

## Legacy 500: Super Midsize Technology Leader Fights For Market Share



[Embraer](#) launched development of the Legacy 500 in 2007, with the aim of creating business aviation’s first super-midsize aircraft with fly-by-wire, throttle-by-wire, brake-by-wire and steer-by-wire systems. Advanced technology, unmatched operating efficiency and unprecedented reliability were intended to be differentiators in a market segment dominated by the simple, yet reliable [Bombardier Challenger 300](#).

The firm succeeded by wide margins, according to flight department managers and pilots we contacted for this article. While much stronger competition emerged from Wichita, Montreal and Savannah during the ensuing seven years, operators say their aircraft still maintain a technology lead to the present day.

“We looked at the Challenger 350 and Gulfstream G280,” says Jerry Bogartz, who flies Serial Number 12 based in West Palm Beach, Florida. “But it beats the others hands down.” He compares it to the [Boeing 777](#) he flew for the airlines for seven years. “It’s a sweetheart of an airplane.”



**“We moved up from a Falcon 20. We looked at the Bombardier Challenger 300, Gulfstream G280 and Citation Latitude. There’s no comparison,” says Stephen Manifesta, who flies s.n. 17 for ABP Capital based in Carlsbad, California. The Legacy 500 outperforms them all.”**

One prime reason for the technological lead is the depth and breadth of Embraer’s engineering talent. Many of the more than 1,000 engineers employed to create the clean-sheet design formerly worked on Embraer’s revolutionary E jets, next-generation passenger aircraft that rewrote the rules for regional airliner technology, performance, comfort, crew situational awareness and operating efficiency.

**“Our owner fell in love with [the Legacy 500’s] technology, the fly-by-wire flight controls and the Rockwell Collins Fusion cockpit,” says Brad Knaack, who flies s.n. 24 based in Sioux City, Iowa. When his company upgraded from its Beechjet 400A, company leaders looked at the Gulfstream G150, G200 and some midsize Cessna Citations, among other aircraft. But all other competitors fell far short of the Legacy 500’s advanced capabilities.**

**“This is like being back in a big airplane, like the Falcon 7X that I flew for Shell,” says Chad Salter, who flies s.n. 14 based in Orlando. The Falcon 7X, the first purpose-built business aircraft to have a full, three-axis digital flight control system, carries a price tag more than twice that of the Legacy 500, Salter notes.**

Embraer engineers knew aircraft design always involves tradeoffs. Following its long-standing business aircraft design process, the goal for the Legacy 500 was to position and price the new model one step below its actual super-midsize market niche. Embraer frequently compared the Legacy 500 to the Cessna Citation Latitude, Gulfstream G150 and Learjets 60 and 85. However, its nearest competitors are the Challenger 300/350 and Gulfstream G280.



**The Rockwell Collins Pro Line Fusion cockpit features four, 15.1-in. flat-panel displays. Synthetic vision is standard.**

Giving the Legacy 500 the largest cabin in class would compromise its performance and fuel efficiency. As a result, engineers created an interior equal in height to that of the Challenger 300 but a few inches narrower and 3 in. shorter in length. The leaner cabin helps reduce both empty weight and wetted area, yielding better fuel economy. However, Embraer made the cabin feel larger than its physical measurements by fitting it with 12 of the largest windows in the super-midsize class, flooding it with bright ambient light.

None of the operators we contacted complained about the cabin being too tight. Several **remarked that it's one of the quietest cabins they've experienced.**

Similar to the Challenger 300 and other popular super-mids, the Legacy 500 has a flat floor and double-club seating for eight passengers, plus an optional belted potty seat. Either or both pairs of facing club chairs in the aft cabin can be replaced with one or two, three-place divans. Such design flexibility was made possible by locating the emergency exit in the aft lavatory.

**However, the aft lav location of that exit did not meet some airworthiness authorities'** passenger access requirements for air taxi/commercial operations. So, Embraer developed an optional mid-cabin emergency exit configuration to meet FAR Part 135 regulations. Corporate operators, though, say that the aft lav emergency exit provides more flexibility in cabin layouts.

