Dassault Falcon Jet's EASy Cockpit

B/CA is first to fly a Falcon with next-generation avionics.

By Fred George

The accident rate for professionally flown business jets and airliners has just about bottomed out at two to three accidents per million flight hours in recent years, according to safety statistics often quoted by Dassault and others. That's mainly because mechanical failures have nearly been eliminated. However, Dassault says, of the few accidents that do occur, about 40 percent involve pilot error or lack of action, and that's unacceptable within the business aviation community.

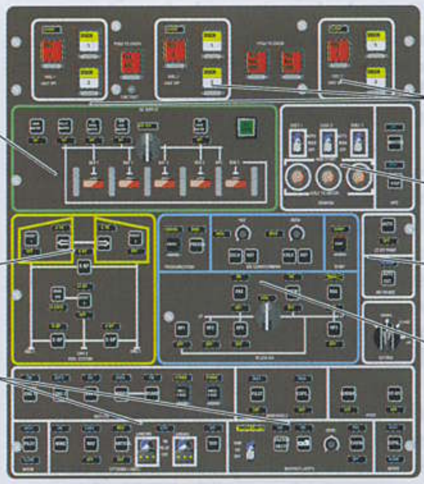
The only way to reduce those kind of accidents is to improve pilot performance. Dassault's research showed that pilots were sometimes so overwhelmed by cockpit automation tasks in high workload situations that they were unaware of the aircraft's proximity to hazards. As a result, the airframer launched Project Primevere in 1995, a clean cockpit design initiative aimed at improving flight crew situational awareness, keeping them "in the loop" with the aircraft, and reducing pilot workload. Primevere soon evolved into the Enhanced Avionics System, or EASy, cockpit.

The time was right in the mid-1990s for developing a clean-sheet cockpit. Avionics firms were developing new products that would enable Dassault to craft its own completely original flight deck design, free from past requirements to cobble up a system from off-the-shelf components. Ultimately, Dassault chose Honeywell's Primus Epic as the basis for EASy because it afforded the best blend of performance, capability and price.

With a long legacy of transferring military technology to civil airplane applications, Dassault lost no time in borrowing Mirage and Rafale control and display design features for the EASy cockpit, specifically a graphic user interface and a cursor control device (CCD). Company engineers believed that what improved situational awareness in single-pilot, 2.0-plus Mach fighters surely would help two pilots in subsonic Falcon Jets. The Rafale, for example, is fitted with a large HUD that features a flight path vector for primary guidance reference. An equally large integrated navigation moving map display is the centerpiece of the instrument panel. Smaller displays that flank the central unit provide control of systems, engines and weapons, along with attitude indication.

EASy, as a result, is like nothing we've flown in any other business jet. It's so different — even revolutionary — that it's bound to be controversial in the business aircraft community. For example, no other avionics system in a business aircraft puts such reliance on use of a CCD. No cockpit display system in a civil aircraft presents such a plethora of information. No business jet in current production will so closely tie the avionics to engines and other systems. The last time business aviation experienced such a radical change in avionics was when Gulfstream's GIV made its debut in the mid-1980s.

Experienced Falcon Jet pilots won't necessarily feel instantly at home in an EASy cockpit, any more than GIII pilots easily adapted to the GIV. The displays embrace the FAA's and JAA's latest standards for use of color, and the changes are noticeably different from current generation EFIS color conventions. The flight guidance control panel in the EASy cockpit has been reorganized and the overhead systems panel is greatly simplified. Many tasks that were formerly pilot controlled are now automated. Gone are the stand-alone radio tuning units, FMS CDU display screens, EFIS display controllers and warning lights



The overhead panel groups the five panel and most controls for the different aircraft systems.

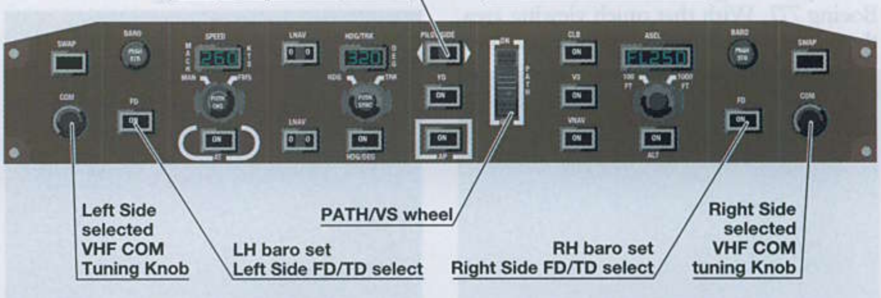
panel. To the maximum extent possible, all such control functions and indicators are integrated into the large-format displays.

