Light Aircraft Association

www.bristolwing.flyer.co.uk

Bristol Wings

Newsletter of the LAA Bristol Wing

February 2010

NEXT MEETING - Air Southwest Presentation

Air Southwest, Britain's Local Airline, is based primarily at Plymouth City Airport, and is one of the few UK operators to operate regularly outside of controlled airspace around the South West of England, particularly in Devon and Cornwall. As a result of such an operation, Air Southwest aircraft share the open FIR (Flight Information Region) with light General Aviation aircraft on a regular basis, which puts them at a higher risk of an AIRPROX or TCAS event involving light aircraft.

Our next meeting will take the form of an informal 35 minute presentation by Captain John Pearce, Air Southwest's General Aviation Liaison, to increase awareness of their operation and the presence of their De Havilland Dash 8-300 aircraft in the FIR around the area of Plymouth City and Newquay Cornwall Airport. The presentation will also explain how they have adapted their operating procedures to increase safety in this area, and how they are working with local Air Traffic Control Facilities to create an operating environment in the FIR which does not have a detrimental effect on the enjoyment of flying for General Aviation pilots, but at the same time enhances safety for all aircraft operating in this airspace.

Prior to airline flying, John spent several years in General Aviation, flying a variety of light aircraft including 4 years as a flight instructor in the South West of England and was also one of the pilots in the Strut's early Young Eagles Days.

LAST MEETING - Electric Powered Aircraft

"The technical barriers and potential for electric powered aircraft"

Last month we were mesmerised by Ian Tadd's report of his investigation of the feasibility of Electric powered aircraft. His presentation was comprehensive and an abridged version is this month's main article (See page 5). For members who missed his talk the complete slide show with a lot more detail can be found here:

http://www.soriano.co.uk/ea/eaindex.html

The bottom line is that from each of the options: batteries, fuel cells and super capacitors, there is some way to go before a feasible alternative to internal combustion comes along. At the moment super capacitors look like the front runners with the most potential. An excellent talk by Ian which must rank as one of the best researched we have ever had.

Steve

Inside this issue:

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Where to go....

Free landing vouchers for February in:
Flyer Magazine: Bodmin, Eaglescott, Sturgate, and Sutton Bank,
Pilot Magazine: Andrewsfield, Fife (Glenrothes) , Leicester, Old Sarum, Peterboro Sibson, Sturgate,
Today's Pilot: Cromer, Eaglescott, Longside, Netherthorpe, Panshanger and Sandtoft.
Light Aviation (LAA Mag) Farway Common, Old Buckenham

Sunday 7th Feb. Vintage Fly-in at Old Sarum. Free Landing for pre 1955 aircraft. www.oldsarumairfield.co.uk
Saturday13th Feb. LAA AGM at Turweston 01280 846786
Sunday 14th Feb Vintage Aircraft Club Valentine Rally at Old Sarum www.vintageaircraftclub.org.uk

Forthcoming Wing Meetings:

11th March - *CAA Safety Evening* with David Cockburn in Concorde Room, BAWA 7.30pm. Bring your log book to get it stamped

8th April - David Joyce - 'Travel with my Europa' plus 'Half Million Island Challenge'

13th May - Talk on Gyros and a chance to see one up close.

They shall mount up
with wings as eagles.

– Isaiah 40:31.

MEMBERS' NEWS

Brian Osley has kindly offered 'a pile' of back copies of Pilot Magazine to anyone who wishes to take them off his hands. If you are interested please contact the Editor and I'll pass on your details to Brian.

News from Bristol Areo Club

We've received the following from Phil Green of Bristol Aero Club, with whom we are building a closer relationship (Skittles challenge coming up soon!) :

Bristol Fighter replica

You may have heard that Airbus, RR and others are building a **Bristol Fighter replica** (not flying) for the Bristol celebrations this year. Do you have any contacts in the PFA (LAA) who would be interested in helping (and have the skills: covering and rigging....)? The contact for this is Don Bookman, who is a BAC club member, so if you have the inclination, skills and time then please do contact Don on : Don.Brookman@Airbus.com to help with this project.

