Front office of the future pushes the tech envelope

by Matt Thurber

Take a look at the dramatic photograph splashed across this page. I bet you want to fly this airplane. Look at the color-drenched synthetic landscape projected onto the windshield, below the head-up display bracketed by a system synoptic and FMS page. As if that isn’t enough, a huge display on the instrument panel shows a high-resolution outside view from above the aircraft flying over photo-realistic terrain. The FMS page adds more detail, with a 3-D depiction of what appears to be your flight path and perhaps another airplane’s planned flight. There appears to be a cursor-control device for your right hand, but I would be surprised if this display not only is a touchscreen but also allows you to grab any element and move it anywhere you want in the cockpit, including onto the windshield, like the transparent displays featured in the Tom Cruise film Minority Report.

There’s just one thing wrong with this picture: only half of a current two-pilot crew will get to fly this display because this is clearly a cockpit built for one pilot. And it doesn’t take much imagination to picture the business jet that this cockpit is attached to. Maybe a light jet, maybe something heavier; eventually this type of cockpit will fill the streamlined aerodynamic nose of all kinds of aircraft.

And although this graphic comes from the fertile minds of forward-looking engineers and designers at Rockwell Collins and the hardware is nowhere near ready for prime time, there is no doubt that solo-piloted large aircraft are coming. And this will likely lead to no-pilot or unmanned aircraft, controlled by computers with an occasional nudge from a bored “aircraft manager” sitting in a climate-controlled office safely on the ground watching the progress of multiple aircraft on giant monitors.

For now, although the military is taking full advantage of unmanned aircraft, the commercial world needs pilots (see article on page 58), and avionics manufacturers are still designing their products with pilots as the primary interface with the aircraft. And while aerodynamic design has plateaued for the most part, avionics are clearly where the action is taking place in aircraft development. Clever avionics engineers are constantly coming up with better ways for pilots to use avionics and new and improved uses for avionics, and those of us flying now will get to enjoy the results for, hopefully, many years to come.

Aspen Avionics

Aspen Avionics is targeting increasingly larger aircraft with its unique glass-panel Evolution flight display PFD and MFD systems, which slot into existing three-inch instrument panel holes and are completely self-contained with ADAHRS, backup battery, emergency GPS, altitude alerter and electronics all housed inside the instruments. By the end of the first quarter or early in the second quarter, Aspen will begin delivering a synthetic vision system (SVS) for $2,995. SVS should be deployable on both the PFD and MFD, but that is still being worked on as part of certification, according to Brad Hayden, vice president of marketing.

The software upgradeability of the Aspen EFDs is one of the key features that has led to sales of thousands of PFDs and MFDs so far. “That is one of the underlying premises of our product offering,” Hayden said. “It guarantees the investment in your panel. People are used to consumer electronics being modular, upgradeable and expandable. We had some education to do for what that meant for avionics. We’re on the third software upgrade that continually adds more functionality to our products.”

Before mid-year, Aspen should also be delivering the EFD1000 as a backup instrument that replaces mechanical backup instruments. “Technically speaking you could put it in right now,” Hayden said, “but you still need a mechanical attitude indicator. We’re working with the FAA to overcome that requirement.” The likely installation will be for two Aspen screens with no mechanical backup required, he said.

Last year, Aspen added geo-referenced approach charts from Seattle Avionics to the MFD as a free upgrade (for existing subscribers to the static Seattle Avionics charts). “The next time [customers] did the Seattle Avionics download, it automatically gave them that capability,” Hayden said. “Those are the types of pleasant surprise we want to keep building in for our customers.”

More recently, Aspen introduced the EA100 autopilot adapter, which sits between an EFD1000 and analog autopilots, converting digital attitude signals from the EFD to analog for the autopilot. Both the EFD PFD and MFD can output the necessary attitude signals, providing redundancy to the autopilot and eliminating the problem of legacy designs where the autopilot responds to attitude commands from a failed single gyro. Aspen is looking into making the EA100 work with autopilots in larger aircraft that still use older Collins and Sperry systems, according to Hayden.

