

Cockpit Avionics 2010



The innovations of the next 20 years will eclipse anything the industry has seen thus far

by Stephen Pope

Sure, it's fun to think about how far aviation—and in particular the avionics field—has come in the last 100 years. But the technology innovations of the last century will pale in comparison with what we're likely to witness in the next 20 years, researchers predict.

Consider what has come to pass so far. Aviation legend Jimmy Doolittle made the first "blind" landings in 1929 using an experimental Sperry gyroscopic artificial horizon and runway homing beacons. Digital fly-by-wire flight controls grew out of NASA's Apollo space program, making powered flight a sophisticated endeavor long before Apple's iPad and Google's Android cellphone made us drool.

Flight management systems and EFIS technology were created and evolved in the 1970s and 1980s, culminating with the introduction of the first fully integrated avionics systems in the 1990s. These cockpits have grown into the cursor-control-driven cockpits of today, appreciated by pilots for delivering an ever expanding array of flight-related information, from the latest Nexrad weather radar graphics beamed by satellite to 3-D synthetic-vision presentations of the world outside.

But looking back at how far aviation has come only adds to the intrigue of hearing avionics technologists explain why the innovations just beyond the horizon will eclipse everything that has emerged so far.

Setting aside dystopian visions of pilotless aircraft shuttling cargo and passengers among major transportation hubs, the way pilots fly by the middle of this century should be vastly different from what it is today. That really shouldn't

come as a huge surprise. The ATC system we are burdened with today was created in the 1950s for aircraft that carried four-course radio range receivers and other relics from aviation's past. But considering the quickly evolving and highly specialized roles military UAVs are playing in places like Afghanistan and Iraq, it might not be too far a stretch to imagine a day when transport-category aircraft can be flown by a single pilot instead of the two that are required today.

Avionics makers are researching cockpits for future single-crew airliners and business jets, notable among them Honeywell and Rockwell Collins, both of which say higher levels of cockpit automation could eliminate the need for a copilot in future airliners and large business jets. Thales, as part of a program called Cockpit 3.0, says it is targeting introduction of a single-pilot integrated avionics system sometime around 2030. Embraer, meanwhile, is the first aircraft maker to indicate a serious interest in airliners that can be flown single pilot.

Thales says the goal of its Cockpit 3.0 project is to reduce crew workload and complexity, which in turn could lead to a reduction in human errors. The company is also looking at ways of reducing the physical size of a single-pilot flight deck to provide more space for passengers and payload. As a bridge to reaching these goals, Thales is studying workload reduction for two-pilot crews.

Certainly Embraer could apply lessons learned in the development of the single-pilot cockpits for its Phenom 100 and 300 light jets to its jetliners. Technologically speaking, flying complex aircraft single pilot isn't a big deal—after all, Cessna Citations have been single pilot since the 1970s.

Changing the regulations that currently require two-pilot crews in transport-category airplanes, however, will be a tall hurdle. And if the rules are changed eventually, business jets weighing more than 12,500 pounds are likely to be the first

approved for single-pilot operations. Only after several years of proof that safety isn't jeopardized will cargo aircraft, and then passenger-carrying airliners, be allowed to fly single pilot.

Still, with a pilot shortage looming and the airlines scavenging for ever more inventive ways to cut costs, advances in automation technology could speed the development of single-pilot cockpits for the next generation of airliners.

For now avionics makers are focusing on improvements to their current product lines while continuing with research and development work on the avionics products that will reach the market in the next few years. Honeywell and its OEM partners continue to flight test the latest versions of the Primus Epic avionics system, with two milestone achievements within reach.

The avionics maker has been honing the synthetic-vision display and other improvements for the Dassault EASy II cockpit due for certification next year while simultaneously working with Gulfstream on the latest version of the PlaneView cockpit for the G650, the all-new ultra-long-range, large-cabin business jet due to hit the market in 2012. This work follows on the heels of the recent approval of the Cert Foxtrot software upgrade in other large-cabin Gulfstreams, which brought enhancements to the cockpit's SVS displays as well as XM weather capability, electronic terminal charts and various other upgrades.