Phil also writes:

We are also holding our club dinner at BAWA on **Friday 12th Feb** - any of your members who are interested are welcome to attend - details are available at our club website, http://www.bristolaeroclub.co.uk/pages/Members.htm It is an informal event and our guest is from the Great Western Air Ambulance.

Best Regards, Philip

The Besler Steam Plane

An interesting video is available on You Tube, if you've got internet access click here: The Besler steam plane. There are a few comments on the page below the screen and some other 'local' comments are :

First question – is this genuine? There are a lot of "fake videos" doing the rounds on the net at the moment!

I always thought that steam couldn't give sufficient power to weight ratio for aircraft use. Also, I wouldn't have thought that the power characteristics of a steam engine are particularly useful in an aircraft (e.g. ability to develop high torque at very low revs).

However, it is just possible that this really worked but my guess is that it would literally have "run out of steam" within a few minutes (unless of course it carried a very large and very heavy water feed tank!).

Anyhow, as it was designed by the Great Western Railway, I shall treat it with a great deal of suspicion!

and:

What's the price of coal?

SNIPPETS

AIRSPACE AWARENESS DEVICE

Those of you who were interested in NATS initiative £150 GPS shown by Trevor and Graham at our last meeting can find further details here: http://www.airspaceaware.com/aboutaware

OFCOM CONSTULTATION

Do click on the link : http://www.ofcom.org.uk/consult/condocs/spectrum_pricing/ to get more information and although consultation does not end until 22nd March 2010 it's important to get genned up.
This could really impact the operation of small fields such as Oaksey Park as well as impacting safety. No doubt John Brady will be pulling something together, but we need to be out in force on this one.

THREAT TO THE BBMF

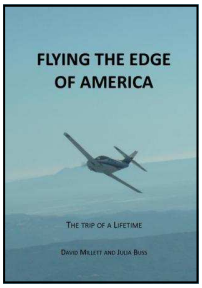
The petition reads:
We the undersigned Petition the Prime Minister to Ensure that the Battle of Britain Memorial Flight is not axed in any defence cuts

It has been suggested that the Battle of Britain Memorial Flight (BBMF) - which celebrates the sacrifice of those who flew during the 2nd World War - will be cut in the next round of defence cuts. This will be a travesty if it was to go ahead. The BBMF is said to cost a mere £3m a year, less than 0.1% of the defence budget. It is a great delight for all who see their displays, and, if closed, the memory of 'The Few' will be lost.
Please vote to ensure that the BBMF is not closed.
Simply click on the link http://petitions.number10.gov.uk/BBMFCuts/, fill in the form and then pass this on.

Looking for something to read?

For those of you who like adventure stories then this may be for you. David Millett and Julia Buss flew a Commander 112A around the USA. They have published a book about their adventures

This link goes directly to the online store where the book is available for purchase on amazon.com and there is lots of other info here: http://www.davidmillett.net/Books/FEOA.html

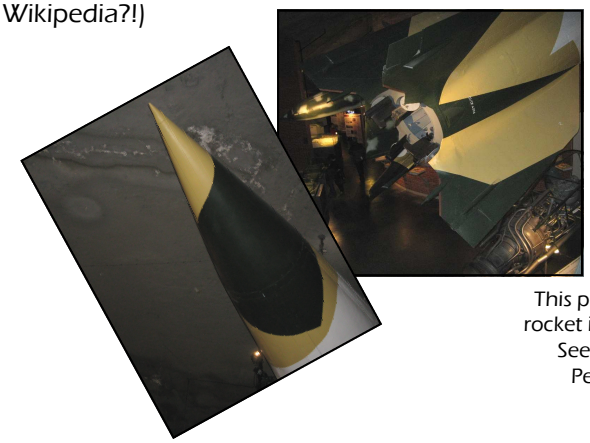


PICTURE QUIZ

There was a limited response to this picture quiz, (which was in fact not submitted by Graham but by the Editor!) Maybe it was a bit too specific but all those who offered suggestions were correct. They are pictures of the V2 at La Coupole, Wizernes, France. In fact we had all visited the museum during the Weekend at St Omer in September last year. Well done to Graham Clark, Nigel Phillips and Trevor Wilcock.