The turboprop market is a big opportunity for Aspen’s products, he said. “The perception is that our smaller glass wouldn’t be attractive to that market. Actually we’re seeing people saying, ‘It’s a lot better than what I’ve got right now.’” Aspen’s EFD1000 C5 is qualified to DO-178 Level B standards and is approved for installation under an approved model list (AML) in aircraft through Class III.

Avidyne’s Protected Envelope

Last year both Avidyne and Garmin introduced envelope protection for aircraft equipped with their avionics and flight control systems. Until now, envelope protection, where the flight control system is designed to prevent pilots from losing control or crashing, was a feature found primarily in fly-by-wire systems. But all it really takes is the right kind of autopilot. And the advent of these systems raises questions about why this hasn’t been done earlier in larger aircraft, given some pilot-induced accidents that have occurred. These envelope-protection systems are a great example of general aviation leading the technological way.

Avidyne is offering two capabilities for envelope protection: flight envelope alerting and flight envelope protection. When the flight director is engaged, alerting delivers aural and visual alerts to the pilot for impending excursions such as approaching stall or overspeed. When the autopilot is engaged, the protection system not only provides aural and visual alerts but also actively intervenes and prevents the airplane from stalling or flying too fast. The DFC90 flight control system offers both these capabilities, but the recently certified DFC100 also offers full-time envelope alerting, which works all the time, not only when the flight director is engaged.

With the autopilot engaged, both systems use the roll and pitch servos to keep the airplane within the flight envelope. A typical example of when the system can help a pilot is during a descending spiral, during an IFR approach. When an autopilot levels the airplane at the preselected altitude near the final approach fix, if the pilot is distracted and fails to advance the power, the airspeed will decay. When the autopilot’s parameters are exceeded, it will normally turn off, leaving control to the pilot, who suddenly has to figure out what’s wrong and why the airplane is suddenly too low and slow.

With envelope protection, the autopilot’s aural and visual “underspeed” warning will alert the pilot and the system will also lower the pitch attitude to maintain a 20-percent margin above full speed, according to Avidyne. If the airplane is turning, the system will also reduce the bank angle to help maintain the 20-percent margin.

Flight envelope protection can help a pilot survive an oxygen system failure, too. In this emergency, Avidyne poses a
pilot flying at high altitude in a turbocharged airplane but suffering from hypoxia due to oxygen system failure. The autopilot will maintain altitude until the engine runs out of gas; then instead of allowing the airplane to stall after the autopilot exceeds limits and turns off, the system will lower the nose to maintain the 20-percent stall margin, allowing the airplane to descend to a lower altitude where, hopefully, the pilot will wake up, switch to a tank with fuel and restart the engine or make an emergency landing.

According to Avidyne, “For flight envelope protection, available lift and speed margin are calculated constantly whenever any autopilot or flight director modes are in operation. Accident data has pointed to many [instances] where flight envelope protection could have made a positive difference.”

In addition to the recent certification of the DFC100, Avidyne expects certification shortly for the Entegra Release 9 flight deck in Extra’s 500 Spirit single-engine turboprop. Piper’s Matrix is now certified with the Entegra R9 and the Mirage and Meridian are next in line. These systems are certified with the Entegra R9 turboprop. Piper’s Matrix is now in Extra’s 500 Spirit single-engine airplane will include the three-display suite and the Mirage and Meridian are next in line. These systems expect certification shortly for the Mirage and Meridian.

Last October, CMC licensed the SmartDeck integrated avionics system from L-3. “We’re excited about the opportunity that presents from a cockpit and production portfolio,” said Yeldon. CMC’s plans are to offer SmartDeck for the Part 23 market and for smaller Part 25 aircraft. “We see an opportunity to retrofit older cockpits that are not glass,” he said.

SmartDeck doesn’t include an autopilot, but CMC will work with partners to offer an autopilot solution, according to Patrick Champagne, vice president of cockpits. “We do not intend to develop our own.” In SmartDeck, he added, “We acquired a cockpit design philosophy; that’s one of the key values. Everybody we’ve talked to likes that interface a lot. There are elements of the design philosophy that we’ll have to change, but our objective is to evolve and not change it.”