## Operator Profiles

Close to 70% of the 50+ Legacy 500 jets are based in the U.S. Only a few are flown by large public companies. Most are owned by Fortune 1000-size private firms or high-net-worth individuals. A sizable number are operated on behalf of owners by management companies.

**Directional Aviation Capital's Flexjet subsidiary, for instance, operates four Legacy 500s and it's planning to trade up from its five six-passenger Legacy 450 jets to five Legacy 500s. The transition will make it the world's largest fleet operator of the aircraft.**

Corporate operators include MGM Resorts in Las Vegas, which uses two aircraft mainly to transport VIPs to its gaming facilities; Michels Corp., a utility and civil engineering and construction firm in Fond du Lac, Wisconsin, with two aircraft; coal mining magnate and philanthropist Christopher Cline of North Palm Beach, Florida; Prince Manufacturing, a major B2B hydraulic component manufacturer in Sioux City, Iowa; and Universal Health Management, a senior care and assisted-living firm in Tampa, Florida.

Others include Double Eagle Development, an oil exploration firm in Fort Worth; Lou Sobh Group, a large car dealership holding company in Jacksonville, Florida; Sicar Farms in

McAllen, Texas; Lockwood Holdings, an oil field developer in Houston; Paradox Security Systems in Ronkonkoma, New York; and LMG, a nationwide provider of video, audio and lighting support based in Orlando, Florida. Real estate investment firm ABP Capital in Encinitas, California, flies one, as do Cambridge Holdings in Dallas, gaming equipment pioneer Charles Mathewson in Reno, Nevada, and hotel staffing specialist Mastercorp and Life Care Centers in Crossville and Chattanooga, Tennessee, respectively.



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**Outside the U.S., Servicios Aereos Across SA de CV (dba “Fly Across”) in Toluca, one of Mexico’s largest air charter and management companies, operates four Legacy 500s, along with Embraer Phenom 100 and 300 light jets, several models of Cessna Citations, plus some large-cabin aircraft. The Brazilian Air Force flies two Legacy 500s. Civilian operators in Brazil include GJP Resorts, Almeida Junior Shopping Centers and Eurofarma Laboratories, plus holding company Mahil Investments and Ventures Ltd.**

In Europe, Air Hamburg and Elite Jet Service in Dusseldorf, Germany, operate the aircraft, as do Saxon Air and Centreline Air charter in the U.K., along with a high-net-worth individual in Kazan, Russia. Air taxi operator Bon Air in Istanbul flies one, along with several Cessna Citations, two Hawker 800-series jets and two

Challengers. Charter operator Cedar Executive in Beirut and Sky Prime in Riyadh operate the aircraft. In Asia-Pacific, Regional Insurance Brokers in Queensland, Australia, PT Ers

Eastern in Jakarta and luxury goods purveyor Sparkle Roll Group in Beijing each operate one aircraft.

Fleet operators work their aircraft hard, flying them 700+ hr. per year. Single aircraft operators typically fly their aircraft 150-200 hr. per year. Average mission length for most operators is less than 2 hr.

As expected, most operators reported upgrading to the Legacy 500 from smaller, shorter-range aircraft. Previous operating experience with other Embraer business aircraft often influenced the purchasing decision.

**“We went through a comprehensive RFP [request for proposal] process to arrive at the best value proposition,” says David Cox, flight department manager for MGM Resorts. “Reliability, performance and cost ultimately drove us back to Embraer. The Legacy 500 is 12 to 14 times more reliable than any [purpose-built business aircraft] we’ve ever operated. It’s on par with a BBJ.” Cox says his firm actually is downsizing some of its large-cabin aircraft in favor of the Legacy 500. It also operates an Embraer Lineage 1000E.**



**The galley area may be closed off from the main seating area with an optional pocket door in the bulkhead. It has a 4-gal. water reservoir and electric water heater.**

“We had a Phenom 300. We looked at the Challenger 300 and Gulfstream G280. The Legacy 500 beat them hands down,” says Bogartz. “We can easily operate out of 4,000-ft. runways for 2-hr. missions.” On comparable length missions, the Legacy 500 has the shortest runway requirements of any current production super-midsize aircraft, according to *BCA’s May 2017 Purchase Planning Handbook*.

