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Embraer Legacy 450

Raising the bar in **technology**

BY **FRED GEORGE** fred.george@penton.com

The battle is joined. The Legacy 450 now has both Brazilian ANAC and U.S. FAA type certificates. And once again, Embraer has Cessna directly in its sights as it challenges its North American competitor for another class championship title. This time, it's the new Legacy 450 going head to head against the Citation Latitude in the entry-level super-midsize category. Embraer modestly calls the Legacy 450 a "mid light" business jet, even though it has the same fuselage cross-section as its 3,100-nm Legacy 500 super-midsize jet. Cessna says its 2,850-nm Citation Latitude is a midsize jet with the most cabin volume in class.

The 2,575-nm Brazilian entry, though, sets new and higher standards for passenger comfort, cruise speed and systems technology in this size of business aircraft. Maximum cabin width is 5 in. greater and floor width is 7 in. more generous than the Latitude's. But cabin length is about 15 in. shorter, so the Legacy 450's overall cabin volume, excluding its 35-cu.-ft. aft internal luggage compartment, is within 2% of its Wichita rival's.

While the Latitude has a 275-nm range advantage, the Legacy 450 excels in many other areas. It's the only business aircraft priced under $50 million, other than the Legacy 500, to boast fly-by-wire (FBW) flight controls. The digital system lowers pilot workload by providing flight envelope protection, thrust asymmetry compensation in the event of engine failure and maintaining a constant flight path when changes are made to thrust, speed or configuration.

Nestling into the left seat, we were reminded of the excellent visibility afforded by the large windows and cockpit layout. The four large EFIS screens, along with standard synthetic vision, provide robust situational awareness.

More importantly to passengers, FBW provides a considerably smoother ride because it damps out minor bumps, gusts and shears.

The aircraft also has throttle-by-wire, steer-by-wire and brake-by-wire digital control systems. Auto-brakes, HUD, EVS and a steep approach capability are options. No competitor has lower interior sound levels or a more comfortable ride in turbulence, based upon our observations. The aircraft's vacuum lavatory is standard. And it's very quiet when flushed.

Compared to the Legacy 500, which is $4 million more expensive, the Legacy 450 has one fewer row of seats, a 4 ft. shorter cabin and 500 nm less range. Similar to the Legacy 500, it typically cruises at Mach 0.78 to 0.80 in the low to mid-forties and it can dash at Mach 0.82 in the high-thirties. The Legacy 450 only is about 2 to 5 min. faster than the Latitude on typical 1- to 3-hr. missions because it climbs to higher altitudes for those profiles. However, it also consumes less fuel on such missions compared to the Latitude as it cruises higher. Because of its slippery, swept, super-critical wing, its long-range cruise speed actually is 10 kt. faster than the Latitude's high-speed cruise.

Heavy Duty Structure and Systems

Shortening a structurally optimized aircraft, such as the Legacy 500, to create a smaller variant seldom yields a significant savings in aircraft empty weight. The Legacy 450 is no exception. The 4-ft. reduction in fuselage length lowered BOW by 509 lb., a scant 2% reduction. The Citation Latitude, in contrast, gained only 245 lb. when Textron grafted the considerably larger fuselage onto the Citation Sovereign+ airframe.

The Legacy 450's wing structure remains essentially unchanged from the Legacy 500, except for a 3,207-lb. reduction in fuel capacity. The primary airframe is a semi-monocoque, high-strength aluminum alloy structure with stressed skins, longerons and hoop frames in the fuselage and stressed skins with integral longerons, chord-wise ribs and twin main spars plus a rear sub spar in the wings. The airfoil has 27 deg. of sweep at quarter chord and an area of about 432 sq. ft. The wing has a "hard" leading edge with no slats and a sharply swept inboard section to increase internal volume for fuel. Long-range cruise speed is Mach 0.76, but there is very little drag rise at Mach 0.80.

The wing's trailing edge has four, electrically actuated flap panels. The power drive units are easily accessible through access panels on the bottom of the wing-to-fuselage fairing. The winglets are bolted on, facilitating easy replacement if they suffer damage.