Honeywell has also received a supplemental type certificate (STC) allowing installation of its Primus Elite cockpit upgrades in Global-series business jets. The cockpit upgrade for the Global 5000, Global Express and Global Express XRS is available as a retrofit and on new airplanes as an option. The Primus Elite flight deck replaces the Global's original Primus 2000XP system (saddled with CRT screens) with LCDs. The change permits the addition of XM graphical weather, Jeppesen electronic charts and maps, video-input capability and cursor-control interface. In the future, Honeywell's SmartView synthetic-vision system will be added to the Primus Elite cockpit upgrade, according to Bombardier. Installation takes about three weeks and can be performed at Bombardier's business aircraft service centers in the U.S. or at authorized service facilities for Global jets.

The Primus Elite conversion package has been garnering considerable interest from operators and OEMs alike. The Elite LCD displays slide into the holes of CRTs in Primus 1000/2000/XP, SPZ-8400/8500



Honeywell is continuing development of its synthetic-vision display for Dassault's EASy II cockpit.



Honeywell's Primus Elite can be retrofit into legacy aircraft with CRT screens, and it will also serve as the avionics for the in-development Legacy 650.



Viking's Twin Otter revival of the de Havilland Canada workhorse features a Honeywell Primus Apex in the front office.

and some SPZ-8000 avionics, incorporate internal computing power that allows operators to obtain technology previously available only in newer aircraft. Embraer has selected Primus Elite for the Legacy 650, and Cessna recently announced it will bring the cockpit to the Citation X, in new airplanes and as retrofit installations. Gulfstream, meanwhile, has said it will add the Elite cockpit to the G300 as an option.

Honeywell, meanwhile, has added functionality to its Primus Apex avionics system, incorporating Waas LPV approach capability, as well as a new trackball cursor control, XM weather and the FMS 7.1 flight management system upgrade in the latest version of the cockpit. Primus Apex is flying on the Pilatus PC-12NG and Viking Twin Otter and has been selected for the Spectrum S-40 and Comp Air 12.

Fusion on Final

Rockwell Collins is fast approaching the certification threshold as it prepares the FAA paperwork for its Pro Line Fusion integrated cockpit, which will serve as the baseline avionics system for Gulfstream's G250 and Bombardier's Global Express XRS and Global 5000 when approvals are completed next year.

Collins test pilots spent part of the past winter braving the cold temperatures and omnipresent turbulence in Alaska to put the



The Rockwell Collins Pro Line Fusion—chosen for the Gulfstream G250, Bombardier's Global series, the Learjet 85 and Embraer's 450 and 500—is the top-selling integrated cockpit among new business jets.

synthetic-vision portion of the Pro Line Fusion cockpit through its paces. Flight-test crews shot dozens of low-visibility approaches into Alaska airports in the company's Challenger 601 test bed. The point of the exercise was to evaluate the SVS's capabilities in areas of challenging terrain before bringing the technology to the cockpits of the Global Express and G250.

Pro Line Fusion has logged more than 350 hours aloft as part of a test regimen that the avionics maker expects to complete by year-end. Three airplanes have joined the certification program, with the Collins Challenger 601 logging the bulk of hours aloft (more than 200) since the shakeout flights started last fall.

OEM test pilots are also evaluating Pro Line Fusion in the Global Express and the G250, although only the Global is equipped with SVS so far, testing for which has been limited mainly to the flatlands of central Kansas. Gulfstream plans to offer SVS to G250 buyers as an option, but for now the focus has remained on testing Fusion's core capabilities, including an all-new flight management system that relies heavily on graphical flight-planning tools. Collins first plans to obtain an STC for Pro Line Fusion in its Challenger, a step that is expected to ease the subsequent certification efforts for the OEMs that have selected the cockpit.

