Flying with an EFIS

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This article was first published in the UK Light Aircraft Association magazine '*Light Aviation*' in early 2009. It is copyright © of Gloster Air Parts in 2009 and may not be reproduced in whole or in part without permission. At the time of writing IMC flight in homebuilt aircraft is not permitted in the UK. The images used in this article are © of the respective EFIS companies. Since this article was written Blue Mountain Avionics have stopped producing new systems.

Part one of this series looked at how an Electronic Flight Information System (EFIS – called a 'glass panel' from here on) is put together, and part two looked behind the screen at what various manufacturers do to generate the pictures. This time I will look at a few things to bear in mind while flying behind a glass panel. Clearly flying is what this is all about. It's all well and good having the best designed hardware and software in the World, but if the pilot doesn't understand what is presented in front of him, or her, then its all for nothing. On the other hand, modern electronics can cram an awful lot of power into one box, and display an amazing amount of data on one screen, so it's worth spending some time learning about what the pictures are saying.

The first thing is … Don't Get Fixated – Look Outside when Flying VFR. This will be a recurring theme through out this article. You have installed a device that presents an awful lot of information. It is really easy to look at it to the exclusion of just about everything else, including what is going on around you when flying VFR/VMC. A good look out remains essential; one of the essential skills to develop is how to divide your time between extracting the relevant information from the glass panel and looking out the window.

The second thing is … read the instructions and practice. I know that somehow while learning to fly we somehow get a subliminal message that it is un-cool to read instruction books. The only trouble is that the thing you have just bolted in your panel is properly complicated, and you will rely on it to provide you with information that will really help you to fly more safely. So you should know how it works and the instruction book is a very good place to start. Once you have read the book, power the box of tricks up in your front room, or sit in the cockpit for a while and practice using all the functions.

All glass panels present information that would otherwise take at least 6 conventional instruments to display, and very probably more. The density of the information on the screen will be much more than with a conventional 6 pack. Consequently practice is required to extract all the relevant data from the display. More practise is need to be able to change things like the altimeter setting and a way point quickly during flight. The more practice the easier operating the glass panel will become, and the more you will enjoy flying your aeroplane. The other side of the coin is that any glass panel worth the name will have many functions that can't be found by just pressing buttons, so why let all of the super-dooper functions sit in the box unused? Many glass panels have a training or replay function to teach buyers how to use it. If your glass panel manufacturer provides a training DVD or computer program, then so much the better.

It really is essential to have some idea what you are going to be staring at before flying for the first time, otherwise you are unlikely to be able to give the required attention to the normal piloting tasks – you will be too busy trying to understand what the glass panel is saying. Learn what your magic box can do, practice using it to the full and use it to make flying easier, more enjoyable, and much safer.

All the manufacturers of certified glass panels suggest that pilots converting to aircraft that have glass panels fly with an instructor for between 3 and 5 hours to ensure they are fully up to speed on flying with an EFIS. In fact the FAA has coined the term "Technologically Advanced Aircraft" for aeroplanes (airplanes) with glass cockpits. For certified systems it is relatively easy (if rather expensive) to obtain instruction as there are not that many systems in use and they are increasingly widely fitted to flying school aircraft. The same is not true for un-certified systems. There are few instructors, or LAA coaches, who have very much experience flying behind glass panels. It is unlikely that your local coach has experience on the system that you have installed – but do ask. So while it remains very good advice to get airborne behind a glass panel with someone who can instruct you in its use, practically it is difficult to achieve.

So you've read the book and had some practice, but how to give yourself adequate experience before flying your pride and joy? There are likely to be 2 issues, firstly you have little experience on type and secondly you have little experience on your instrumentation system. One way out is to find a test pilot who has experience on type and is willing to carry out the initial flights on your aeroplane (you could even teach him how the panel works). As a bonus if you pick the right test pilot he could also convert you to type. Many builders find the desire to carry out the first flight of their creation irresistible – as this is a glass panel article I'll leave that subject there. So let's assume you have some time on type, but your first flight for real with a glass panel will be the first flight of your aeroplane.