Notably, the aircraft is a full MSG-3 design with 750-hr./12-month maintenance intervals. Most operators are expected to fly fewer than half that many hours per year, thus the aircraft maintenance can be scheduled for once per year. Economic design life is 27,500 hr., so in theory the average aircraft could remain in service for more than 70 years.

The two Legacy models also share virtually identical Honeywell HTF7500E (AS907-3-1E) turbofan engines, the latest and lightest weight versions of the powerplants that made their debut 12 years ago aboard the Bombardier Challenger 300. The engines are factory rated at 7,638 lb. thrust to ISA+18C. Aboard the Legacy 450, they're derated to 6,540 lb. thrust to ISA+18C to reduce stress, increase reliability and shrink maintenance cost.

The 11 primary flight control surfaces, including the two elevators, rudder, two ailerons and six-panel multifunction spoilers are electrically controlled by the FBW system and hydraulically actuated. The horizontal stabilizer is electrically controlled by the FBW system in normal mode and repositioned by dual electrical actuators. The stab can be manually trimmed by the pilots by means of an up/down rocker switch in the center console when operating in direct law mode. Before engine start, the crew manually adjusts stab pitch position in relation to aircraft center of gravity.

All fuel is carried in left and right wet wing tanks, with outboard surge and vent tanks. The APU feeds off the right tank, so cross-feed may be necessary during prolonged operations. Each tank has a main and backup DC pump. Cross-feed, rather than fuel transfer, remedies fuel imbalance. The single-point pressure refueling adapter, with a selectable refill quantity function, is ahead of the right wing. Alternatively, the aircraft can be refueled using over the wing refueling ports. Embraer reduced the Legacy 450's fuel capacity by 3,200+ lb. by moving the outer bulkheads of the wet wing tanks inboard and relocating the filler caps closer to the wing roots.

All three landing gear mounts have dual wheels. The main landing gear has trailing link geometry for smooth touchdowns. It's fitted with 2,000-cycle design life carbon brake packs, controlled

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Embraer Enhanced Vision System (E2VS)

The Legacy 450 and Legacy 500 are the launch platforms for Rockwell Collins' new HGS-3500 compact head-up guidance system and uncooled, tri-spectral EVS-3000 enhanced vision sensor. Embraer and Rockwell Collins are pursuing Enhanced Flight Vision System certification for the combined HGS/EVS system that will enable operators to fly down to 100 ft. AGL/1,600 ft. RVR minimums on low-visibility instrument approaches.

The HGS-3500 has an integral micro LED image generator directly adjacent to the image display combiner glass, so it needs no bulky overhead projector unit. The EVS-3000 has a highly sensitive, low-light video camera, a short-wave infrared sensor to detect incandescent lights and a long-wave infrared sensor that detects background thermal radiation from runways, buildings, aircraft and vehicles.

We've flown the system and performance is impressive, but there's plenty of development work to be done before system certification in mid-2016. Weight, volume, power consumption and installed price should be half of current generation EFVS systems'. The uncooled EVS sensor also should have considerably better reliability and lower maintenance costs than today's cryo-cooled InSb sensors.

by means of a brake-by-wire system. There are brake temperature indicators on the EICAS. The speed proportionate nosewheel steer-by-wire has +/-62 deg. of steering authority and is controlled through the rudder pedals. The steering system may be disengaged by toggling a switch on a ground service panel, enabling the nosewheel to be rotated +/-170 deg. This action also activates a "towing allowed on green" annunciator light on the panel.

Bleed air is used for engine starting, heating/air-conditioning and pressurization, anti-ice protection and primary door seal inflation, plus aft baggage bay heating. Notably, the aircraft has both wing and horizontal stab leading edge anti-ice systems, providing a superior level of ice protection.

There is a single air-cycle machine pack and a backup bleed-air heat exchanger system. The cockpit and cabin have separate thermostats. Pressurization is fully automatic, with destination airport field elevation provided by the FMS. Cabin altitude is 6,000 ft. at the aircraft's certified ceiling of FL 450. A 77-cu.-ft. oxygen bottle, mounted in the aft fuselage, is standard and a 115-cu.-ft. bottle is optional.

