Is my avionics approach over the top?

Peter Armstrong text and photographs
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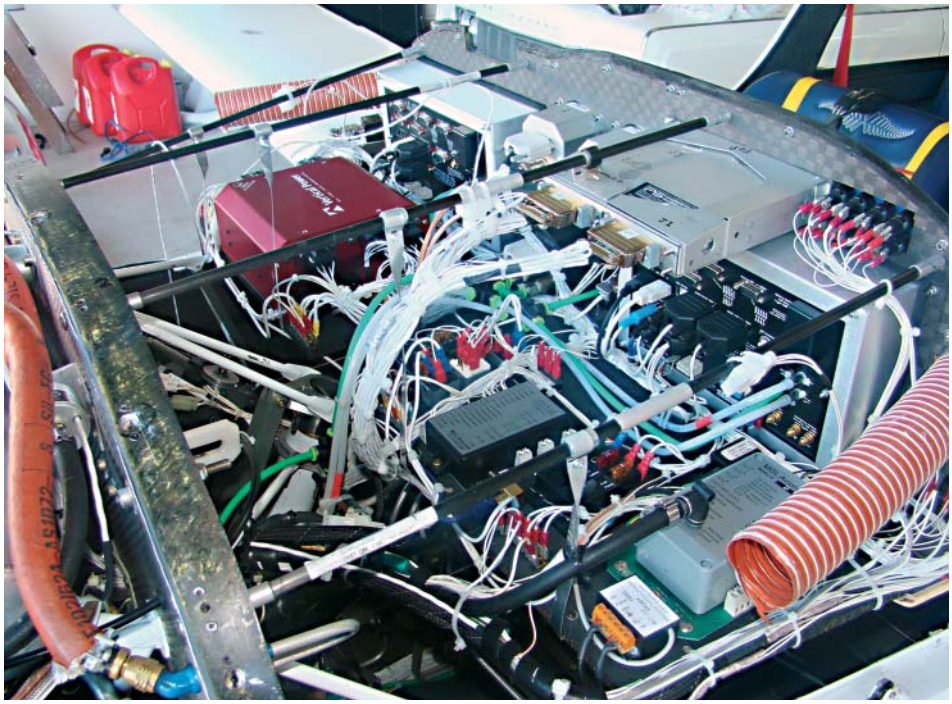

Between the firewall (left) and the instrument panel of ZK-PSA is a mass of wiring and equipment that is easier to interpret if the builder has designed it in the first place — and fills 32 pages of schematics.. The Vertical Power unit is the metallic maroon box at top, and the entire panel is rubber mounted.

In the Spring 2011 issue of *Sport Flying* I mentioned I would touch upon the avionics in my DynAero MCR-4S ZK-PSA in a following issue.

As mentioned at the time, I am now the proud possessor of 32 pages of electrical schematics for the plane. How did this all come about, and why?

A little background. I started working life as telegraph technician with the New Zealand Post Office in the 1960s — all those clunking teleprinters and telex machines were an excellent background for training in data and computers. I subsequently joined Digital Equipment Corporation in the mid-1970s as a computer engineer.

From this point I have remained in computers and data communications and now have used this interest in electronics into how I wanted to wire my aeroplane.

As I mentioned, my involvement with DynAero came about largely due to Gilles Thesee from Grenoble in France whom I met during my search for my ideal aircraft. As he is physics tutor at Grenoble University he had already planned his schematics for his MCR-4S and drew heavily on "Electric Bob" — Bob Nuckells of the AeroElectric website http://www.aeroelectric.com who is the recognised OBAM (owner built and maintained aircraft) guru when it comes to resilience and redundancy in aircraft electrics.

I have followed this practice, along with my own requirements which were — no round instruments and as current a panel I could get with resilience and redundancy. Given that the Rotax 914 has no mechanical fuel pumps, just two electric ones, I decided that my plane would be all-electric, based around Bob's architecture using Gilles's approach.

I also learned from Gilles that the Rotax stated 18A alternator output might be a little romantic so certainly had to keep my electrical budget requirements in check.

So where does one go from here? Same way as I selected my plane — you read a lot via the web, then you pick the phone up and then you visit Oshkosh, which I did in 2007 and 2008. I stayed a full week each time and had my requirements as to who I wanted to visit well set out prior to my visit.

