8X pilots I talked to said the airplane flies like any other: Move the stick to put the nose where you want it and be done with it. But the other half said, “Move the stick, release and guard,” to take full advantage of the aircraft “path stable” flight control system. As it turns out, they were both right. You can fly the 8X like any other aircraft. But only the “release and guard" pilots were taking full advantage of the closed loop.

The Open/Closed Loops Explained

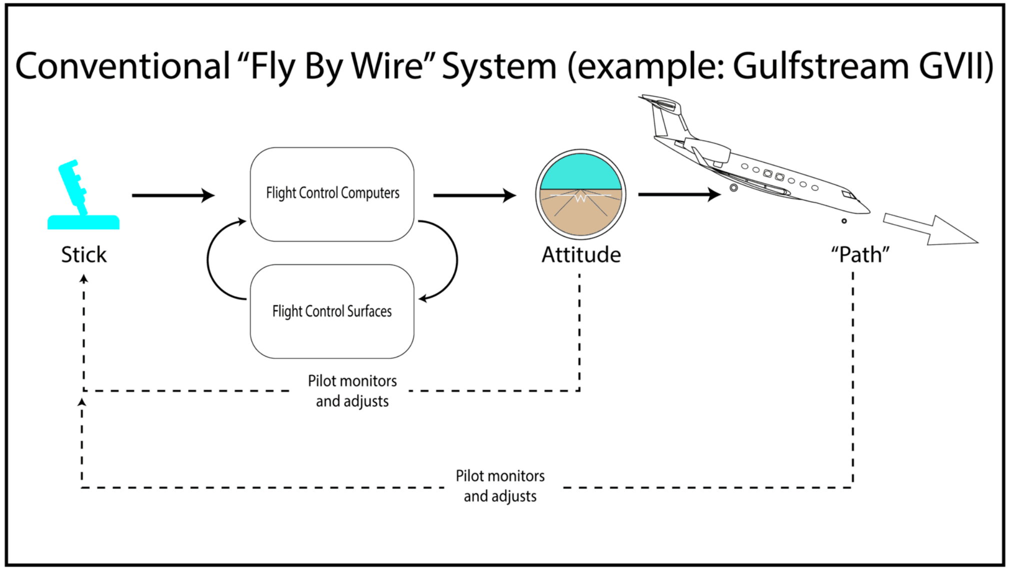
In a conventional aircraft where the stick is connected to the control surfaces via cables, pulley, and other mechanical devices ("fly by cable"), the pilot knows with absolute certainty that the ailerons and elevators are in positions directly correlated with the position of the stick. The resulting aircraft attitude, however, is influenced by many other factors. The aircraft's speed, weight and center of gravity, for example, can result in different attitudes for the same stick position. It is up to the pilot to "close" this loop by monitoring the aircraft's attitude and adjusting with the stick.



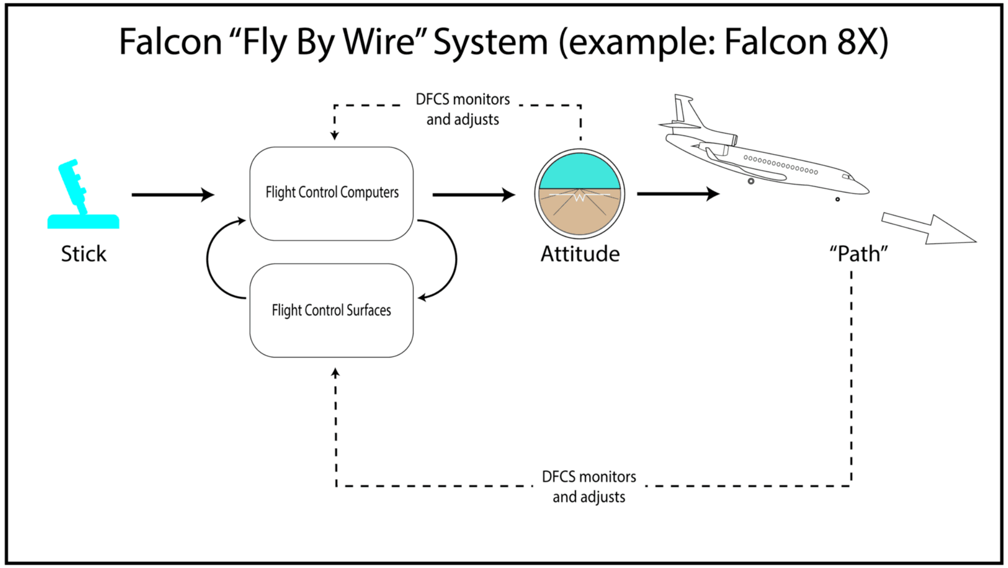
A simple "fly by cable" input/output schematic. Credit: James Albright