All exterior and interior lights are LEDs. The interior LEDs used for reading and table lights, upwash and downwash, floor area and ordnance signs have a 50,000-hr. design life. Exterior LEDs, used for landing and taxi lights, logo and nav, beacon and strobe, ice detection and service area illumination, have a 10,000-hr. design life in accordance with TSO specs.

Fire protection is another strong suit of the aircraft. The engines and APU have fire detection and two fire extinguishing bottles. The aft exterior and interior baggage compartments both have smoke detectors. The exterior baggage bay has dual bottles, one with fast discharge to knock down a fire and a second with slow discharge to keep the fire extinguished. An optional smoke detector is available for the lavatory.

Honeywell's 36-150 APU provides bleed air for main engine starting on the ground and up to 23,000 ft., air-conditioning and pressurization up to 20,000 ft. and electrical power up to 31,000 ft. In theory, this would enable the APU to be used for pressurization on takeoff, thereby making possible main engine bleeds off operation to boost performance for hot-and-high departures. But there's really no need because the engines are so highly flat rated.

Cabin Comfort and Utility

The interior of this aircraft is top grade. Aboard the Legacy 500, Embraer succeeded in raising form, fit, function and finish quality to Bombardier, Gulfstream and Textron levels. This has been carried over into the Legacy 450.

Approaching the aircraft with the APU running, we noticed how quiet it was, no doubt a result of Embraer's careful intake and exhaust duct acoustical treatment for the Honeywell engine. Inside the aircraft, with the airstair entry door open, the cabin seems even quieter than the Legacy 500 we flew last year, thanks to refinements to acoustical insulation, the air distribution system and interior panels.

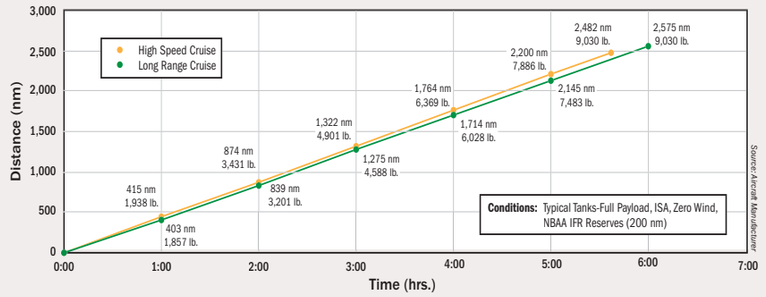
Cabin cooling performance provided by air-conditioning packs was impressive on a warm, humid summer day in São José dos Campos, Brazil. The air distribution system and recirculation fan were as quiet as in any super-mid-size jet we've experienced.

The high-gloss, wood-veneer cabinetry and monuments are supplied by List Components & Furniture of Vienna, Austria. BE Aerospace furnishes the cabin chairs. Honeywell supplies its Ovation Select cabin management system.

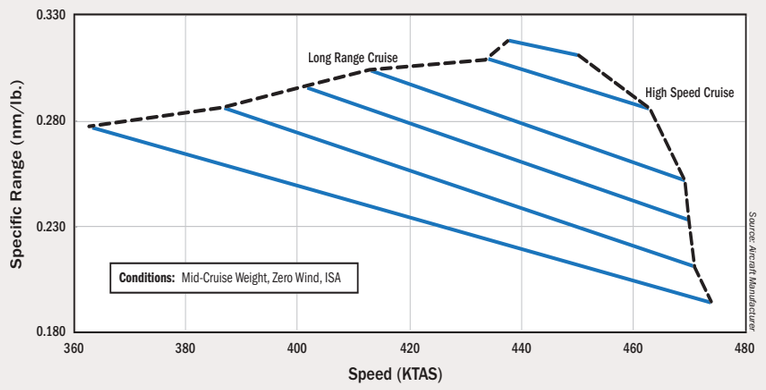
The passenger seats are available with optional heating, massage and adjustable lumbar support, plus fold-out leg rests. The fold-out worktables extend and retract smoothly. They are sturdy when deployed and the work