Rockwell Collins installed Pro Line Fusion in its own corporate Challenger 601 on the right side of the cockpit, leaving in place the original Pro Line 21 cockpit system on the left. Most of the Alaska testing was flown into Juneau International Airport, famous for the extreme terrain surrounding the approach through Gastineau Channel and the unceasing turbulence. Test pilots flew multiple low-visibility approaches through the channel using both the head-up guidance system and the head-down SVS display.

The Collins SVS uses a massive database of the earth's terrain, obstacles and airports to create a 3-D image on the pilot's primary flight display that is intended to replicate on the computer screens the same view out the window that would be seen on a clear day. Each manufacturer adds its own nuances to the concept, and Rockwell Collins is no exception. For example, airports in the distance appear on the Fusion SVS display first as translucent domes. As the airplane approaches, the dome slowly disappears, leaving a computer-generated view of the runways.

In addition to the Globals and G250, Pro Line Fusion has been selected for the Learjet 85 and Embraer Legacy 450 and 500, as well as the Bombardier C Series and Mitsubishi MRJ regional jets, making the cockpit the top seller among new business jet market entrants since it was announced in 2007.

Universal Appeal

Universal Avionics is a company that prides itself on a long list of firsts in aviation. The avionics maker introduced business aviation's first flight management systems in the early 1980s. It was the first to obtain Part 25 certification of a syn-



Universal Avionics offers a full array of Waas/SBAS FMS equipment for business aircraft.

thetic-vision system, incorporated in its Vision 1 retrofit cockpit. And Universal was the first FMS maker to certify Waas LPV, opening up thousands of approaches to business aircraft operators.

The list of Waas FMS STCs Universal and its dealers have obtained is impressive. It includes upgrades for the Falcon 20 and 50, Citation 550/650, Learjet 45 and 60, Challenger 600/601, Astra, Hawker 700 and 800 and the King Air series. On the cockpit retrofit side of its business, Universal has gained installation approvals for its EFI-890R system in a wide range of airplanes, including the King Air 300, Learjet 60, Pilatus PC-12, Challenger 600/601, Astra, Hawker 700A, Gulfstream II/IIB/III, Learjet 25 and Falcon 20.

This spring Universal announced the -1M to -1Ew exchange program, which triples the standard trade-in credit for existing UNS-1M FMS units customers trade in toward the purchase of a new UNS-1Ew Waas/SBAS FMS. The problem with the -1M FMS is its limited memory. Expansion of navigation data, especially with the addition of Rnav GPS approaches, has resulted in massive growth in the size of nav databases in the 17 years since the UNS-1M FMS was introduced.

Business jet operators who still fly with older equipment such as the UNS-1M complain of continual reductions in database coverage because their flight management systems can't hold all the data. Benefits of upgrading include the ability to load every approach to every runway in the world, including the latest Rnav (GPS) LPV Waas approaches, which now greatly outnumber ILS procedures in the U.S. Universal says additional benefits of the -1Ew FMS include the ability to download data from the Internet to a USB drive or SD card and 3-D approach mode.

Considering how big a name Garmin has become in the consumer electronics and marine markets, it's easy to forget the company started out as tiny ProNav Communication & Navigation in Lenexa, Kan. Garmin changed its name early on after a competing GPS maker called NavPro sued, alleging trademark infringement. The name Garmin is a combination of the first names of company founders Gary Burrell and Min Kao.

Garmin's focus in aviation these days is on development of its latest integrated avionics system for light turbine-powered airplanes, called G3000 and unique in the aviation world for incorporating menu-driven touchscreens for accessing nearly all of the functions that pilots flying with the G1000 control with buttons and dials.