Once the pilot is satisfied with the aircraft's attitude, they must evaluate the resulting path to ensure it is acceptable. Let's say the pilot wants to establish a 3-deg. descent with a turn that will allow rolling out on final in a visual traffic pattern. The pilot moves the stick to establish a pitch 2 deg. below level flight and a bank of 25 deg. to the right. If the resulting pitch is too high and the bank angle is too shallow, the pilot moves the stick again to correct, closing the first loop. Once satisfied with the aircraft's attitude, the pilot then checks the aircraft's path. It could be that the descent rate is good, but the aircraft will roll out inside the desired track, indicating the target bank angle is too steep. The pilot then closes the second loop by again adjusting the stick, this time to reduce the bank angle. The pilot, of course, is doing all of this continuously and, in a sense, subconsciously. The pilot is also the only thing preventing an excursion outside the flight envelope, as the flight controls obey the commands, even if they are wrong.

A conventional fly-by-wire system doesn't change the input/output flow at all, except that flight envelope protection software could prevent unacceptable attitudes and there may be monitoring and feedback systems in play. One or more flight control computers send instructions from the stick and other sources to flight control actuators and report back flight control position to ensure the stick and control surfaces agree. It is still up to the pilot to ensure the aircraft attitude is as intended (the first loop). The



A conventional fly-by-wire input/output schematic.
Credit: James Albright



A "closed loop" fly-by-wire input/output schematic.
Credit: James Albright

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pilot must also cross-check the resulting path (the second loop).

The Falcon 8X DFCS closes the first loop by moving whatever control surfaces are needed to achieve the desired aircraft attitude. The pilot moves the stick with the aim of establishing an aircraft path or trajectory relative to the ground and the DFCS does whatever it takes to achieve and maintain that path, provided it is within the aircraft's flight envelope. The DFCS then monitors the actual aircraft trajectory with its inertial reference systems and other computers to close the second loop.

Approach and Landing

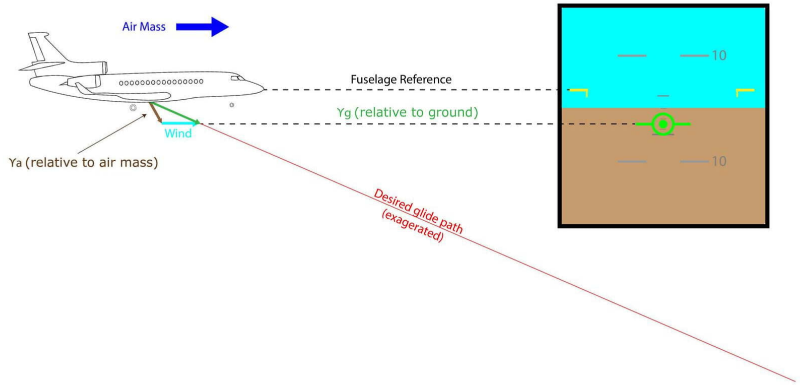
The Bedford pattern was busy, and we were instructed to intercept a long final, giving me a chance to better understand the "path stable" and "trajectory based" flight control system. While on final, I was able to see that positioning the FPV to establish a desired descent rate was quite easy. In non-Falcon terms, I moved the stick to put the nose where I wanted it, took my hand off the stick and the nose stayed where I left it.

The limiting flap speeds are tightly spaced at 200, 190 and 180 KIAS for SF1, SF2 and SF3. The landing gear operating speed is also 200 KIAS. Once at 200 kt., we quickly configured and settled on an SF3 approach speed of 117 kt. at a gross weight of just over 43,000 lb.