As I had planned pilot/copilot EFISs, with a miniature version for back-up, I wanted to visit all the current crop, being MGL Avionics, Dynon, GRT and AFS, and in 2007 Blue Mountain still existed albeit with the guillotine already dropping.

What I found was that American manufacturers are very wary of their liability laws and do not want the user playing around too much with configurations. At that time Dynon and AFS

The electronic circuit breakers can be displayed on the panel (left) and individually set by means of the keypad on a further display (right). Should a breaker pop, or whatever the virtual digital equivalent is, this display will automatically come up with the relevant breaker highlighted for immediate action. The TCU switch at extreme right is an example of the switching in ZK-PSA. Because the owner/builder/pilot has had a lifetime of switches down for on, unlike the American system commonly used in aviation, switching down for on will lead to reduced confustion — and each rocker switch has a red upper surface to highlight that fact. The emphasis here is automation and lack of confusion.

Every self-respecting aircraft must have a moving map GPS these days, and ZK-PSA is no exception. The red lines through the map tell the pilot that his aeroplane is sitting in the hangar and therefore not receiving and satellite signals.

were behind MGL, GRT (expensive compared to MGL but good). Americans also like buying American made.

They are in reality are a pretty introspective lot and it takes a lot of push for them to purchase non-USA made.

I chose MGL as my base. I liked their upgrade capability which I have already done, making my MGL G1 Voyagers now the G2 version. They had a simulator and screen designer which I have used extensively and designed my own screens, enabling me to play around on my PC using New Zealand maps and database terrain. Lastly they have a very keen local New Zealand distributor, Stuart Parker of SparxFly.

No, I am not connected in any way to MGL and if I was decision making today my choice would be between AFS and MGL.

Based on my comments earlier I designed my system to include:

Auxiliary bus

Secondary battery just powering the second fuel pump and cigarette lighter socket, designed as a last-resort, get-me-home option.

Endurance bus — secondary battery powered

MGL Xtreme EFIS/EMS (electronic flight instrument/engine management system)
1 x AHRS (three-axis)
1 x compass system

Infinity sticks with their myriad functions allow HOTAS operation, and on top of the coaming to the left of the spidertracks unit are three EFIS GPS aerials. The author calculates the number of GPS units on board, including the ELT and his watch, to be eight to cater for redundancies.

(both provide data to the Xtreme EFIS and copilot Voyager EFIS)
TCU (turbo control unit of the Rotax 914)
spidertracks tracking system (well worth it; use the Alaskan package)
Secondary VHF radio
RDAC engine data acquisition unit — provides data separately to each of the three EFIS
Power to the over-voltage protection circuit

The endurance bus (protected by standard automobile fuses) and its battery are protected by a low-voltage system that isolates by automatically disconnecting itself from the primary bus, protecting the battery if the voltage drops below 13.1v. This is done to ensure the integrity of the voltage on the endurance bus is preserved should the alternator not provide enough capacity (stop working, in other words).

Primary Bus — primary battery powered

Charges both the primary battery and secondary battery and is cross-coupled to the endurance bus. Powers the:

Aerials: mounted vertically inside each fibreglass winglet is this VHF aerial. Aluminium foil connects it to the carbon fibre wing structure which serves as a massive ground plane.

Vertical Power VPX ECB unit (electronic circuit breakers) with data being displayed on the pilot EFIS, which supports the following:
LED strobes
LED landing lights
LED navigation lights
Primary radio
Autopilot (two-axis)
Dual MGL Voyager EFIS (pilot, copilot)
Zaon XRX TCAS
PS Engineering intercom
MGL input/output data extender
Trig TT21 Mode S transponder
CO Guardian carbon monoxide monitor with data output to the EFIS
1 x AHRS (three-axis) and
1 x compass system (both provide data to the pilot Voyager EFIS).

So a lot is going on, which means that monitoring of the electrical budget is important, hence the choice

With the transponder aerial in the aft keel, the only external antenna is the ELT, just aft of the ballistic recovery chute.

LED landing lights and strobes use less current, always a consideration with this all-electric aeroplane.

of LED-based navigation lighting. However, current draw and voltage output data are depicted on my EFIS, so at all times I know my loadings.

I chose the Vertical Power unit as it also provides my trim and flap controls with protection of deployment of flaps if my IAS is greater than 86 knots. It also controls my landing lights which are set to wig-wag (alternate) automatically above the speed of 65 knots. I have my strobes and landing lights on in flight.