**Acquisition and operating costs figured strongly into operators’ purchasing decisions, often involving a three-way competition between the Legacy 500, Bombardier Challenger 300/350 and Gulfstream G280. Operators say that the Challenger 300/350 carries a retail price \$7 million higher than the Legacy 500, but Bombardier offered deep discounts that equaled or beat Embraer’s firm \$20 million price for the Legacy 500. Until recently, they say, Gulfstream held firm on its \$24.5 million price for the G280. Embraer, in contrast, held firm on prices, maintaining that the aircraft provides better “value for the money,” according to Marco Tulio Pelligrini, former head of Embraer Executive Jets.**

Some operators say they were deterred from considering the Challenger 300/350 because **they were concerned about Bombardier’s product support and long-term viability** because of the acute financial stress it underwent while developing the C Series regional jets. Much of that concern disappeared **when Alain Bellemare was appointed Bombardier’s president and CEO in February 2015. One of Bellemare’s first moves was to bring back David Coleal, former head of Learjet, and move him up to run Bombardier’s business aircraft division.**

**Others say Gulfstream’s product support is excellent but that its aftermarket support and parts prices are too steep. Operating cost concerns made them shy away from the G280.**

**Tulio’s policy of not slashing the Legacy 500’s \$20 million price tag has had a two-pronged effect. It dampened initial demand for the aircraft, but operators say it will pay long-term dividends in bolstering resale values. Nonetheless, the first few Legacy 500s offered on the resale market have lost 25% of their value because of the glut of used super-midsize aircraft on the pre-owned market.**

### Best and Worst Features

Operators frequently ranked that having the most advanced technology in class frequently is the best feature of the aircraft.

**This starts with the aircraft’s full, three-axis digital fly-by-wire (FBW) flight control system, a technology that was previously only offered on a few large-cabin jets, such as the Falcon 7X**

and Gulfstream G650. Similar to [Dassault](#) and [Gulfstream](#), Embraer's FBW development team took a decidedly pilot-centric approach to the flight control system.

However, Embraer **didn't** derive its FBW system from earlier French or American designs. It's all-Brazilian and it's intended to be used on a whole new family of Embraer business aircraft, as well as being adapted for Embraer's [KC-390](#) military transport and the second generation of regional [E-Jets](#). The major investment in FBW now is paying dividends as the E2 nears entry into service.



**The aircraft also has standard full-authority autothrottles and autobrakes, features currently found only on the G280 and larger aircraft**

Embraer's approach to FBW is elegant in its simplicity. Similar to some tactical military aircraft, the Legacy 500's system offers carefree handling characteristics to minimize workload most of the time, but it also provides natural aerodynamic feel in the landing pattern. The pitch control law uses flight path stability when up and away, similar to an [Airbus](#) or Falcon 7X. Down and dirty in the landing pattern, the pitch control law switches to artificial speed stability, similar to that on a [Boeing 787](#), [Bombardier C Series](#) or [Gulfstream G500/600/650](#).

There are no absolute pitch or roll limits, but the normal maneuvering envelope has +30-deg./-15-deg. pitch and +/-33-deg. bank soft limits that can be exceeded by maintaining sidestick control deflection. Flight crews thus have virtually unlimited pitch and roll maneuverability with the FBW system only guarding them against overspeed and overstress, stall and spin.

**Additionally, the Legacy 500's advanced technology standard full-authority autothrottles and autobrakes are features currently found only on Gulfstream's super-midsize G280 and larger aircraft.**

The Rockwell Collins Pro Line Fusion cockpit features four, 15.1-in. flat-panel displays, the largest available for use in business aircraft. Synthetic vision is standard.