The test plan, so now work out what data is needed from the panel at each stage of the flight. Step through the first flight, or first few flights, in your mind and figure out what information is needed and when. If your glass panel has engine monitor and moving map functions as well as a primary flight display (PFD) the list of information that is needed from the panel might look something like this:

Phase of flight	**Data Required**
Pre-flight	Fuel indications and battery condition, trim indicators
Start-up	Check lists, fuel pressure (for priming) and oil pressure & rpm.
After start	Electrical system status (volts & amps)
Pre-taxi	While the AHRS is aligning set altimeter – how will you know when the AHRS is aligned and it is safe to start to taxi?
Taxi	Start timer, compare heading indications between glass, compass and GPS
Run-up	Engine temperatures, mag checks – swap rpm input
Pre-flight checks	(does it provide a check list?) fuel qty, altimeter, electrics, set

	flaps and trim. Set 1st waypoint in GPS/map
Take-off & initial climb	Heading (aligned with runway number), start 2nd timer, rpm, airspeed, rate of climb, altitude
Further climb	Turn on to outbound heading, reduce rpm & manifold pressure
Cruise	Manage engine (EGT, CHT & fuel flow) Manage navigation & fuel quantity, wind
Alternative cruise	G level
Approach to destination	Calculate descent profile, identify destination
Descent	Set altimeter, rate of engine cooling
Circuit entry	Before landing checks complete, slow down, altitude, engine OK, fuel sufficient
Approach and landing	Lower intermediate flaps, airspeed, altitude, engine rpm
After landing	Stop timer 2
shut down	Stop timer 1, fuel remaining
Emergencies	Does the glass panel make such a big deal of minor faults that it distracts you from the primary task of flying the aeroplane?

Now the task is to figure out where all that information is and to ensure you are able to easily move between the various pages without spending inordinate amounts of time with your head buried inside the cockpit – remember that look out.

So the first time flying behind a glass panel is quite a learning experience? Probably, yes! To avoid it being an overwhelming experience it is a good idea to limit the amount of data displayed to start with. Most glass panels have a ‘de-clutter’ function, that is they allow the amount of data displayed to be reduced (see sidebar). That is likely to require some reading of the instruction manual. The first few flights will be quite close to your base airfield, so complex navigation can be ignored. I would suggest limiting the basic display to airspeed, altitude and heading, as well as attitude that will always be shown, and being able to change the altimeter setting. On a map display the local features are needed to maintain orientation, along with the ability to change range scale and perhaps the active waypoint. The engine display can be a little more tricky as new engines can require several parameters to be watched. Perhaps one objective during the pre-flight ground runs should be to become very familiar with the engine monitor functions, including ‘accepting’ a warning (this is the process to stop the screen flashing at you warning that some limit has been exceeded – often during the first few flights you have set the limit too conservatively).

The object is to limit the amount of data displayed so that your brain, which is being assaulted by all these new sensations, has a fighting chance of figuring out that it is being told.

What about the first flight? Most first flights are a somewhat tense time accompanied by a fair dose of adrenaline. That's not the ideal time to start to learn to use anything new. If you have little experience with glass panels, then use the huff & puff back-up instruments as your primary sources(at least for the initial few minutes), and then start including some of the basic flight info from the screen, such as airspeed, altitude, heading, rate of climb. If you are already familiar with the glass panel system and practised in its use will help things go smoothly. Think about what you are going to believe if the glass panel and the back-up instruments vastly disagree, and cross-check the readings regularly. Pitot-static checks will have been carried out shortly before flying, so you will be confident the glass panel and back-up instruments agree, but have you been able to test any of the other functions? Of course the first flight is as much about the engine as anything else. Engine runs carried out before the aeroplane was approved for flight will have provided a good learning opportunity for the engine monitor functions of the glass panel. You should know exactly where to look for rpm, oil pressure, fuel pressure and CHT data, you will also know what the alarm function looks like and will have thought about what action to take should any of the alarms trigger early in your flight. So throttle forward, concentrate of flying the aeroplane, before lift off glance in to ensure rpm is as expected and airspeed rising. At the appropriate speed lift off, maintain the correct climb speed, ensure you are really climbing and a brief check of engine indications. Look outside, try to relax! As you become more accustomed to the new sensations take in more of the data on offer, stay close to your landing area and complete your test plan. An approach to the stall might be one of the more important tests. What will the glass panel tell you as you slow down? How will it tell you of the impending stall? The time to find out is at altitude, not as you flare for landing. Through out the flight cross-check what the glass panel is saying against the other instruments, of course if there is a discrepancy it may not be immediately clear which is correct, but at least you can keep an eye on all available sources. If time allows write down what is happening to help in later fault finding. Anticipate that the glass panel and the stand-bys may not agree and be prepared to turn the glass panel off (to avoid distraction) and land straight away.