Embraer Legacy 450 Performance

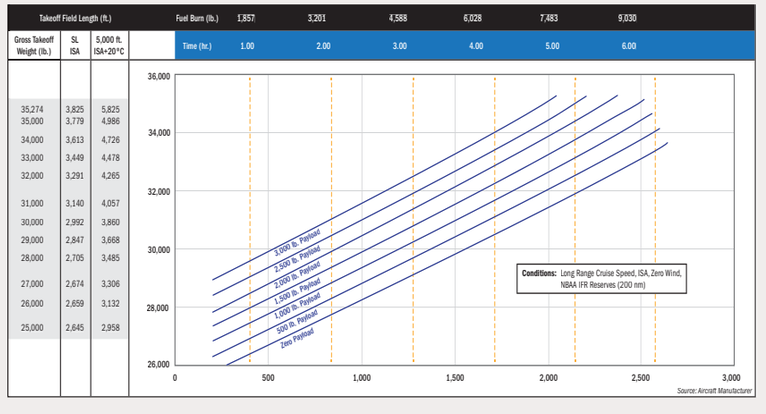
Time and Fuel vs. Distance



Specific Range



Range/Payload Profile



These graphs are designed to illustrate the performance of the Embraer Legacy 450 under a variety of range, payload, speed and density altitude conditions. Do not use these data for flight planning purposes because they are gross approximations of actual aircraft performance.

TIME AND FUEL VERSUS DISTANCE
This graph shows the relationship between distance flown, block time and fuel consumption. The Legacy 450 has an average long-range cruise speed of about Mach 0.76 that yields about 3.7% better fuel efficiency than cruising at an average Mach 0.80. Most operators are likely to cruise at Mach 0.78 to 0.80 because there's so little range loss compared to flying at long-range cruise.

SPECIFIC RANGE (MID-RANGE WEIGHT, ISA) This graph shows the relationship between cruise speed and fuel consumption for the Legacy 450 at representative cruise altitudes for 29,000-lb., mid-weight aircraft. We did not have the opportunity to verify all these data during our evaluation flight, especially as OATs at cruise altitude were 10C colder than ISA.

RANGE/PAYLOAD PROFILE
The purpose of this graph is to provide simulations of various trips under a variety of payload and two airport density altitude conditions, with the goal of flying the longest distance at high-speed cruise. Each of the seven payload/range lines was plotted from multiple data points, ending at the maximum range for each payload condition. The time and fuel burn dashed lines are based upon long-range cruise speeds taken from the Time and Fuel Versus Distance graph. Runway distances for sea-level standard day and for BCA's 5,000-ft. elevation, ISA+20C airport accompany the takeoff weights, using the optimum flap configuration in light of FAR Part 25 runway and second-segment OEI climb performance requirements.

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Each of the seven chairs has a cupholder, storage pocket and a touchscreen passenger control unit (PCU) to control area reading and table lights and IFE choices. There also are shallow storage pockets in the sidewalls to hold PDAs, periodicals and personal readers.

surface extends almost seamlessly from cabin sidewall to aisle side. Each pair of facing chairs has three windows, providing a good view outside the aircraft and bright ambient light over the worktable surface. Each window has a manually operated shade.

The color temperature and brightness of the overhead wash lights may be adjusted by touchscreen control panels in the vestibule and at the master chair in the cabin. A pocket door separating the flight deck from the vestibule is optional.

Optional are individual 9-in. IFE video displays for each seat. Each pair of facing chairs has a 110-VAC duplex power outlet below the fold-out worktable. Each of the rear seats has a single 110-VAC power outlet.

If the two-place divan is ordered in place of the single aft-facing chair in the forward cabin, the outboard armrests have PCUs, sockets for individual monitors and inputs for personal electronic devices.

On the left side of the vestibule, just behind the pilot's chair, there is a standard compact dry galley with various compartments for utensils, ice, beverages and trash. Options include a coffee pot and/or Nespresso machine, a hot beverage container and a convection or microwave oven.

