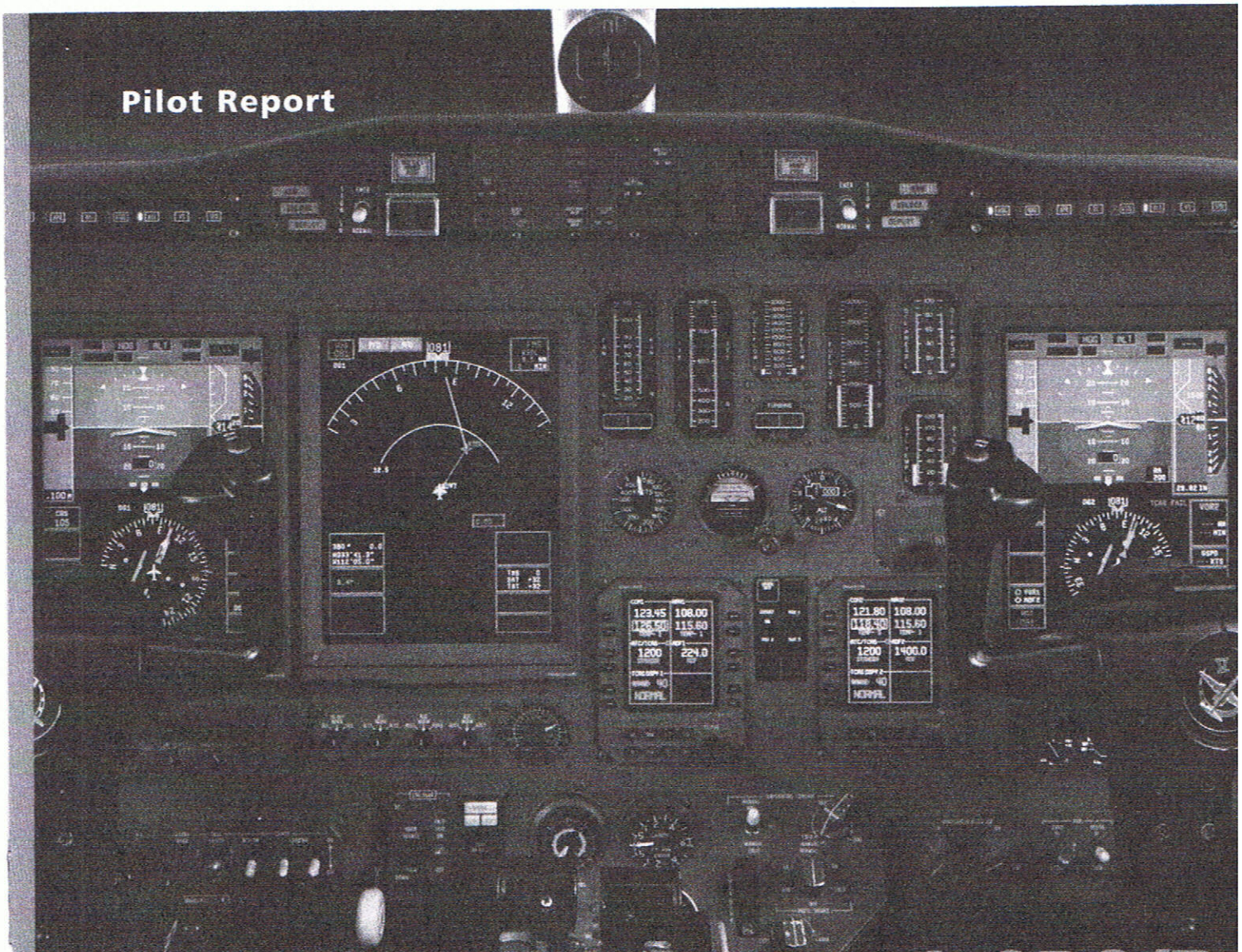

The Simplified World of CDS/R

The large LCDs in Honeywell's Primus Epic retrofit package can provide a lot of information to enhance pilot situational awareness. But they are designed not to burden the pilot, especially during critical periods of flight.

By Harry Kraemer

AS ELECTROMECHANICAL INSTRUMENTS rapidly become a part of aviation history and electronic flight instrument systems (EFIS) are pushed to their limits, newer flat panel displays are emerging as mainstays in corporate aircraft cockpits. These displays are not only clearer, but are often larger, as is the

case with Honeywell 's Control Display System/Retrofit (CDS/R). A version of the Primus Epic display system, CDS/R presents a plethora of data in formats that allow quick comprehension and situational awareness.