Do all of these changes really improve situational awareness and safety margins? We flew a Falcon 900EX equipped with the EASy cockpit in late August to find out firsthand.

EASy Display Design Logic

The 900EX EASy's basic instrument panel layout consists of four, 14.1-inch (measured diagonally) displays arranged in T-configuration with left- and right-side Primary Display Units (PDUs) intended for tactical use by each pilot and two centrally located Multifunction Display Units (MDUs) used primarily for strategic functions. The idea is to group centrally all functions that require crew coordination, including systems control on the overhead panel, flight guidance control on the glareshield, and flight planning, systems synoptics, checklists and engine controls on the pedestal.

Each of the screens is divided into one-third and one-sixth sections for most operations. While the four displays initially may appear overloaded with data, each is divided into logical window panes, so it's not difficult to adapt to layout, according to line pilots who've flown the system. The PDUs have conventional PFD sections, plus EICAS and configurable display sections. The configurable section in the PDU's lower inside corner typically displays secondary engine instruments, trim position and brake temperatures. If the aircraft encounters proximate traffic, a TCAS alert automatically pops up in the configurable window. The pilot also can manually select engine/trim/brake, terrain, sensors or complete radio tuning functions in the configurable window. Potential operators told *B/CA* they like both pilots being able



The flight guidance panel gathers most controls to manage AFCS modes, set their reference and engage autopilot and/or autothrottle.

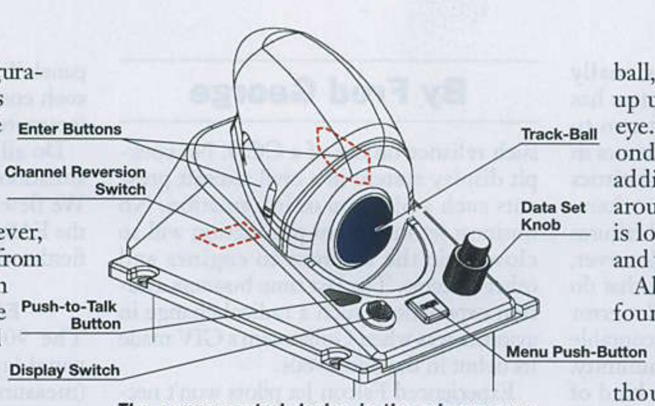
to view gear, flap and trim configuration on each of the PDUs. Various interactive parts of the PDU are used to select bearing pointers, handle comm/nav/ident (CNI) functions, and HSI modes. The ADI and EICAS windows, however, are read-only, and thus protected from inadvertent pilot inputs. Caution and warning CAS messages are displayed in plain language, and when they first appear, they're displayed in black to capture the crew's attention. They revert to conventional color letters when the anomaly is acknowledged.

A full two-thirds of the upper MDU screen typically is used for integrated navigation (I-NAV) functions, providing the crew with a large moving map with various terrain depiction modes, including EGPWS, plus weather and traffic. The I-NAV window also is used for graphic, point-and-click flight planning using the CCD. The right one-third window can be used to show a list of waypoints in the active and alternate flight plans, or the full upper screen can be used for the I-NAV moving map. I-NAV is a leap forward in promoting situational awareness, according to several 900EX EASy buyers with whom we spoke.

The top half of the lower MDU typically is configured for flight planning or it may be used to display a list of flight plan waypoints. Flight planning is divided into five phases: preflight, takeoff/climb, cruise, descent/approach/landing or post-flight. All the data fields needed for each of the five phases are displayed at once. There is no need to call up several pages of data for each phase of flight as with conventional FMS CDUs. And all flight planning functions are displayed where both pilots can see them.

The bottom half of the lower MDU typically is used to display interactive system synoptic diagrams and a context-sensitive electronic checklist.

The viewing area of EASy's four screens actually is as big as all six screens aboard a Boeing 777. With that much viewing area, the center MDUs can be used for reversion with little loss of functionality in the event of a PDU failure.



The cursor control device is the primary crew interface with the display.