A full-featured, right-side wet galley is optional. It takes the place of an aft-facing chair behind the copilot's seat. If this option is ordered, the right-side window in the forward vestibule is hidden by the galley monument. The wet galley has a 4-gal. water reservoir and electric water heater. The right-side forward cabinet has a top-mounted master touchscreen control station for CMS lighting, IFE, cabin temperature and galley functions. The standard galley counter surface is synthetic stone, but it's optionally available with lightweight granite veneer from List. Above the counter is a tableware storage compartment, with optional inserts for glassware, dishes and utensils. Below the counter is a generously sized cabinet with three drawers, large pullout ice and trash bins, plus a galley stores compartment. Options include microwave and convection ovens, refrigerator and coffee maker/espresso machine.

With the optional right-side wet galley, the standard left-side dry galley can be replaced with a 5-cu.-ft. storage compartment behind the pilot's chair. Other options in place of the dry galley include a fold-down seat for a flight attendant or a fold-out jump seat for a third flight crewmember.

The right forward-facing chair in the four-seat club section is the designated VIP seat. Its PCU also has cabin temperature and lighting controls, including adjustments for color and intensity of interior wash lighting. Apps are available for iPhone, iPod Touch and iPad to transform them into remote controls for the CMS.

At the rear of the cabin, there's a full-width aft lav with a solid, pocket, privacy door. The compartment is brightly illuminated with ambient light when the window shade is opened. The lav features a high-capacity vacuum toilet, a vanity with hot and cold running water and a storage cabinet underneath the sink. A belted potty seat and 115-VAC power outlet are optional.

On the aft side of the lav, there is a 35-cu.-ft. center storage closet with fold-down shelves and a clothes rack that accommodates carry-on luggage and coats. Left and right aft electrical equipment bays flank the center storage closet, providing a climate-controlled environment for sensitive components.

The Honeywell Ovation Select package comes standard with a 1080p HD video system, including high-fidelity cabin audio system, Blu-ray player and master control station in the galley. Available inputs include devices that use HDMI, USB, RCA, VGA and 3.5-mm mini-jacks, so Ovation Select is compatible with most consumer electronics and office equipment boxes, including Apple TV, the Mac mini, iPads and iPhones. Standard equipment includes the Blu-ray player and a single 17-in. monitor on the left forward cabin bulkhead. Front and rear 19-in. bulkhead-mounted monitors are optional. AVOD is not yet available for the aircraft, but Embraer is developing the capability.

The entry door is manually actuated but counter-sprung. It has a primary seal inflated with bleed-air pressure and a secondary seal inflated by cabin pressure. It has an integrated airstair, tread lights, folding arm rail, a cabin pressure relief port and a small window to assure the area below the door is clear before it's extended by aircraft occupants. A secondary acoustical curtain closes off the door in flight to reduce wind noise.

Let's Go Flying

We belted into the left seat of serial number 20, Embraer's factory demonstrator, accompanied by senior test pilot Eduardo Camelier in the right seat, Capt. Luiz E. L. Salgado Ribeiro as safety pilot and flight test engineer Carlos Masaki "Koba" Kobayashi, on the ramp at Embraer's São José dos Campos headquarters. The aircraft's BOW was 23,148 lb., or 220 lb. higher than Embraer's spec weight because of interior options and some residual flight test equipment. As equipped, the aircraft could carry seven passengers with full fuel.

For the evaluation flight, though, the aircraft carried a 1,235-lb. payload and 6,600 lb. of fuel. Ramp weight was approximately 31,000 lb. and computed takeoff weight was 30,820 lb. Koba computed takeoff speeds as 114 KIAS for V1 takeoff decision speed, 114 KIAS for rotation, 121 KIAS for V2 takeoff safety speed and 142 KIAS for flap retraction speed, based upon using flaps 1 and full thrust, the airport's 2,100-ft. elevation, 28C outside air temperature and 1022 altimeter setting. Computed takeoff field length was 4,498 ft. and available runway was 8,710 ft.

The APU was running when we boarded the aircraft. With the airstair entry door open, interior sound levels were quite low in the vestibule, even more so in the main seating area. The demonstrator was equipped with a belted lavatory seat; one premium chair with adjustable lumbar support, footrest and electric massage; a two-place forward divan across from the entry door; and an espresso machine, hot beverage container and convection oven in the left-side refreshment center, plus front and rear 19-in. bulkhead-mounted LCD IFE monitors and individual seat plug-in monitors.