Initial flight test of the CDS/R began as early as September 1998, and Honeywell received supplemental type certification (STC) and technical standard order (TSO) approval on Oct. 15, 2001. As the name implies, this is a retrofit system developed to replace electromechanical and cathode ray tube (CRT) EFIS systems in corporate aircraft (January 2002, page 19). Honeywell originally targeted Gulfstream GII and GIII, Challenger 600 and older-series Citation operators who want to upgrade their equipment and enhance safety. But the company now is looking at other business aircraft, as well as cargo airplanes and helicopters.

The system is offered in two-, three- or four-display configurations. The color, 8-by-10-inch (20.3-by-25.4-cm) DU-1080 active matrix liquid crystal displays (AMLCDs) are accompanied by display controls and connected via a 1-MHz communications bus to an integrated processor, which contains extra analog input/output functions to ensure a broad range of applications.

Avionics Magazine had the opportunity to get hands-on experience with a three-display system in Honeywell's Citation development and test aircraft. The pilot and copilot each has a primary flight display (PFD); the third screen, just to the right of the PFD for the pilot in command, is a multifunction display (MFD). They combine to present an uncluttered cockpit, something not often expected in a Citation V.

As the avionics came alive, I was impressed with the AMLCDs' clarity. They were sufficiently legible to present checklists, which contribute to the goal of achieving a paperless cockpit. The display controller included both "NORM" and "EMER" buttons to access each checklist series.

Takeoff and Climb

Prior to takeoff in the Honeywell Citation, I was able to set the V-speeds (takeoff speed, decision speed, initial climb speed, etc.), using the menu on the pilot's PFD. The CDS/R system uses drop-down menus similar to Windows software. I inputted the speeds by means of the "TO Speeds" menu, working through the options with a cursor and joystick. To verify that the V-speeds are set and correct, they are repeated at the bottom of the airspeed tape.

As I added power and started the takeoff roll, the airspeed tape came alive, indicating the velocity of our forward movement. The V-speeds I had set appeared as bugs on the correct speed—calculated, based on aircraft weight and atmospheric conditions—on the left side of the pilot's PFD. The background of the tape will turn from black to red if the airspeed exceeds the overspeed value. My selected airspeed was indicated with a magenta airspeed bug, and VMO, or maximum airspeed, is displayed with a red and white line, also on the airspeed tape.

After rotation I pitched up, aligning the aircraft symbol with the command bars on the attitude indicator, which were set for the climb. Honeywell has added a low bank limit mode that enhances passenger comfort and flight efficiency at altitude. Passing through the predetermined altitude (according to aircraft type) triggers the mode, which becomes active when the pilot is using the flight director in the heading mode. This reduces the bank limit from 27 degrees to between 13 and 17 degrees, which is preferable at higher altitudes.

During the climb, I found the vertical speed indicator (VSI) easy to read with a resolution of 50 feet per minute (fpm), instead of the usual 100 fpm intervals. If the vertical speed exceeds plus or minus 4,000 fpm, the pointer would park at the upper or lower end of its scale, depending

on whether you are climbing or descending.

As I approached our assigned altitude, the magenta bug came into view on the altitude tape. I leveled the Citation V at 18,000 feet mean sea level (MSL), still hand flying. I found the altitude trend indicator added to the big picture, showing what altitude the aircraft would be at in six seconds if the current vertical speed were maintained.

For flights at and above 18,000 feet, the CDS/R includes a handy PUSH STD button to set 29.92 in as the altimeter setting. There was no need to dial in the setting manually.

All Before Me

The simple, three-screen configuration made an instrument scan quite easy. All pertinent information was directly in front of me, keeping head movement to a minimum. I had the airspeed, pitch and bank, and altitude on the left side of the PFD, and just below that, the horizontal situation indicator (HSI).

On the HSI, I could display two radio magnetic indicator (RMI) needles, as well as the primary navigation information. The navigation information for the HSI and RMIs can come from sources such as the GPS/flight management system (GPS/FMS), automatic direction finder (ADF), VOR and TACAN. For pilots transitioning from the older aircraft with the conventional six flight instruments, the joy of convenience awaits them. (Honeywell claims the PFD replaces up to 10 electromechanical indicators.)