Cursor Control Device

No element of EASy is more controversial than its CCD, primarily because no other advanced avionics system in a business aircraft relies so heavily on its use. Other systems we've flown rely upon more-conventional control devices, such as switches, knobs and buttons, with use of the CCD as an option. But the CCD worked so well in its Mirage and Rafale fighters that Dassault elected to make it a primary control device in the EASy cockpit. That decision eliminated dozens of stand-alone buttons and switches and made use of the CCD mandatory in the EASy cockpit.

EASy's CCD has a palm support with a well-damped track ball in front. Ahead of the track ball are concentric knob controls for changing numeric values, a menu button and a left-right/up-down toggle switch, similar to a trim switch, for quick movement between various windows on the screens. There also is an "enter" button below the thumb side of the palm support.

One of the challenges in learning to use the CCD is just finding out where the cursor is parked. Its last known position could be one of several places on any of three screens — the on-side PDU, the upper MDU or lower MDU. Dassault helped solve this problem by surrounding the cursor with a prominent white halo while it's in motion. A little wiggle on the track ball, as a result, causes the halo to pop up under the cursor and catch one's eye. The halo fades away in a few seconds if the cursor is not moved. In addition, a cyan border illuminates around the window where the cursor is located. Look for the cyan border and you'll find the cursor nearby.

All pilots with whom *B/CA* spoke found the CCD easy to use and adapted well to the point-and-click user interface. Some, though, said it will take a while to master all the system's capabilities. Comprehensive initial and recurrent training will be a must.

The MDUs are accessible by either pilot's cursor, so it's necessary to differentiate between the pilot's and copilot's cursor icons on screen. The pilot's cursor is shaped like a plus sign and the copilot's cursor resembles an X. Each crewmember can position the on-side cursor in certain areas of the on-side PFD and virtually anywhere on either of the two central MFDs.

Dassault wasn't mesmerized by the CCD's magic. If there's an easier way to accomplish cursor movement, then it's not necessary to use the CCD. When filling in fields on an FMS phase-of-flight page, for example, the CCD only needs to be used to navigate to the first entry field. After that, the twist knobs can be used to select a numeric entry and pressing the "enter" button under the thumb on the CCD automatically advances the cursor to the next required field on the menu. Alternatively, alphanumeric values can be typed in using either of the Multifunction Key Boards (MKBs) in the center pedestal.

Flying Impressions

Accompanied by Yves "Bill" Kerherve, Dassault's chief test pilot, in the right seat and Philippe DeLeume, Dassault's chief

I-NAV map in Heading Up Mode

PDU display

FMS functions

pilot in Bordeaux, we buckled into the left seat of Falcon 900EX serial number 134 for a two-and-one-half-hour introduction to EASy. Beginning with s.n. 120, all Falcon 900EXes are equipped with EASy cockpits. EASy cockpits for the Falcon 2000EX begin with s.n. 28, which is to be delivered in the second quarter of 2004.

Our first impression, later shared by other pilots, was that the displays offered excellent direct sunlight readability. The CCD, along with the menu, enter and twist knobs, also seemed easy to use. We built the flight plan using the FMS phase-of-flight pages and alphanumeric waypoint entry. Alternatively, we could have used the CCD to point to waypoints on the screen map and then click to enter them into the active flight plan. Point-and-click also can be used to build a flight plan with pilot-defined waypoints on the I-NAV map. One pilot said this process reminded him of drawing out a route on a paper navigation chart, but when it was complete the route was automatically stored in the FMS.

Dassault also has simplified many of the cockpit systems controls and automated many functions. Starting the engines, for example, is about as easy as twisting the key in the ignition of a car because of a new twist-to-start switch ahead of the throttle quadrant. Many fuel, electrical and hydraulic system functions also have been automated. The Falcon 900EX EASy also is being fitted with a brake-by-wire system similar to that installed on the Falcon 2000/2000EX.

EASy has the most interactive electronic checklist feature ever installed in a business jet. Most folks will "flow" checks by rote memory and then use the checklist to confirm all items have been properly completed. EASy will incorporate an "auto sense" feature that will check off items as they're done and prominently display open items until the step is completed. Even more impressive, there's a dedicated checklist button on the MKB. If a malfunction should occur, pressing the checklist button calls up the proper abnormal or emergency checklist, along with the appropriate system synoptic diagram. "Auto sense" will check off items as they're completed and show the results on the interactive system synoptic.