We previously had flown the Legacy 500 with Camelier, so even the crew assignments up front in the Legacy 450 made the two aircraft feel identical. Nestling into the left seat, we were reminded of the excellent visibility afforded by the large windows and cockpit layout. The four large EFIS screens, along with standard synthetic vision, provide robust situational awareness. The screens may be split to host two or more functions, such as PFD and interactive Jeppesen chart on the left and/or right displays.

Flight deck design philosophy is closely aligned with that of Airbus, Boeing, Bombardier and Dassault, with emphasis on a graphic user interface, menu-driven, point-and-click data entry and control functions, and a full array of interactive diagrams or symbols. Embraer's use of display colors is clean, conventional and intuitive.

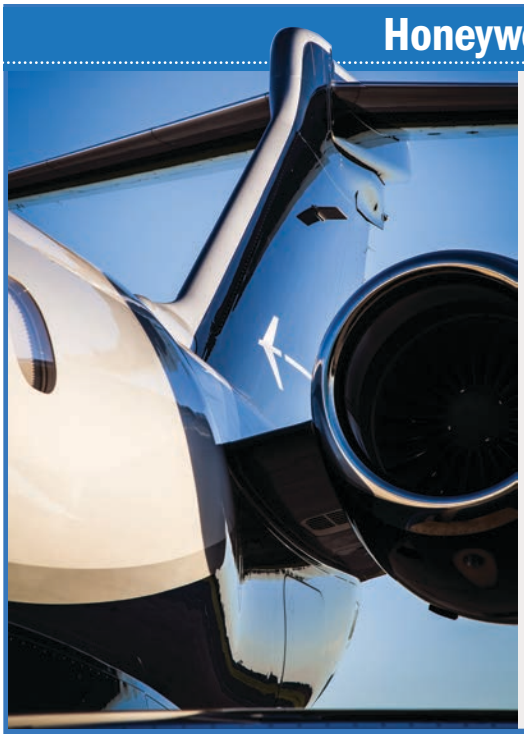
Systems are automated and checklists are short. The aircraft epitomizes the quiet, dark cockpit design philosophy. With most knobs in the 12 o'clock position, annunciator button lights extinguished and a few normal CAS messages displayed, the aircraft is ready to start. To crank the engines, the crew needs only to turn on the red beacon, switch on hydraulic system No. 3, check that the throttles are fully back at idle and twist each engine run switch to the 2 o'clock start position. The aircraft automatically changes the configuration of pneumatic, fuel, electrical and environmental systems for the start sequence and normal operation.

With both engines running, we secured the APU, had the chocks removed and began taxiing to Runway 15. There was ample residual thrust at idle to start the aircraft rolling. The aircraft has no tiller. Nosewheel steering is controlled through the rudder pedals with plenty of turning authority for maneuvering on tight ramps. NWS authority is variably proportionate to rudder pedal displacement and inversely proportionate to ground speed.

Rolling downhill from Embraer's delivery center ramp on Taxiway E to Runway 15, we deployed one or two thrust reversers to stabilize taxi speed to prevent our having to ride the brakes. Approaching Runway 15, Camelier checked brake temperature on the EICAS, and verified proper flap, pitch trim and parking brake positions by pressing a takeoff check button on the center console. A synthetic voice responded, "Takeoff OK."

Directed to line up and wait, we armed the autothrottles, selected autobrakes to rejected takeoff, and switched on strobes and landing lights. Cleared for takeoff, we advanced the throttles to 40%, causing the servos to engage and push up the levers to the stops. Initial acceleration was brisk. At 80 kt., the autothrottle servos disengaged, parking

Honeywell HTF7500E Turbofan Engines



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Well proven over the last 12 years in service aboard business aircraft, the HTF7500E is a twin-spool, medium-bypass-ratio turbofan. Up front, there's a single-stage, wide-chord, damperless fan, driven by an uncooled and shrouded three-stage low-pressure turbine. Aft of the fan, air is routed to the compressor through an inertial separator that causes most FOD to pass out the bypass duct rather than be ingested by the engine. The compressor consists of four axial compressor stages, with two variable geometry stator stages, and a single centrifugal compressor. A two-stage high-pressure turbine with cooled blades drives the compressor. The combustor is an annular, effusion cooled through-flow chamber that features a rich-quench-lean burn cycle to reduce emissions.