FMS has long been a key CMC product line, and the company offers standalone FMS boxes for retrofit installations as well as integrated FMS functions wrapped into avionics systems. In SmartDeck, for example, the FMS is software-based. “We’ll work with the customers to do what they prefer,” Champagne said. “Our philosophy is to make what our customers need, not to push on them what we think is best. That’s why we’ve been successful in the retrofit market.”

CMC has delivered more than 400 of its third-generation CMA-2600 SureSight infrared sensor systems and is working on the next-generation CMA-2700, which will be certified this year in the Rockwell Collins Fusion/Bombardier Global Vision avionics suite.

Garmin’s Part 25

It was inevitable, but Garmin took the industry by surprise when it announced at last year’s NBAA Convention that it is developing a Part 25 avionics suite, the G5000, and that Cesna is the launch customer with its stretched Citation Ten. The G5000 is scheduled to enter service on the Citation Ten in 2013. “It has always been a target to grow into that [Part 25] marketplace,” said Gary Kelley, vice president of marketing. The G1000 system was launched with Cesna’s Mustang, he added. “We’ve had our eyes on the turbine market since the beginning of our integrated flight decks, and it is a natural progression to go upward.”

The G5000 uses the same GTC touch controller found on the G3000 system, which is making its debut in Honda Aircraft’s HondaJet. On the G5000, each panel display—either the 14.1-inch GDU 1400 or 12.1-inch GDU 1200—will have its own service on the Citation Ten. And on the Citation Ten, there will be four GTCs, two in the pedestal and one next to each pilot’s EFB.

Garmin is venturing further into new technology with its touch controllers instead of cursor-control devices, with the goal of reducing the amount of pilot training and especially memorization needed to operate the G3000 and G5000. Icons replace knobs and buttons found on the earlier-generation G1000 and the icons are used for flight management tasks, setting radio frequencies, audio adjustment, synoptics and other functions.

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<td>ADAHRS</td>
<td>air data attitude heading reference system</td>
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<td>ADS-B</td>
<td>automatic dependent surveillance-broadcast</td>
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<td>AML</td>
<td>approved model list</td>
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<td>AHIR</td>
<td>attitude-heading reference system</td>
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<td>CPDLC</td>
<td>controller-pilot datalink communications</td>
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<td>CRT</td>
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<td>EVS</td>
<td>enhanced vision system</td>
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<td>FMS</td>
<td>flight management system</td>
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<td>GTC</td>
<td>Garmin touch controller</td>
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<td>HUD</td>
<td>head-up display</td>
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<td>LCD</td>
<td>liquid crystal display</td>
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<td>OEM</td>
<td>original equipment manufacturer</td>
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<td>RNP</td>
<td>required navigation performance</td>
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<td>SEVS</td>
<td>synthetic enhanced vision system</td>
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<td>SMC</td>
<td>supplemental type certificate</td>
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<td>SVS</td>
<td>synthetic vision system</td>
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<td>TAWS</td>
<td>terrain awareness warning system</td>
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<td>TCAS</td>
<td>traffic alert collision avoidance system</td>
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<tr>
<td>TSO</td>
<td>FAA technical standard order</td>
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<tr>
<td>UAV</td>
<td>unmanned aerial vehicles</td>
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sensors for the stricter certification requirements of Part 25, including new AHRS, air data computers, a new weather radar system and a new Teas. The G3000 and G5000 are compliant with new controller-pilot data-link communications (CPDLC) standards and will allow pilots to communicate in a text-messaging-type interface on the GFC800, which will offer an inertial reference system—required for long-range overwater flights—but this will come from a supplier, as it is one of the few items that highly vertically integrated Garmin doesn’t manufacture.

The U.S. STC for Garmin’s G1000 retrofit program for the Beechcraft King Air 200 and 200 received EASA validation in December. The G3000 for the King Air meets European regulatory requirements, including 8.33-KHz VHF, VHF com immunity from FM radio, B-Rnav, P-Rnav, mode-S elementary surveillance, ADS-B and TAWS Class B. Garmin’s SVT and geo-referenced ChartView are available as options on the King Air retrofit. Garmin is also offering its new electronic stability and protection (ESP) technology—available as a $17,995 option for the G1000-equipped King Air 200 and other King Air models approved for the G1000 retrofit. ESP will also be an option on G3000 systems. There is a large number of opportunities in retrofit integrated systems,” said Kelley. Garmin is also partnered with Cessna on a CitationJet integrated cockpit retrofit. And those aircraft equipped with CRTs will need upgrade paths to LCDs because CRTs are no less available for thousands of aircraft. Older-style mechanical instruments means that more than just the cockpit will be involved in these efforts. We’re looking at this not only from the cockpit perspective but also from the architecture of the aircraft,” he explained. The way the pilots interact with the systems is high and we’re working with the FAA on what we call equivalent visual operations to be able to use that technology for lower landing minimums.