Developed for the upper end of the Part

23 business aircraft market, the G3000 cockpit incorporates a pair of 5.7-inch-diagonal touchscreen controllers below the main flight displays. The screens include desktop-like menu interfaces with icons that can be pushed to access most of the system's features. Audio and visual feedback is used to let pilots know exactly how the system is responding to their inputs. The touchscreen unit, called the GTC 570, also incorporates conventional controls at the bottom of the display, including a



Garmin's G3000 avionics system replaces traditional buttons and controls with a touchscreen display mounted in the cockpit between the pilots.

volume control knob, map joystick and dual concentric knob for data entry.

The basic hardware behind the scenes in the G3000 system is based on technology first developed for the G1000 system, which in business aviation flies in the Cessna Citation Mustang and Embraer's Phenom 100 and 300 and is offered as a retrofit upgrade in Beechcraft King Airs. The G3000 system's "extra-wide" primary and multifunction displays measure 14.1 inches diagonally, versus the G1000's normal 10.4-inch screen size. The G3000 displays include a number of bezel-mounted soft keys, but the buttons on the MFD serve no function. Garmin chose to include the soft keys on the MFD only so that the displays would be interchangeable, meaning the same part number can be shipped to customers needing a replacement PFD or MFD.

The G3000 system was originally scheduled for certification in next year's second half, but that timeline is now in doubt as the system's first two OEM platforms—the PiperJet and HondaJet—face delays. Piper is targeting entry into service for the PiperJet in mid-2013, while Honda now says the HondaJet will enter service in the third quarter of 2012.

Innovative Solutions & Support in Exton, Pa., meanwhile, continues to add to the list of STCs allowing installations of

its retrofit flat-panel avionics. Cessna Aircraft has gained an STC for installations of IS&S's AdViz flat-panel cockpit display system in legacy Cessna Citations. The AdViz system is certified for installation in the Cessna Citation 500, 550, S550 and 560. It is available in two or three 10.4-inch display unit architectures with options for Jeppesen electronic charts, XM weather downlink, display of EMS camera images and Waas LPV approach capability. The first Cessna Citation V retrofitted with the AdViz system was certified recently following three years of development. The AdViz system is available for purchase through the Cessna-owned Citation service center network and will eventually be distributed through the full Cessna authorized network.

IS&S also recently added electronic chart and XM satellite weather display to the avionics upgrade it provides for the Eclipse 500. IS&S was selected in 2007 to develop a replacement for the Avidyne avionics system in the Eclipse 500. IS&S delivered about 30 of its Avio NG glass cockpit suites a month to Eclipse Aviation until production in Albuquerque ceased. Today, some 150 aircraft in the Eclipse fleet have the Avio NG system, with approximately 80 of the Avidyne Avio-equipped VLJs yet to be upgraded via STC. Eclipse Aerospace, the new company that emerged after the bankruptcy of the original Eclipse Aviation, is offering the Avio NG replacement system through its facilities at Albuquerque Sunport International Airport and in the Chicago area.

The IS&S Avio NG system controls, monitors and displays all aircraft system functions on two 10.4-inch primary flight displays and a 15.4-inch landscape-format multifunction display with standby and reversionary features. Besides controlling and displaying primary and multifunction flight information, Avio NG also monitors all aircraft systems, including fuel, electrical, electronic circuit breakers, hydraulics, engine instruments and environmental. The bezels of the active-matrix liquid crystal displays contain the line select buttons and rotational knobs through which the user can access and manipulate all subsystems.

CMC's New Frontier

The Canadian government in January 2009 announced it would invest C\$52 million (\$50 million) in a five-year avionics R&D initiative, which funding beneficiary Esterline CMC Electronics is calling Frontier. As part of the program, CMC has been tasked with developing a suite of "highly innovative and capable technologies," including new enhanced-vision systems and paperless cockpit products. CMC is already a leading supplier of EVS and EFB products for civil and military applications. Frontier will allow CMC engineers to work on the next generations of these technologies while also giving the Montreal company the opportunity to develop an entire cockpit using Frontier's open-architecture design philosophy.

So far CMC has acted as a cockpit integrator only for military aircraft, including

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the Hawker Beechcraft T-6B trainer. It has served as integrator for several commercial cockpit modernization programs, but has never developed an integrated cockpit for a new airliner or business jet.