In the past, it was a challenge to present current wind direction and velocity information to the pilot. Some older displays couldn't represent this information, so pilots relied on pre-takeoff weather forecasts and observations of aircraft movement. With the CDS/R, wind information (only with FMS installed) is displayed on the PFDs. It shows wind velocity, direction, headwind/tailwind, and left/right components. Such information on an approach can be a great asset.

Another valuable piece of information—courtesy of the CDS/R system—is the drift bug, especially on an approach in instrument meteorological conditions (IMC). It is a hollow white bug, much like a heading bug, indicating ground track on the HSI.

As I descended below 550 feet above ground level (AGL) the gray altitude tape on the PFD was replaced with a brown background, adding to my low-altitude awareness. When the aircraft reached minimums, "MIN" was displayed on the right side of my attitude director indicator (ADI). A "MINIMUMS" knob on the display controller allowed me to set the "MIN" value.

Overlays

With the CDS/R system that I flew, I could overlay weather radar or enhanced ground proximity warning system (EGPWS) information on either the PFD or the MFD. I could

Aircraft Fitted with CDS/R

The Citation V

In addition to the Citation V, the Primus Epic CDS/R system has been installed and approved by the Federal Aviation Administration in the Gulfstream II and III and the Lockheed Martin L382, the civil version of the C-130 Hercules. In addition, the retrofit display system is being installed in the Shaanxi Aircraft Y8, a four-engine, turboprop cargo plane made in the People's Republic of China.

not overlay both types of data on one display. By the same token, I could display traffic alert collision avoidance system (TCAS) data and weather radar data on the MFD. But radar, TCAS and EGPWS data could not be combined on the MFD. This is good for safety reasons, as weather radar and EGPWS symbols are fairly similar in appearance and could possibly be confused.

The ADI on the PFD also offers valuable information to the pilot when a TCAS advisory is displayed. A red goalpost emerges on the ADI, to indicate the no-fly zone; a green box on the ADI provides guidance cues to the fly-to zone, again adding to the situational awareness.

All the information that can be presented on systems like CDS/R can create a dilemma, however. TCAS, EGPWS, uplinked weather and numerous potential malfunction messages (heading failure, altitude failure, vertical speed failure, etc.) undoubtedly improve pilot situational awareness. (The Honeywell system even includes display comparison monitors to alert the crew of a difference between the data on the pilot's and the copilot's display.) But all this—welcome as it is—can create screen clutter and demand more mental processing from the pilots. MFDs help eliminate clutter by providing another display on which information can be dispersed. But pilots need an uncluttered, "big picture" view of their situation.

That is why Honeywell included a declutter mode for the CDS/R system. If the aircraft enters an unusual attitude (defined by roll greater than 65 degrees, pitch up greater than 30 degrees or pitch down greater than 20 degrees), the system automatically removes non-essential information from the display, enhancing the pilot's ability to make a quick and easy recovery. This definitely enhances safety.

Red excessive-attitude chevrons appear on the ADI display when the aircraft is at an extreme attitude: 45 and 65 degrees nose up or at 35, 50 and 65 degrees nose down. A small "eyebrow" indicator appears on the display if aircraft pitch attitude exceeds plus or minus 17.5 degrees. The screen does not go completely blue or brown in these cases, where the aircraft pitch exceeds the limits of the display. The eyebrow indicator provides a triangular-shaped, brown area to signal an excessive nose-high attitude and a blue area to indicate an excessive pitch-down attitude, so the pilot will know which way to recover.

In Summary

Overall, a pilot could not help but like the large displays. They are crisp, clear and easy to read. And Honeywell has almost eliminated any side-angle viewing problems even in bright sunlight.

I also found that the drop-down menus made flying easy. I used a joystick to control them. Honeywell designed the PFD menus so that, with the exception of landing reference speeds, everything was inputted on the ground before takeoff, requiring limited use of the menus in flight. Pilots who have flown with EFIS should have no problem becoming comfortable with the CDS/R. I have flown several different EFIS systems and felt right at home with the CDS/R system after a short briefing and some hands-on experience.

The range of display capabilities permits pilots to present just the data they feel is needed for a flight profile. Flight information is presented in a logical and familiar way, resembling more conventional panels. This simplifies the transition and minimizes training time. Honeywell also has a training program to aid pilots in the transition. A