Honeywell has a lot of experience designing control systems for unmanned aerial vehicles (UAVs) and this will help with design of future cockpits, which could include single-pilot configurations in Part 25 aircraft. “We make single-pilot cockpits,” Esposito said. “We understand the complexities of certification and the redundancy needed.” Honeywell’s experience with manufacturing not only avionics but engines and environmental systems means that once a pilot gets used to ESP, that once a pilot gets used to ESP, the brain to make the transition from the brain to make the transition from mechanical instruments to LCDs allows Honeywell to continue to demonstrate the EVS enhancement in Part 25 aircraft. “We’re looking at this not only from the cockpit perspective but also from the architecture of the aircraft,” he said.

In the retrofit market, Honeywell’s Primus Elite upgrade is available for thousands of aircraft originally equipped with CRTs that are no longer available. “We are investing in LCD technology and drop-in retrofits to keep airplanes current for a long time,” said Esposito. Upgrading to LCDs allows Honeywell to offer many new capabilities that couldn’t be displayed on CRTs, including maps and charts, unlinked weather and the latest ES technology. “We’re working with the FAA to explore fused SVS and EVS for the NextGen flight environment.”

King Air retrofit. Garmin is offering new electronic navigation view. A great example is Primus Epic, which is serving many market segments, including regional, air transport and business aviation. The Gulfstream G650 is a great application for that technology.

Gulfstream was first to certify Honeywell’s synthetic vision system on the PlaneView avionics platform, and both companies are working on the fused SVS/EVS, called synthetic and was recently received an AML STC for more than 1,000 Part 23 aircraft models through Class III. The AML is the same for all the Trilogy displays. The ESI-2000’s battery is lithium-ion, while the ESI-1000 uses lead-acid, with design with the battery. Both feature a 3.7-inch backlit screen, integrated air data computer, solid-state attitude sensor and optional external magnetometer, and information displayed includes attitude, altitude, airspeed and (with the optional magnetometer) heading. L-3 is also working on products for the nascent NextGen infrastructure, and the ADS-B Upgrade for the SkyWatch HP is scheduled to be available in the middle of this year.

Rockwell Collins

As a relatively new avionics company like Garmin has to select the right time and the right place to introduce a new technology. For instance, Rockwell Collins is looking at bringing the fruit of its technological developments downtown market into light jets while exploring single-pilot cockpits that will eventually be found on Part 25 aircraft. “We believe in a future where you’ll see larger

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Embraer has selected Sennheiser to provide its HMEC 26 active noise-reduction headsets for the Waas signals. If these are satisfactory the FAA will begin transmitting communications and control segment contractor, March. The FAA and Lockheed Martin, the ground to 133 degrees west or a location near that in early some airports in Alaska on December 16, is back ceased broadcasting the Waas signal covering wireless local area networking 802.11 b/g standard. battery, charging cradle and adjustable keypad Aviator also features a 2.2-inch TFT color screen, incorporated to improve audio quality; the handset can make calls. Noise and echo cancellation is pilots can contact the ground and passengers pairing allows users to receive in-flight calls, so handset, designed to work with the Danish satcom –Matt Thurber atlantic service should begin this year.

Row 44's MultiScan weather radar, which craft also feature Rockwell Collins's lower approaches. lights put out no heat, there remain of its infrared sensors to penetrate aircraft if you actually fly through moisture-laden fog. And with air- of the world on a head-down display, making sure they create a dynamic situation for the world, “So it know what it is they're looking at, especially as crews try to use these capabilities for credit on low-visibility approach and landing.” EVS still has drawbacks, namely the inability of its infrared sensors to penetrate moisture-laden fog. And with airports switching to lower-cost LED runway lighting systems, which the EVS sensor cannot see because the lights put out no heat, there remain difficulties in trying to get credit for lower approaches.