Dassault's use of color on screen is logical, consistent and compliant with the latest FAA/JAA standards for EFIS. Any target speed, course, heading, altitude, flight or thrust director cue, for instance, is depicted in magenta on the EASy screens, regardless of source. Cyan indicates the value of a field can be changed by the crew. Green is used for indications of speed, altitude, pressure, quantity and current, plus operating components on the systems synoptics. White is used for labels, tick marks on scales and upcoming legs on the flight plan map. Notably, white colors on the CDI don't indicate a lack of valid nav data. They just mean that the lateral nav mode of the flight guidance system has yet to be engaged, so it's not the target course. Some other lateral mode, such as heading or track, is the selected mode, so it's depicted in magenta.

For takeoff, we used the go-around pitch command, which holds runway heading until another flight guidance mode is selected. On initial rotation to 14 degrees nose up, the go-around cue disappears, replaced by a flight path guidance director cue. The aircraft's flight path vector symbol is flown to the flight director cue rather than using attitude. A thrust director cue also appears on screen to help the pilot speed up or slow down to the target speed bug. Just match the available "energy carat" to the thrust director, and aircraft speed will adjust to the target value. If you pull up until the energy carat is aligned with the aircraft pitch attitude indicator, the speed stabilizes precisely without acceleration or deceleration. That's quite handy when the goal is maximum rate of climb at a stabilized speed following an engine failure.

The Falcon 900EX EASy flight deck features four large LCDs, a graphical interface system and modular avionics architecture.

The flight path vector-based flight director and thrust director offer substantially better guidance than conventional attitude and speed guidance computers. Based upon HUD functionality, these two guidance cues enable the pilot to fly considerably more precisely because they help manage trajectory and energy rather than just attitude and acceleration. However, making the transition to this advanced guidance system requires some adjustment to one's stick and throttle technique. Some folks, unfamiliar with the Falcon, reported being able to fly 60-degree bank turns with no change in altitude or airspeed because of the precision guidance of the flight path vector and energy carat cues.

EASy also has envelope protection. If the autopilot and autothrottles are engaged, the system automatically retards thrust and then it provides a nose-up pitch command if VMO or MMO are exceeded. Conversely, if the aircraft slows to stall warning speed, full thrust is automatically applied and then it issues a nose-down pitch command.

We then descended toward Antichan, a small general aviation airport in the foothills of the Pyrenees Mountains, to evaluate I-NAV's terrain depiction and EGPWS interface. The map may be oriented either north up or heading up. Imagery from the aircraft's weather radar can be depicted in either mode and it's drawn in the same scale as the map. This enables the crew to cross the terrain contours generated by the aircraft's digital terrain elevation database with radar echoes, thereby double-checking the aircraft's proximity to potential terrain hazards.

As the aircraft's altitude approached that of the top elevations of the foothills, the terrain ahead changed in color from soft brown tone relief into vivid green. Continuing the descent resulted in the hilltops being depicted in yellow as our altitude approached within 1,000 feet of the peak elevations. As we descended below the peaks, they were shown in red. The relatively long distance of the terrain hazards depicted by these color cues enabled us to plan well ahead for a safe approach into the Antichan area.

But, of course, we wanted to experience the last-ditch escape aural and visual warnings provided by the EGPWS. As we approached a hill crest at 250 KIAS, it was

Dassault is working closely with FlightSafety International to develop initial and recurrent EASy avionics training courses.

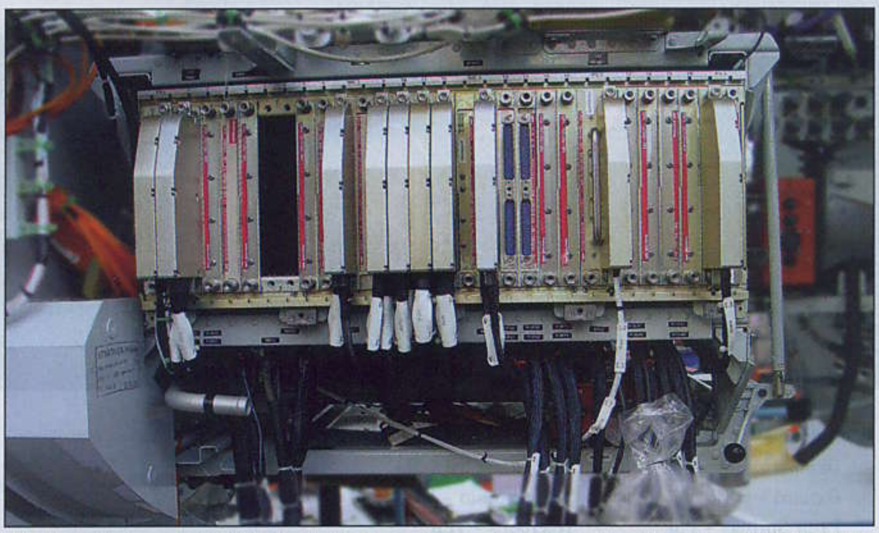
depicted on screen in bright yellow, accompanied by the familiar "caution terrain" aural alert. The terrain hazard was depicted in bright red on screen, contrasting very well with the non-threat terrain depictions. We heard, "Terrain, terrain, pull-up, pull-up," and executed the appropriate avoidance maneuver.