This unit is initially set up from my laptop where I am able to configure all electronic circuit breaker values individually — breaker current, time without power, for example. In flight I am able to switch ECBs on/off with automatic failure annunciation on the pilot EFIS.

Other tricks in use

I simulate the squat switch of a retractable undercarriage (mine is fixed) by use of MGL scripts in the input/output data extender. This drives my Mode S transponder from Ground Mode to Altitude Mode, so my transponder is always left in Altitude Mode and the squat switch simulation does the rest. I also take an NMEA GPS output from pilot EFIS and feed this input into the Mode S transponder, so I squawk not only my unique Hex identity but also my real GPS position.

Some might say this is letting the authorities know too much about you. When New Zealand adopts ADSB, the MGL EFIS and the Trig transponder, supplemented by a NAVWORX ADSB ADS600-B UAT (universal access transceiver) system is able to fully implement ADSB including WX (weather) via the up datalink capability of ADSB. Pity Airways NZ cannot display Mode S at most manned ATC locations.

The four headsets are panel powered using LEMO connectors and connect to a PS Engineering PMA9000EX intercom. This contains a MP3 player and has Bluetooth capability with the rear seat passengers able to individually connect their music devices and listen to the music of their choice.

The headsets, like most these days, also have Bluetooth capability. This unit matched to the MGL radios allows me to dual watch on both radios (if you ever wanted to — my wife says I have difficulty in listening to one conversation without concentrating on four).

My ELT model is a Emerging Lifesaving Technologies' # ELT406, chosen because it has an internal GPS with a dual polarised antenna providing both vertical and horizontal transmission field.

What does this all mean? Quicker location response with GPS position being transmitted in the first six seconds, rather than waiting for the satellites to sweep over to triangulate the fix. The diversity of the antenna means that in a crash if the aircraft is on its side its ELT signal has a lot better chance of being picked up by the 406 satellites, unlike most current ELT whip antennae. Its low profile also provides better protection from damage.

For VHF antennae I use Archer Sport Aircraft Antennas Model 1A hidden in each of the composite curved wingtips with my transponder antenna being located inside the rear keel, so apart from the ELT I have no protruding antennae.

Both pilot and copilot EFIS have all current VNCs on board and all Vol 4 plates, plus others I have added. In addition, as I subscribe to PocketFMS out of The Netherlands I get a two-weekly update cycle, at reasonable rates, of my navdata information. This means that my EFIS VNC's waypoints, as per the most recent AIP release, are current. I just export the information onto my SD card from PocketFMS via the Internet.

I use the same package for route planning (vertical and horizontal) and am able to drive my autopilot to any runway destination with the choice of intersects depending on wind characteristics. Each three EFIS units (each with its own GPS) has a complete navdata file of all New Zealand airports.

The pilot and copilot have moving maps, the Xtreme CDI in a simpler format but good enough to get you home. I use the flight director capability of the EFIS for route setting and monitoring.

John King

Weight and balance calculations are automatically tied to the weight of fuel in the tanks and require only passenger and baggage weight inputs for calculation of the w&b envelope.

Radio frequencies are all set by the database within the EFISs, so nearly every time no look-up of frequencies is required.

I also use Infinity joysticks for HOTAS (hands on throttle and stick). These units control my trim, flaps, PTT (push to talk), flaps up/down, autopilot connect/disconnect and lastly, via MGL scripts, the ability to bring up menus on each of pilot and copilot EFIS and drive the cursor up/down and select an item on the menu.

Now, before anyone says it, I fully recognise that you fly an aircraft by looking out the window, not at the panel. What I have attempted to do is to make life easier by taking technology and using to simplify the pilot load where I can. I like technology, am comfortable with it and find it easy to use. However, I have also tried to keep a backdoor at all times within my designs.

What else have I learned? What I decided on in the beginning was superseded during my build process. As this process always takes longer than you think, I unfortunately had already purchased some kit.

I now have a little box of superseded parts not used, which I dare not tell my wife the value of. If anyone wants some cheaper bits let me know. I have a bookmark list of web addresses that goes to several pages, but that is the value of the web and why I have the technology within my plane that I want.

Am I going to repeat the exercise with another build? Not sure. However, I am already planning for the next upgrades, given the new products always around the corner.