Meanwhile, Rockwell Collins HGS-3500 head-up guidance and multi-spectrum EVS-3000 camera systems are available as options, but few operators have the equipment installed in their aircraft. The IR/videocam requires no complex external cooling and it is able to detect LED runway and taxiway lights. Rockwell Collins says the HGS-3500/EVS-3000 are qualified **as an enhanced flight vision system in accordance with FAR Part 91.175. But Cox says he's not impressed with the field of view or image resolution of the mini-HUD.**



**With 27 deg. of wing sweep, long-range speed is about Mach 0.76 to 0.78. However, there is only about a 3% range penalty from cruising at Mach 0.80. Initial cruise altitude is FL 430 and time to climb is 22 min.**

Performance is another Legacy 500 strong suit, operators say. The aircraft can climb directly to FL 430 in 22 min. at MTOW, assuming standard-day conditions. But most operators say they level off at FL 390 to FL 410 on day-to-day shorter-range missions, preferring shorter block times to optimum fuel efficiency.

First-hour fuel burns are 2,200-2,400 lb. Second-hour consumption ranges from 1,700-1,800 lb. at heavy weights to 1,500-1,600 lb. at lighter weights. Operators are comfortable with **Embraer's 3,000+ nm range projection at an average long-range cruise speed of 436 KTAS. And they say that fuel burns and operating costs closely match Embraer's** estimates. [Honeywell](#) MSP rates for the two HTF7500E turbofans run about \$642 to \$658, depending on plan details and annual utilization. Embraer Executive Care costs about \$4,300 per month plus \$321 per hour for low-utilization operators. Fleet operators declined to share operating costs for competitive reasons.

Notably, operators report that BOWs are 200-**400 lb. heavier than Embraer's 23,699 lb.** estimate for the aircraft. So, tanks-full payload drops from 1,780 lb. to 1,580 lb. or 1,380 lb. **One operator says he's run the numbers to fly four passengers from Oakland, California, to Maui, Hawaii, and he could land with comfortable reserves. However, he didn't compute** aircraft range numbers with an engine failure or loss of cabin pressurization at the equal time point in the transpacific mission.

**Dispatch reliability frequently exceeds 99%, operators report. The airplane's jetliner DNA pays tangible dividends. If something does break, there's easy access to most components** mounted outside the pressure vessel.

One notable exception is battery access. The forward battery is mounted behind the copilot and the aft battery is located behind upholstery panels in the lavatory compartment. Interior pieces have to be removed and replaced to change or service the batteries.

The other exception is potable water servicing. The separate galley and lavatory refill ports both are inside the cabin. Operators say they would like one refill port that is located outside.

Other assets of the aircraft praised by operators include its high-capacity, vacuum toilet system that permits multiple leg operations without the need for servicing; cockpit ergonomics; hand-flying ease; and wide CG range.

**"It doesn't matter where you seat the elephant. It's going to stay in the CG envelope,"** quips Bogartz.

The aircraft has a heated, but unpressurized, 110-cu.-ft. aft baggage compartment that is well shaped to accommodate bulky items. It has another 40 cu. ft. in the aft cabin and lavatory

compartment. Only a few operators said they missed having inflight access to a pressurized aft baggage compartment, as offered by the Challenger 300/350 and Gulfstream G280.

But as with most clean-sheet designs, the Legacy 500 comes with its share of IOUs and opportunities for improvement.

Perhaps most pressing is Do-260B ADS-B compliance in time for the [FAA's Jan. 1, 2020](#), deadline. Early serial number aircraft were delivered with Do-260A-compliant ADS-B gear that lack the position accuracy verification, system monitoring and extended message set required by Do-260B. The later standard also requires either TSO C-145/146 satellite-augmented GPS or TSO C-196 aircraft-augmented GPS receivers. Embraer is developing an upgrade kit, including modified Mode S extended squitter (ES) and TSO C-145/146 GPS **receivers, including new GPS antennas. It's not yet clear when the kits will be widely available** and who will pay to install the equipment. Replacing the top fuselage-mounted unaugmented GPS antennas with SBAS GPS antennas and cabling, for instance, requires removal and replacement of large sections of the interior, entailing several days in the shop and dozens of labor hours.

For transatlantic missions, operators also say they want Embraer to develop a FANS-1/A over Iridium Satcom capability. Embraer apparently is working on that, but no firm date for availability has been announced.