So now you're past the first few flights, everything is settling down and you have a full permit. What to do now? Test out what your device is capable of in terms of dynamic performance especially at high roll rates, how does it cope with bright days and dim days, what effect does aerobatics have (if permit allows) and how does GPS/radio navigation integration work. It is worth approaches questions like this in a methodical way. Write down what you intend to do (a test plan), record what happens as the flight progresses and review the data after landing.

A few words on panel design, backs ups and cross checking. The only reason LAA Engineering require back-up instruments to be fitted in your panel is that just about all glass panels, certainly all that are likely to be fitted to homebuilts, are not sufficiently reliable to be used as the sole source of flight critical data (as I discussed at some length over the last couple of months). So the back-ups should be in easy view of the pilot. There is not much point in putting them on the far side of the passenger. During the first few flights its difficult to know what to believe. Being able to easily include the back-ups in your instrument scan will allow comparison between the conventional instruments and glass panel. When they tell the same story your confidence in the

glass panel will start to increase. It is well worth getting in the habit of regularly cross-checking the readings. Hopefully 99.9% of the time they will both agree, but …

When to update the software? Let's set the scene, the aeroplane has been in the workshop for a few years. Although the decision on the panel was delayed as long as possible it has still been several months since the glass panel was delivered. Although a couple of software updates have been offered in that time the building effort has been quite intense as the project neared completion and those updates have never been uploaded. So it's obvious, isn't it? Load up the updates now so that you have the latest standard to fly with. Well, I'm not so sure that is such a great idea. The box has been providing good service as all the bugs have been ironed out of the aeroplane and you have become reasonably familiar with the various pages, especially during the engine runs. So everything is running properly, as far as can be determined on the ground (otherwise send it back and get it fixed). Take a look at the list of functions that have been updated, or are new, since your system was supplied. Are any important to flight safety? If the answer is no, then can the update wait until you have a few hours on the aeroplane? Think of it this way; the system works and is providing all the data required for the first few flights, why change something that you have a reasonable level of confidence in?