All of the Fusion-equipped aircraft also feature Rockwell Collins's MultiScan weather radar, which helps pilots spot potential weather threats that might affect the flight, rather than just showing levels of moisture in the atmosphere. “We've done a lot of work to make sure we understand where you are in the flight planning and weather data services from the former Air Routing. With so many aircraft equipped with real-time high-bandwidth communications capabilities, it's natural to wonder whether a Multiscan-equipped jet could send radar images of what it is seeing back to Ascend for redistribution to clients without the same equipment. “We are researching the transmission of MultiScan radar imagery to ground sources and to other airborne aircraft,” Otto noted. The transmission of onboard radar as part of the Ascend synchronization is technically feasible, so our research focus is how to best package data to make it usable. In the meantime, our integrated flight information system provides weather uplink functionality. Rockwell Collins more recently announced the purchase of software provider Computing Technologies for Aviation (CTA), which will add to Ascend’s capabilities to provide trip initiation to post-landing close-out flight services to operators. CTA

The Rockwell Collins Fusion system shows synthetic vision images on the HUD, including the “dome” identifying the airport in the distance.
is the developer of the Flight Operations System scheduling and dispatching software.

There are more than 4,000 Rockwell Collins Pro Line 21 and 1,700 Pro Line 4 flight decks in the field, and the company is working on keeping those systems current using technology derived from Fusion. “We’ve got several different roadmaps,” said John Peterson, director of business and regional systems marketing. Both Pro Line 4 and 21 have Waas LPV solutions now, and other technologies such as ADS-B and synthetic vision are likely future capabilities. “We’re absolutely committed to maintaining the value [of that fleet],” he said. “We’re working through certifications to make sure operators always have a long-term roadmap to maintaining value of those aircraft.” Projects featuring replacement of the Pro Line 4 CRTs with Pro Line 21 LCDs and upgraded capabilities include Rockwell Collins’s STC programs for the Falcon 50EX and 2000 and the Nextant Aerospace 400XT.

For Rockwell Collins, the future is not just the Fusion avionics suite, with all of its advanced capabilities, but also with something like the conceptual cockpit depicted at the beginning of this article. And the Rockwell Collins roadmap paves the way to a future with single-pilot-configured Part 25 cockpits. “For OEMs and the industry, realizing the aerodynamic and other economic benefits of such designs is really a continuation of a trend in pilot task distribution that we’ve been enabling since the early days of flight,” explained Irmen at the pre-NBAA briefing.

On the way to that cockpit, pilots should expect to see key technologies in their cockpits, such as head-up synthetic vision as well as touchscreen forward displays, which allow users to keep their eyes on the information shown on the display while interacting with the display. The trackball cursor control device is a step toward what Irmen terms “eyes-forward touch control” in the flight deck, but touchscreen PFDs and MFDs are the goal. “If it’s good to have your eyes on the main displays when you’re interacting with information there,” he asked, “then isn’t it even more natural to have both your eyes and your hands in the same place?”

The concept cockpit remains that, for now. “We’re using this as a formative type of structure to make us think about the future of business aviation,” Otto said. “What does that flight deck look like and what capabilities do you need to include in your avionics or in the aircraft to maintain the safety rate of the industry and to be effective in flying?”

Universal Avionics

Universal Avionics continues to make strides in cockpit retrofits and late last year announced a technologically advanced cockpit for the Falcon 900B in partnership with Western Aircraft. The upgrade calls for replacing the original avionics with five Universal EFI-890R LCDs. This includes the UNS-1Fw FMS with Waas LPV and Universal’s new engine indication unit for power instrumentation. Options on the retrofit suite include Universal’s Vision-1 SVS, single- or dual-side charts, graphical weather, video capability, checklists and other features.

The STC will be done by Western Aircraft and certification in the 900B is expected in the middle of this year. Last November, Jet Aviation St. Louis completed the first Waas LPV FMS installation in a Falcon 2000, with two UNS-1Fw FMSs approved under the FAA’s engineering assisted field approval process. Universal Avionics has delivered more than 20,000 FMSs since the first customer delivery in 1983.