Dual-channel FADECs manage all engine functions, including operating envelope protection, engine synchronization and maintenance diagnostics. Air turbine starters use bleed air supplied by the APU, a ground source or the cross-side engine. Engine bleed air is extracted for the wing, engine and empennage anti-ice system, along with heating, air-conditioning and pressurization. The thrust reverser is hydraulically actuated.

the throttles in the takeoff position, but releasing the clutches to make it easy for us to snap them back to idle in case of a high-speed abort.

As with the Legacy 500, initial pitch response to sidestick inputs on rotation was crisp, but the pitch attitude was well damped when the stick was released. With weight off wheels, the FBW system started to transition from pitch command mode to gamma dot, or G rate command, control law. We could make small inputs to the sidestick to change attitude. When it was released, the aircraft's flight path vector remained stable with speed and configuration changes as long as we stayed within the normal flight envelope.

We used the PFD's selectable HUD-like symbology with flight path vector, speed error tape and energy caret cues for optimum attitude and energy awareness. Make a note: Both the Legacy 450 and 500 have comparatively soft control feel and sporty control response to sidestick inputs. Pilots need make only small, gentle fingertip inputs to control the aircraft with precision and smoothness.

The FMS default climb schedule is 300 KIAS to Mach 0.74. Considering our comparatively light weight, Camelier recommended 250 KIAS/0.74. ATC cleared us to climb directly to FL 450 on a northeasterly course for a cruise performance check. OATs during the climb were ISA+10C from 10,000 ft. to FL 390. Above that altitude, the OAT dropped to ISA-10C. Passing FL 410, we had to make a sharp U-turn back to the southwest to stay in Embraer's flight test area. With the 2-min. pause for the turn, the aircraft reached FL 450 in 25 min., burning 1,080 lb. of fuel.

At a weight of 29,300 lb., the aircraft stabilized at Mach 0.79, yielding 441 KTAS while burning 1,400 lb./hr. in ISA-10C conditions at FL 450. The recorded data were consistent with Embraer's prediction of 450 KIAS cruise while burning 1,447 lb./hr. at the same weight in ISA conditions.

Cruise check complete, we descended to check speed brake response, to sample its steep approach capabilities and evaluated its FBW envelope protections. As with the Legacy 500, the speed brake extension is infinitely variable. Extending or retracting the speed brakes produces a noticeable pitch change but virtually no change in flight path. When the panels were fully extended, there was very mild buffet.

Next, we sampled the FBW's overspeed, under-speed and g-load flight envelope protections. For each of these features, we intentionally attempted to exceed the normal flight envelope. We noted that the FBW not only prevented exceedances when we slowly approached the limits, but it also was sensitive to high rate changes. So, if we dived the aircraft sharply, snatched back on the sidestick at high speed or suddenly attempted to stall the aircraft at low speed, the flight control system anticipated the exceedances and kept the aircraft safely in the certified flight envelope.

Both the Legacy 450 and Legacy 500 will be certified by mid-2016 for steep approach. The aircraft's FBW flight control system is ideally suited for this added capability because it can schedule speed brake extension as needed to increase drag and directly control available lift. Camelier pressed a button to activate the function. This arms the speed brakes for partial extension with full flap extension. VREF also is bumped up 10 kt. for greater lift with the speed brakes retracted.

To sample the new function, Camelier dialed in a -5.5-deg. flight path cue on the flight director. We configured the airplane for landing with gear and full flaps extended and nosed over to put the flight path vector on the selected 5.5-deg. glidepath. It was easy to maintain VREF because of the extra drag of the speed brakes. Camelier suggested increasing the angle of descent to -7.5 deg. As we further nosed over, the speed

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brake extension automatically increased to provide more drag to stabilize the descent.