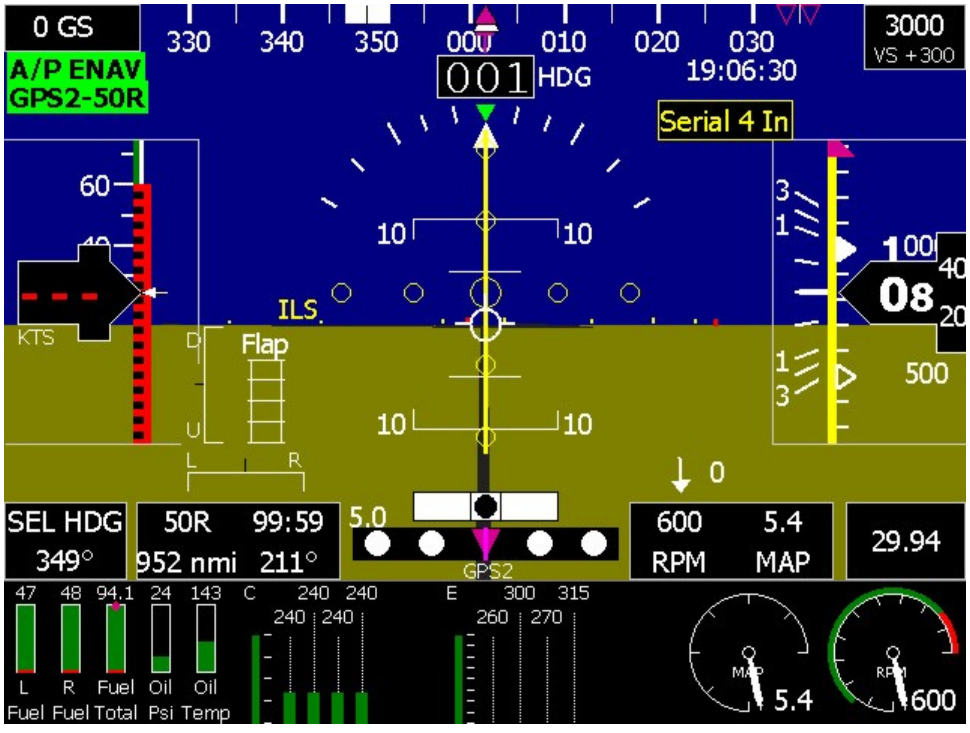
There are at least two parts to the software in your glass panel that might be updated, the navigation database and the software that drives the glass panel (I'll call it the 'firmware' for now, not strictly correct, but it will do). The basic problem is that the software updating process is not 100% reliable (it is often operator finger trouble as much as anything else) but you can never be completely sure that the new software will work completely as advertised. Once you have been through the update process a couple of times and are familiar with the procedure its unlikely to be a problem, but there is a small chance that an update will not work as planned. I would suggest the navigation database is updated as often as new data is made available to get the benefit from the latest airspace information and waypoints. The firmware is a different issue and needs a little more thought. My advice is not to update any time when you can't fly for a couple of hours when failure of the glass panel will be no more than annoying. It is a very good idea to operate your newly updated system in all of its modes just to make sure nothing has 'broken' before setting off on a long trip.

After an update is posted by the manufacturer if you can live without the new features for a few weeks then let a few other customers make the update first and make use of their experiences. Certainly don't update just before first flight – even if the system has been sitting in a box for a year or more. Few builders have the equipment to properly check out all of the functions in the glass panel on the ground – (I hope) the manufacturer checked it out before shipping, so use it as shipped for a few flights, and then make the updates. One of the best resources is the manufacturers' newsgroups, forums or bulletin boards. Fellow owners are often very willing to share their experiences.

To give you some idea of the data that can be displayed in an average glass panel the picture below is from the Advanced Flight Systems website and points out 15 different parameters that are displayed, and that doesn't include the time, OAT and all of the engine data, flap, trim positions or AoA display (not shown in this picture)! When radio navigation needles or a split screen moving map are added it all gets a

whole lot more busy. The subsequent pictures show how the other manufacturers that we heard from in the last article display the same kind of data.