We then proceeded northwest, past Bordeaux to La Rochelle Laleu at the mouth of the Gironde, for a series of instrument approaches. No phase of flight better shows off the qualities of EASy than approach and landing. Primus Epic has such prodigious storage capacity that the default navigation database is worldwide, containing all civil airports having straight-in instrument approaches and runways at least 3,000 feet long. That still leaves 62 percent unused, providing expansion room for new GLS and LPV approaches that will be published in coming years.

Downside? Epic won't draw on screen all the ARINC 424 procedure legs associated with an approach. At La Rochelle, for example, the outbound leg of a procedure teardrop was depicted, along with the inbound final approach course. The left 210-degree turn between the outbound leg and final approach course wasn't depicted. The system, in essence, wanted us to just "trust it" without drawing out all of its plans on screen. It did, though, provide a text message indicating that it intended to make the correct turn to final. Dassault and Honeywell are studying the issue of some ARINC 424 legs not being drawn on the screen map.

The location of the localizer final approach course was quite apparent on the I-NAV map. The inbound course was flanked by localizer "feathers," so it was unmistakable. Full Jeppesen e-charts will be made available as an I-NAV option for EASy by the end of 2004, according to Dassault officials.

One other shortcoming is worth noting. Epic's nav database doesn't have instrument approach procedures that require a circle-to-land maneuver. For example, if you're intending to fly the VOR/DME or GPS-C approach to Runway 15 at Aspen, Colo., you won't be able to call up the approach from the Epic nav database. Or, if you're flying the commonly assigned VOR/DME-A into Teterboro, you'll have to manually input all the waypoints and hope that you don't make any "fat finger" entry errors.



Modular avionics unit (MAU) is located in the nose cone. Interconnection of modules within the MAUs is accomplished by use of VbPCI, a high-speed, bidirectional, parallel bus based on the industry standard PCI. Each channel of an MAU has an independent VbPCI.

EASy Type Rating

Dassault is working closely with FlightSafety International to develop initial and recurrent EASy avionics training courses. FlightSafety has an EASy-equipped Falcon 900EX simulator in operation at its Teterboro training center. Pilots with Falcon 2000EX or 900EX type ratings won't share type ratings with Falcon 2000EX and 900EX EASy rated flight crews. This has been the plan from the onset of the program.

If Dassault has its preference, the FAA and JAA would establish an EASy type rating and make the aircraft type rating a secondary consideration. Additional Falcon Jet qualifications then only would entail completing a differences training course rather than earning a new type rating, not unlike having a common Boeing 757/767 or Airbus 330/340 type rating. Regardless of the outcome of that initiative, Dassault's insistence that crew be specifically qualified in the EASy cockpit will be just as imperative to improving situational awareness and safety margins as the avionics equipment.

But folks who are qualified to fly specific models of Falcon Jets with two different cockpit layouts, one with conventional instruments and the other with EASy, may not find it comfortable to swap airplanes on a routine basis. This might be as difficult as a dual rated airline captain flying an Airbus one day and then piloting a Boeing the next day.

With apologies for the cliché, EASy represents an undeniable paradigm shift in avionics design, according to all pilots we contacted for this report. There will be some pilots for whom the step up to EASy is too great a leap, not unlike some GII and GIII pilots who two decades ago were overwhelmed by the GIV's glass cockpit wizardry. These folks will be content to fly aircraft with more conventional instrumentation, counting the days remaining in their aviation careers.

EASy certification is imminent. Meanwhile, the EASy beta test group has already spoken with near unanimity. Folks willing to put the effort into mastering EASy will be rewarded with the best situational awareness and cockpit resource management ever available in a Falcon Jet. **B/CA**