Once we intercepted the glidepath, I placed the FPV on the touchdown zone of the runway, using the HUD, and took my hand off the stick. The FPV just stayed there, even as the wind direction changed and increased in velocity as we descended. It took me a while to understand the magic behind the mirrors and I think a short explanation will help show the beauty of the "hands off" approach to the 8X's sidestick.

To illustrate this, consider the aircraft on ILS final at 1,000 ft. where there is a tailwind. The deck angle of the aircraft is relatively flat to increase the its descent rate relative to the air mass, which allows the aircraft to maintain the flight path relative to the ground. We know this instinctively because a tailwind requires a higher-than-normal sink rate.

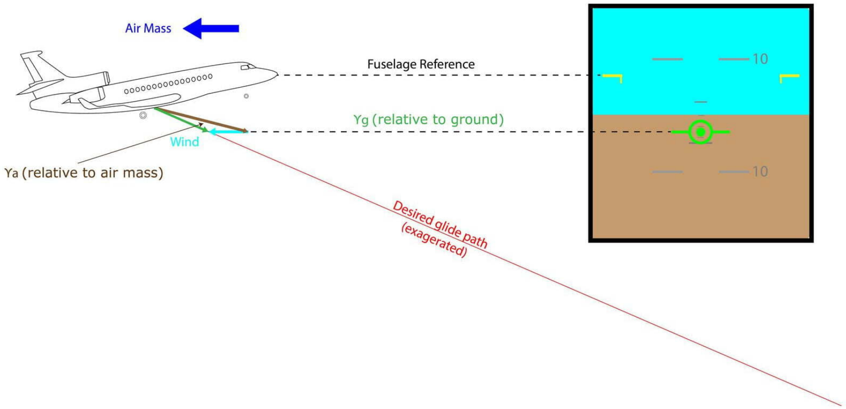
Now consider what happens if there is a wind shift as the aircraft descends; so that at 500 ft., the aircraft now has a headwind. If we want to remain on glidepath relative to the ground, we must raise the pitch. In a conventional aircraft, fly-by-cable or fly-by-wire, the pilot pulls back on the pitch. In the 8X,



A hypothetical stable flight path on ILS final with a tailwind at 1,000 ft. Credit: James Albright

the DFCS does this automatically by targeting the path the pilot commands with the sidestick and then uses the appropriate flight control inputs to achieve the path.

While Bedford is not in a mountainous area, the synthetic vision system (SVS) showed a clear view of the terrain on the top portion of the HUD. The bottom depicted the view from the enhanced vision system (EVS). Unlike other EVS installations, the Falcon 8X uses a combination of six sensors that fuse infrared and visible light spectrums together to create the combined vision system (CVS), also known as FalconEye. With the runway clearly in view, I used the panel-mounted SVS Split control to maximize the SVS. The system automatically cuts out a trapezoid for the EVS image



A hypothetical stable flight path on ILS final with a headwind at 500 ft.
Credit: James Albright

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where the runway appeared, ensuring pilots are seeing an actual view of the runway, not one generated by an SVS database. Even in daylight, visual conditions, the utility of the system was clear. Adding the SVS makes this a much better HUD solution than any I've seen from other manufacturers. For much greater detail on the CVS, see our article, "Dassault FalconEye," in the September 2018 issue of BCA.

At about 30 ft. I pulled the throttles to idle, and we touched down right at the 1,000-ft. fixed distance markers. I fully deployed the center engine's thrust reverser and applied moderate pressure to the wheel brakes, bringing us to taxi speed in less than 3,000 ft.

FalconEye view through the HUD of the SVS on top and EVS on bottom.
Credit: Dassault Aviation

Learning to Speak Falcon 8X
As someone who started flying business jets from what Nese called "Brand G," I came to the Falcon 8X with a set of preconceived notions. The

maximum range statistics of most Falcon aircraft have always been a mystery to me; can the aircraft really be that much more efficient? I must admit to some jealousy over the years from Falcon pilots harping that nothing flies better. While Gulfstreams no longer handle like pickup trucks, I think they are still overpowered beasts. I also arrived wondering about the claims about the trajectory-based nature of the flight control system and its "closed loop." Finally, I needed to dive into the safety question: Is the aircraft a step ahead of its competitors in this, the most important metric? My flight and a little further study answered all my questions.