At the bottom of the descent path, we simulated a flare to touchdown. Speed brake extension automatically was decreased to provide the extra lift for the round out. Then, they extended more fully to prevent float as we settled down to a virtual runway.

Later, we intentionally disabled the FBW system's normal law mode and flew the aircraft in direct law, thereby sampling most of the aircraft's natural aerodynamic characteristics. Direct law, though, does retain limited pitch and yaw damping functions to reduce pilot workload. And when flying approaches to stalls, stall warning is triggered at a slightly reduced angle of attack compared to the low-speed warning of normal law to prompt the pilots to initiate stall recovery while the aircraft still has strong positive static pitch stability even with c.g. at the aft limit.

After the direct law demonstration, we switched back to the FBW system's normal law mode. Camelier noted that Embraer headquarters soon would learn of our intentional use of direct law because the anomaly automatically is recorded in the aircraft's centralized maintenance computer and downloaded by Wi-Fi after landing.

We then flew to Unidade Gavião Peixoto (elevation 1,998 ft.), Embraer's satellite airport facility located 166 nm northwest of São José dos Campos, for pattern work. The first landings were two touch and goes at an approximate weight of 26,500 lb. One was at Flaps 3 and 27,000 lb. with a VREF of 118 KIAS. The next was at full flaps and 26,700 lb. with a VREF of 105 KIAS.

Similar to the Legacy 500, the Legacy 450's normal flight control law incorporates a speed stability function with landing gear extended and flaps 3 or full. A light green caret appears on the PFD's airspeed tape to cue the crew. Pressing the touch control steering button on the sidestick re-indexes the trim speed to the current airspeed. The neutral trim reset feature provides a natural aerodynamic feel to the airplane. Autothrottle performance in the landing mode was smooth and precise.

We also flew a practice steep approach to an experimental ILS installed about one-third down the runway. VREF was 114 KIAS, 10 kt. faster than normal VREF because of the partial speed brake extension. As with our dry run at altitude, the steep approach mode was easy to fly to an actual runway and comfortable to land. However, Runway 20 had no VASI or touchdown zone markings to complement the ILS, so gauging the appropriate touchdown point on the pavement wasn't easy.

Our final landing was at 26,400 lb. using full flaps. VREF was 104 KIAS and computed landing distance was 2,250 ft. with 16,295 ft. of pavement available.

Conclusions from the front office? The Legacy 450 indeed sets new standards in this class for cockpit technologies. FBW makes it a delight to hand-fly, its flight deck provides top-notch situational awareness and its pilot/machine ergonomics are unsurpassed. **BCA**

Rockwell Collins Pro Line Fusion Avionics

Four, 15.1-in. landscape configuration displays, arranged in a T configuration, dominate the instrument panel and center console. Each display may be divided into multiple windows to support multitasking. Synthetic vision is standard for the PFDs.

Fusion is an evolution of Pro Line 21, but it incorporates several advantage features and components. The Legacy 450 user interface is similar to Bombardier's Vision cockpit and Dassault's EASy II designs, such as presenting multitab FMS pages divided into preflight, takeoff and climb, cruise, descent and landing pages on the MFD. It mainly relies on point-and-click data entry using a cursor control device with track ball and buttons. Alphanumeric characters and values are entered with a multifunction keypad.

Less apparent are the powerful components that support the system. These include dual enhanced AHRS that have the precision and rapid response times to replace Laser IRS boxes for both the avionics and the FBW system; Goodrich SmartProbe solid-state, integrated pitot/static/angle of attack/sideslip sensors; dual FMS; dual VHF comm and nav radios; and dual SBAS/WAAS satellite navigation receivers. Also included are Multiscan Doppler turbulence detection weather radar with 18-in. antenna dish, radio altimeter, DME, TCAS II, Enhanced Mode S transponders, electronic charts, CVR and FDR, and a comprehensive onboard maintenance diagnostic and event recording system that ties into most airframe systems.

Embraer retains stand-alone audio and systems control panels in its cockpits, providing instant access to essential functions. **BCA**

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