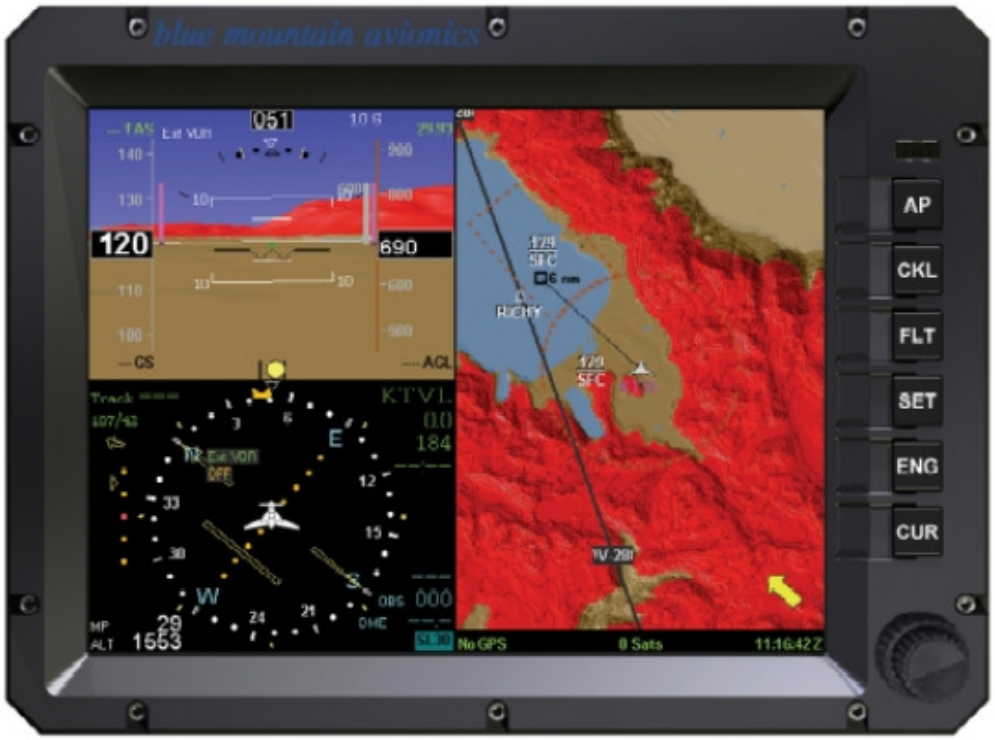
Advanced Flight Systems



Grand Rapids Avionics (without instrument bezel)

Dynon Avionics

MGL Avionics Voyager



Blue Mountain Avionics EFIS One

As the test flying progresses, and you become more familiar with the information that your panel is giving you, gradually increase the amount of data in your instrument scan, either by “un-blanking” some of the data or by using the de-clutter function. Once you can rapidly extract the data that you need then start adding in more, until everything you need for any particular phase of flight is available on the display. Don’t be surprised if this takes several flights.

So in summary learning to fly with a glass panel is as much of a learning experience as anything else to do with aeroplane building and ownership. A huge amount of data is presented at the same time, figure out how to extract the information you need quickly. Avoid becoming fixated on the pretty pictures and keep looking outside. As with anything complex practice is worth while - to get the most benefit from your panel requires a good understanding of its capabilities.

Side bars

De-clutter Many glass panels can limit the amount of data displayed with a function usually known as “De-clutter”. When you start off it is probably worth using the de-clutter function to only display the basic flight data, attitude, airspeed, altitude, heading and perhaps rate of climb. Later add more and more data items until the display is fully populated. If your glass panel offers “levels” of de-clutter then think carefully about what you need for various phases of flight and set the levels appropriately. Some glass panels can display a huge amount of data with the full display very crowded. Some data is only required occasionally, such as flap or trim position, don’t be tempted to keep all the information on the display just because you can. Use all the functions your glass panel offers, including de-clutter.

Potential Gotchas

Do you want to start the engine with the glass panel on? If you do, will the voltage dip during engine cranking (often down to 8v) cause the system to trip out and then re-boot once the engine starts, depriving you of oil pressure and rpm indications until it has re-booted (however long that takes)? [By the way, all glass panels worth spending money on will be able to tolerate being on while the engine is started, they will all withstand the infamous (and almost certainly non-existent) electrical ‘spikes’ supposedly generated on engine start.] Some makers recommend powering the glass panel from the avionics bus (if you have one). Most pilots don’t start the engine with the avionics on, if your glass panel includes an engine monitor that is out of the question. But if your system cannot work on 8v (many require at least 10v) it will be no good anyway as most take a few seconds to re-boot, and that is when you need oil pressure and rpm information. There are a couple of solutions, specify your system with a back-up battery that will tide you over while cranking the engine or fit a standalone oil pressure gauge. Keeping the panel off until after start will mean a second oil pressure gauge and tacho.

Back-up Engine Instruments If you follow the recommendations of many glass panel pundits you will not have installed any back-up engine gauges. They are often awkward to plumb in and can be expensive, but against that they do allow the aircraft to be operated should the glass panel fail for any reason. A separate tacho, oil pressure/temperature gauge and perhaps fuel gauge is perhaps all that is needed, plus manifold pressure for aeroplanes with constant speed propellers. My personal preference is to keep the fuel gauges separate from the glass panel. I think the jury is out on whether back-up engine instruments is a good idea or not.