Electrical load distribution in the event of a left engine failure poses another potential challenge for operators. The left hydraulic system has an engine-driven pump and an electrically powered pump. If the left engine is inoperative, the right engine-driven generator **may not have sufficient reserve power to supply the left hydraulic system's electric pump.** Embraer has issued a Flight Operational **Letter addressing the issue, but essentially it's a** temporary procedural workaround requiring the crew to isolate the left and right electrical buses during certain phases of flight. Turning on the APU for takeoff and landing also can provide the extra electrical power needed for the left hydraulic electric pump in case of left engine failure.

Embraer tapped top-tier aircraft cabinet-maker F/List of Thomasberg, Austria, to supply the monuments of the aircraft. But operators say that early serial number aircraft have foldout tray table hardware that works loose in day-to-day operations, causing the tray tables to rattle and sag. Upgrade kits, containing more-robust hardware, now are being supplied to operators of affected aircraft. A block point change incorporates the improved hardware in newer aircraft.

Several operators report optical distortion of the windshields when heat is turned on. Embraer traced down the problem to defective windshield heat controllers. Upgraded units are being developed that promise to remedy the problem.

A few operators report problems with one or more of the four Gen IV UTC SmartProbe air data sensors. These self-contained probes sense pitot and static pressure, plus angle of attack and sideslip using differential pressure. However, removing and replacing the probes is a comparatively quick and easy task, as opposed to running down plumbing leaks in a conventional air data system.

Spares were in short supply from Brazil when the aircraft first entered service in late 2014. Operators say English to Portuguese language problems made ordering parts more difficult. But now Embraer is shifting much of its parts inventory from Brazil to the U.S., so language barriers have collapsed and parts are considerably faster to order.

**“Embraer gets an ‘A’ for effort,” says Manifesta. “It’s getting better.”**

When the aircraft first entered service, FlightSafety International initially had challenges in preparing ground school staff and sim instructors for the new model at its St. Louis facility. **The training course was modeled after FSI’s FAR Part 121 commercial** airline programs, was long on A & P-like technical training and short on what could be seen and controlled from the cockpit. Now, FlightSafety is moving toward Operational Day Flow scenario-based training for the Legacy 500 and operators say the quality has improved markedly.

**“Embraer’s DNA is high utilization and high reliability,” says Michael Amalfitano, who was appointed president and CEO of Embraer Executive Jets this past February. “I take a very hands-on approach to customers.” He’s directing the** full efforts of his technical team to resolve such customer concerns as soon as possible.

On Balance

**“It’s a really nice airplane,” says Bogartz. “It flies high. It flies fast. Look at the numbers. It’s hard to beat.”**

**“It’s built like a tank. Overall, it’s very, very solid,” Salter claims.**

**“Reliability, performance, operating cost,”** are what make the Legacy 500 stand out from the competition, says Cox.

However, the market is upping the bar for super-midsize performance expectations. To be strongly competitive in class, **it’s no longer sufficient just to offer transcontinental U.S. range**

against 95% probability winter winds and with typical reserves for chronic northeast U.S. ATC delays. Many operators say Embraer needs to develop an extended range version of the aircraft.

Operators are well aware that the Challenger 350 has a slight range advantage and that the **G280 can fly 500 nm farther with four passengers. They're also watching the progress of Textron Aviation's CE-700 Citation Longitude**, as it promises 400 to 500 mi. more range than the Legacy 500.

Embraer is studying a longer-range variant, perhaps known as the Legacy 500EX, operators say. To stretch the range to 3,500 nm, it would need about 2,000 lb. more fuel, and accommodating that much more Jet-A would require major modifications to the design, perhaps even changes to airframe dimensions.

**Operators, though, don't believe that an extended-range version of the Legacy 500 will be announced in the near future. In spite of longer-range super-mid competitors, they're quite content with the capabilities of the current model while they await possible future variants.**

**"Overall, it's a great airplane. Just look at the technologies — fly-by-wire, autothrottles, autobrakes, Pro Line Fusion," says Knaack. And, Salter concludes, "Embraer is going to be a major player in this market for decades to come."**