Is the aircraft design as efficient as they claim? It appears so. The 8X's marvelous range numbers are due in part to efficient engines, which burn less fuel per hour than those of other ultra-long-range aircraft. It is also due in part to the fact that the aircraft itself is designed so efficiently as to provide a lower basic operating weight, which allowed for a greater maximum fuel capacity. The tradeoff, however, is a lower cruise speed.

Higher speeds do impress on shorter distances. For example, a G500 at Mach 0.90 will get you from New York to Frankfurt almost a half hour faster than an 8X at Mach 0.83. But all that extra speed is negated if a fuel stop is needed. I ran the numbers for a given set of conditions from New York to Tokyo. The 8X needed 13+47 (hours + minutes), nonstop, at Mach 0.80. The G500 needed a fuel stop in Anchorage, Alaska, flying 6+23 on the first leg and 6+58 on the second, for a total of 13+21. It is possible to refuel a G500 with a full load of fuel in less than 36 min., but everything must go just right. So, the 8X probably gets you to Japan faster. But if we are measuring efficiency, we need to consider the fuel burn.

The great circle route from New York to Japan is almost 800 mi. shorter than the combined routes from New York to Anchorage to Tokyo. The 8X used 32,300 lb. of fuel while the G500 required 21,273 lb. on the first leg and 24,038 lb. on the second, for a total fuel burn of 45,311 lb. The 8X consumed 40% less fuel.

What about the "nothing flies better" claim? I obviously can't judge "nothing" since I haven't flown "everything." But I can say the 8X flies very nicely. I can go further and say the controls are lighter and more responsive than those of any older Gulfstreams I've flown, but I would place the GVII series of Gulfstreams on a par or maybe even ahead of the 8X. That might be due to my personal preference for an active sidestick, which helps me feel more connected to the aircraft. A seasoned 8X pilot would probably prefer their "hands off" stick.

Is the Falcon 8X really path stable? Pretty much. The aircraft will maintain a flight path to a point. You could, for example, tell the aircraft to maintain a climbing path that is unsustainable. (But why would you do that?) Turbulence can also disturb the targeted path, which may require pilot correction. As I saw during our approach and landing at Bedford, a shift in wind direction can disturb the lateral path, but corrections are easier to make because of the closed-loop flight control system.

Does the Falcon 8X "close the loop" in flight control systems? It does indeed.

In a conventional aircraft, the pilot must constantly monitor the aircraft's attitude and path to ensure they are behaving as intended. If an 8X pilot has the discipline to release the stick after moving it, the DFCS should keep the aircraft on the intended path.

Is the Falcon 8X a step ahead in safety? I know this will be controversial, but my answer is an unequivocable yes for two reasons.

First, the closed loop of the digital flight control system provides a huge advantage to pilots who choose to use it. (The system is always on, but if you don't take your hand off the stick you negate some of the benefits.) Let's say you are on a left base turn to final at a busy airport with a very big and gusty crosswind. (Imagine a typical day at Teterboro Airport, New Jersey.) The aircraft is at 25 deg. of bank and descending about 900 fpm. Tower tells you a helicopter is departing to your left; do you have the traffic in sight? With an open loop system, you have a natural inclination to move the stick or yoke to the left and aft when you look left while in a left turn. In a hectic situation, you could find yourself overbanking and pulling into a stall. If you have the discipline to release the 8X's stick after setting it, the aircraft will maintain its bank and path.

Second, the FalconEye CVS provides pilots a revolutionary situational awareness tool that has no parallel from any competitor. I've been flying with conventional EVS for a long time now and can confidently report these systems are effectively blind in some conditions. If, for example, you are descending along the usual approaches into Eagle Airport, Colorado, on a cold night where the mountain and air temperatures are closely matched, you will not see the mountains at all. The same holds true for most airports drenched in a cold rain. Blending SVS with EVS lets pilots see the terrain based on a terrain database, while still being able to faithfully see the runway based on actual conditions. Any HUD without SVS is at a severe disadvantage.

As a long-time card-carrying member of the over-powered-beasts club, I must admit the Falcon 8X is a revolutionary bird when it comes to efficient design and innovative safety features. I am looking forward to the next big thing from Dassault, the Falcon 10X. With its twin Rolls-Royce engines rated at 18,000 lb. of thrust each, maybe Falcon pilots can finally join the over-powered-beasts club.

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