FLIGHTLOGIC

Synthetic Vision EFIS

By David Adams

> “Unlike other glass cockpit systems, the Chelton EFIS shows you terrain with its *synthetic vision* system”

Some might claim that glass cockpits in GA aeroplanes don't give you much more than you can get from an HSI and a moving map GPS. This certainly can't be said of the FlightLogic Electronic Flight Instrument System (EFIS) from Chelton Flight Systems. The typical installation has two displays on which you'll find everything you need to conduct VFR or IFR flight in three dimensions. Unlike other glass cockpit systems, the Chelton Flight-Logic EFIS shows you the terrain over and toward which you are flying with its “synthetic vision” system. Terrain and other obstructions are shown in real time, with the correct perspective relative to the aeroplane's position. Not only that, but also unlike other systems, it provides both lateral and vertical guidance through departures, en-route and arrival procedures. It uses a different paradigm for displaying information to the other glass cockpit systems found in GA aeroplanes which tend to mimic traditional instrumentation; the Chelton system is more akin to the “heads-up” display found in modern jet fighters.

Approved retrofit

The Chelton EFIS is an after-market system which is approved for installation in a wide variety of aircraft. I spent a dozen hours flying the Chelton EFIS with Field Morey in December amongst the beautiful mountains of Oregon. Field is quite possibly the world's most experienced SEP instrument flying instructor, with tens of thousands of hours of instrument instruction alone. He fitted the Chelton EFIS to his turbo retractable Cessna 182 about 12 months ago. He says he considered upgrading to a new Turbo 182 with a Garmin 1000 glass panel system, but felt it didn't give him enough over what he already had, with his HSI and Garmin GNS530 system. Fitting the Chelton EFIS meant he could keep both the 530 and all the other avionics he already had. All these devices interface with the Chelton system and provide a comforting

level of redundancy. Unlike in a Garmin G1000 equipped aircraft, if the Chelton EFIS fails you still have the Garmin 530, HSI etc - state of the art not so very long ago. The Chelton screen is smaller than a G1000 or an Avidyne FlightMax one at 6.25 inches by 5.5 inches. It's bigger than the 530 and the resolution is much higher and of course, it is readable under any lighting conditions.

Inside each display is an individual processing unit, a shared WAAS GPS receiver, an air data computer, an attitude and heading reference system (AHRS) and various interfaces to the other avionics. The system will output to an autopilot, providing roll steering instructions. Chelton are apparently working on a version which will also output pitch instructions for automated vertical navigation.

Highway in the sky

So far so good, but everything so far is pretty common in glass cockpit aircraft. On the Chelton, course guidance is provided using a series of boxes shown on the PFD, which Chelton call the "Highway in the Sky" or HITS. The space represented by these boxes is actually very small, just 320 feet high and 400 feet wide - they're about half the width of an ILS localizer at the approach end of the runway. To fly the course you simply make sure that you fly "through" the boxes. It sounds simple and in reality, it is. If flying an instrument procedure the HITS will guide you in to and around a hold, a DME arc or a procedure turn, guiding you both laterally and vertically. Because you can see not just the box closest to you but four boxes beyond that, you can anticipate the next as you pass the first. The active runway is also depicted in the correct perspective for its position and dimensions. I flew a 10 mile final approach to a runway solely using the EFIS for guidance: I looked outside for the first time at 40' and was squarely above the runway threshold, a couple of seconds from the flare. This works for any runway in the system, not just those with instrument approaches. Field and other pilots have successfully flown approaches this way right down to the tarmac.

Primary flight display

The Primary Flight Display (PFD) shows the same information that you find on the traditional six-pack of instruments or on the G1000 or FlightMax - an airspeed tape on the left (which also shows dynamically adjusted indicators for Vx, Vy and other critical speeds, G-corrected in real time which of course a traditional ASI doesn't show), an altitude tape on the right with a VSI and a heading tape across the top. The attitude indicator is intelligent in that when you don't really need it, it disappears. If you start to bank in either direction the angle of bank indicators appear. If you climb or descend you'll see at least 10 degrees of scale either side of your current pitch. And if you're in an unusual attitude, large chevrons will point you back towards straight and level. Within 2000 feet of the ground your height above ground level is shown in the middle of the PFD plus an indicator to show how this is derived - this depends on the particular installation but could be GPS-based, barometric or from a radar altimeter. If retractable landing gear is lowered three circles are shown beneath the aircraft symbol in the middle of the display.

Flightpath marker

But it is not the HITS that make precise control of the aeroplane so simple. And it's certainly not the representation of the attitude indicator, the directional gyro or even the CDI you see on other glass cockpit displays. Instead it is three small lines and a dot which show up on the PFD: the flight path marker. The beauty of this small representation of your aeroplane is that it shows you not where you're pointed as with a traditional attitude indicator, but where the aircraft is actually going. The distinction is subtle, but it takes all the brain work out of things like compensating for a cross wind. At 10,000' over the Cascade mountains of Oregon we had 60 knots of crosswind, which pushed the "where am I going" indicator a long way from the "where am I pointed" one, but as long as you keep it in the green boxes, you're proceeding precisely on course, with greater precision than an ILS localiser and glideslope.