By the end of the five-year project CMC plans to bring to market an integrated cockpit based on the technologies developed under FronTier, but the company hasn't announced any OEM customers or publicly shown FronTier hardware, saying only that its hope is for the integrated cockpit eventually to find a home in a variety of helicopters, business

jets and airliners. A team of engineers is working on the project. CMC has committed close to \$100 million of its own funds to the project, and has agreed to repay the government investment in the project after the FronTier cockpit is introduced to the market.

While CMC Electronics hopes to challenge the dominance of Honeywell and Rockwell Collins in the Part 25 business jet market segment, it is appearing less likely the company will field a version of FronTier by 2014. However, the project's other stated goals (reducing the cost of ownership, improving safety, reducing the

environmental impact of aircraft and increasing airspace capacity) could be realized if FronTier R&D efforts yield new stand-alone products.

CMC intends to build FronTier around its existing product portfolio, which includes GPS-based navigation systems, flight management systems, EVS and the PilotView line of EFBs. One of the main goals of the FronTier R&D effort will be to produce an Arinc 653-compliant core computer. CMC already has experience in this field for smaller Part 23-certified aircraft. CMC started discussions with OEMs about its FronTier plans in 2007.

Pilots who've flown with it say Avidyne has hit a home run with its Entegra Release 9 avionics system, a follow-on to the original Entegra glass cockpit certified in a variety of light general aviation airplanes. Featuring high-resolution LCD displays and the company's next-generation FMS900w flight management system, the new cockpit is available as an upgrade for Cirrus owners, who are quickly getting used to the idea of a QWERTY keyboard in the cockpit.

The market introduction of Entegra Release 9 is giving Avidyne a potent answer to the Garmin G1000 avionics system. The R9 version of Entegra features large-format, LED-backlit displays that are interchangeable for use as primary or multifunction displays. An integrated, digital Waas navcom/surveillance suite is managed within the FMS900w—a clean-sheet flight management system that deserves kudos for being possibly the most user-friendly FMS in aviation.

R9's "Page & Tab" user interface lets pilots quickly access data without having to deal with hierarchical menus or pop-up windows, and adding or subtracting a waypoint is greatly simplified by the addition of a prompt line that makes it obvious where in the flight plan a change will occur. Features like GeoFill, which automatically fills in text fields based on what the avionics thinks the pilot wants to enter, are a welcome addition in single-pilot cockpits and, thankfully, the concept really works. Entegra Release 9 includes Avidyne's high-resolution IFD5000 displays, dual air-data and attitude heading reference systems (ADAHRS), dual-redundant FMS900w systems with QWERTY keypad, digital 16-watt VHF navcom radios and dual Waas/RNP-capable GPS receivers.

Aspen Finds a Niche

Another small avionics manufacturer that has been making big waves is Aspen Avionics, which recently received FAA technical standard order authorization its Evolution EFD1000C3 Pro primary flight display in Class III aircraft. The approval brings the Evolution display to operators of aircraft weighing between 6,000 and 12,500 pounds. The target market for the certification is airplanes in the class of the Piper Navajo and Cheyenne, most King Airs, the Cessna 400 series and turbine Twin Commanders.

The EFD1000C3 Pro PFD includes integrated GPS steering, digital HSI with dual bearing pointers and moving map. Aspen is offering Evolution packages that bundle MFDs with the PFD. The company says its EFD1000 MFD and 500 MFD both support hazard awareness features, including XM weather, traffic and Stormscope, electronic charts and geo-referenced airport diagrams. The EFD1000 MFD also includes its own redundant ADAHRS sensors, meaning that in the case of PFD failure, a push of the REV button converts the EFD1000 MFD to a fully functioning PFD. The EFD1000C3 Pro PFD has a list price of \$12,995. A "launch" price of \$10,995 is being offered through the end of October. □