3D terrain

Combined with the three dimensional representation of the terrain beneath you, you can see if you're going to clear a particular mountain peak or other obstruction. If the flight path indicator is above the terrain then you'll miss it. The rendering of the terrain is designed to give true depth perception, including a blurring of the terrain contours as they reach the horizon, hidden line removal and so on. The system incorporates a full Terrain Awareness System (TAWS) which provides various warnings - these are annunciated by a friendly voice, stating for example that you are deviating from your target altitude, getting too close to the terrain, sinking on approach etc. It's a forward looking terrain system, which means it doesn't just look at the ground beneath you, but that which you are projected towards. Traffic is also presented on the three dimensional display in the right place with range and relative altitude, plus it is annunciated verbally if it gets too close. Various other warnings are also spoken - deployment of landing gear, altitude loss after take-off, etc.

> "Course guidance is provided using a series of boxes shown on the primary flight display called ***highway in the sky*** or HITS"

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> The MFD also shows a constantly updated prediction of your power-off glide touchdown point

Map flight display

On the right of the PFD on the typical installation is the map flight display (MFD). This shows a plan view of your route in a similar way to other glass cockpits, over a detailed terrain map. The map can be zoomed very quickly - it redraws in the blink of an eye, no matter how much information is being presented. Unlike the G1000 or FlightMax, when making a turn a small white line is shown, projecting your path forward. Affectionately known as the noodle, this tiny bit of information is incredibly useful in instrument flying. For example, when flying a holding pattern, or intercepting a localizer or other course, simply bank the aeroplane until the projected white line overlies the displayed course. As you come through the turn you intercept your desired course.

Power-off glide area

Given that the EFIS knows your path through the air, which way the wind is blowing and the altitude of the terrain below you, it can also show you a constantly updated prediction of your power-off glide touch down point. It shows this on the MFD as a ring surrounding your aeroplane in the middle of the display.

In common with the G1000 and FlightMax, the MFD also displays various air data: a dynamic wind vector, the current cross wind, outside air temperature, the ISA temperature, density altitude, true airspeed and ground speed.

On start-up the system takes a couple of minutes to initialise. It automatically sets the altimeter to the ground elevation level of the nearest IFR runway. It's not perfect, but it's usually very close and will probably be good enough if you did forget to set the appropriate pressure setting. You then confirm the amount of fuel you have on board.

Flight planning

For a typical airways flight, one enters the desired waypoints in a flight plan. Planning a route is similar to any other IFR GPS system. It helpfully plots the relative position of each waypoint as you enter it, so gross errors can be spotted very easily. The Chelton not only knows about airways, it knows their minimum en-route and crossing altitudes too. We flew various airways trips without referencing an IFR chart in the aircraft even once. If using a departure procedure this is selected for the originating airport. The initial clearance altitude is entered as a target altitude, so the HITS can provide guidance right off the runway and through the departure procedure in three dimensions. If being vectored one simply hits the heading button and dials in the desired heading. As different altitudes are assigned one simply dials them in and follows the HITS up or down accordingly. During installation it is programmed with the climb performance of your own aeroplane. It uses a three degree descent angle and this alleviates the need for conscious descent planning; just fly through the green boxes.

Instrument approaches

As with most systems, the approach can be loaded in advance or as required during the flight. Not only does it understand all instrument approaches, but it has the vertical guidance for them too. We verified the altitudes against an approach plate before commencing the approach, but having done so the whole approach can be flown without reference to the plate. It will continue to provide guidance to the missed approach, pictorially indicating the entry to a hold as required.

The MFD can be turned in to a PFD with a single button push in the event of a failure of the primary display. Sure enough, commenting that flying the HITS seemed to make everything just a bit too easy, Field pulled a circuit breaker or two and the screens went black. But with a slaved HSI and a GNS530 to revert to, it wasn't too stressful. Restoring the power to the devices took them through their initialization process despite being in turbulence as a result of 50 knot winds rolling over the mountains a couple of thousand feet below. The G1000 is designed for mid-air restarts, but the FlightMax generally cannot be relied upon to do this.

Summary

The Chelton EFIS is a phenomenal system which brings new levels of situational awareness to general aviation, comfortably exceeding even that available from the other large display glass cockpit systems. Is it perfect? Well, even leaving aside the cost which is not to be sneezed at, no, it is not absolutely perfect. One of the biggest complaints is that currently you cannot overlay weather satellite weather information on the moving map (although you can overlay data from a sferics device). Chelton are said to be working on it. The user interface is generally very intuitive, but there are a couple of small things which could definitely be made easier. For example, if you create a new flight plan you then have to scroll through all the existing flight plans to activate the one you just entered when in fact it strikes me as likely that the flight plan you are most likely to want to activate is the one you just created. Field's biggest complaint is that you can't modify an instrument approach by, for example, deleting an approach waypoint, as you can on a Garmin system. These niggles aside, this is an amazing system if you can afford it.