The V-2 rocket (German: Vergeltungswaffe 2, retaliation weapon), technical name A4, was a long range ballistic missile that was developed by the end of the Second World War in Nazi Germany. The rocket was the world's first long-range combat-ballistic missile and first human artefact to achieve sub-orbital spaceflight. It was the progenitor of all modern rockets. More information available from:

http://en.wikipedia.org/wiki/V-2_rocket (Where would we be without Wikipedia?!)



This photo shows the scale of the rocket in the museum at Wizernes. See also Ron and Lyn's flight to Peenemunde in Bristol wing July/August 2009

Following on from the report in August 2009 we have heard again from Edwin Shackleton (Recording-breaking TV Star!) giving us an update on his adventures since then and his total of Transport types in 2009.

Flying and Transport in 2009 by Edwin Shackleton

Adding new aircraft types to my record list in 2009 was, as I had forecast, quite limited. In fact only 3 new ones were achieved making my total 864.

I had booked a Virgin Balloon flight, anticipating that their local very large balloon would be a new one for my aircraft list as well as for the newly planned transport attempt. The Virgin balloon season did not start until April and my first booking was thwarted by poor weather as did numbers 2, 3 and 4 in May, July and early August. Luck came eventually on 18th August from Ashton Park in the huge Cameron A375 with 16 passengers plus pilot. The route took us over Bristol and directly over my home in Filton with a landing just north of Thornbury.

I had been hoping that the balloon flight would be my 100th transport type and in desperation, I rang Clive Bailey of Bailey Balloons to ask if he could fix me a flight for this number and he said it may be possible. Clive rang back and invited me to fly with Wallace and Gromit from Ashton park. So, with media coverage, I was able to make my 100th transport type on a short trip to Bedminster Down. I had flown in this Cameron Z140 with Clive on a previous occasion. It was not until late September that I added another aircraft type. On a pre-arranged trip to North Yorkshire, I had contacted Ivan Shaw in the hope of a flight in his Liberty XL-2 which is a US development of Ivan's Europa homebuilt. We flew from Wombleton which was the venue for a flight in the prototype Europa way back in 1995. My third new aircraft type was the Elmwood Christavia, a Canadian designed high wing homebuilt (the only one in Europe) - Rotax 912 powered. We flew from its home base at Barton Ashes to nearby Popham and after some lunch and a local sightseeing sortie, we flew back to base.

I reached my transport target of 100 on 10th July and the aircraft part included Light aircraft (Cessna 172) from Filton, Glider (ZS Jesow) at Aston Down, Helicopter (Jetranger) at Weston super Mare, Homebuilt (Kitfox) from Weston Zoyland, Executive Jet (Citation) from Gloucestershire, Gyro (Rotorsport MT03) from Popham, Jet airliner (Boeing 737) to Glasgow, Motor glider (Falke) Mendip Gliding Club, Flexwing microlight from Clench Common and Hot Air Balloon (Cameron Z140) from Bristol.

I missed out on a seaplane trip due to gales in Glasgow but the ticket is valid for a replay! For the future in 2010, maybe I will do a trip to the Isle of Man from Blackpool for a turboprop flight and I have a promise of a paraplane trip (powered parachute) from Melton Mowbray. I tried to get a Hercules flight (Military transport) but this was rapidly negated! Maybe someone has an idea of another flying type for me, please.

By the end of 2009, my transport total had reached 136 and I plan to continue. My son and daughter have been brilliant helpers and I have wonderful support from all quarters, so thanks to everybody.

PS: Adding the aircraft total and the transport number makes exactly 1000 which was certainly not planned or foreseen!

Elmwood Christavia No 864 (in aircraft record)

Libery XL–2 No 863 (in aircraft record)

Cameron A375 with 16 passengers and pilot who took the photo with camera fixed on an outrigger frame.

No 862 (in aircraft record)

Electric Aircraft

I shall be looking at what is required in terms of existing and further development, to enable a practical 2 seat Permit aircraft to fly using an electric motor in a standard permit airframe, usually powered by a Rotax 912.

While I will consider potential efficiency benefits, I will not be cheating by assuming costly high lift wings or costly construction methods to reduce the weight of the airframe and hence allow more weight for batteries or fuel cell.

I will however take into account the weight gained from no longer having to have a fuel tank, fuel system and the weight of the fuel itself.

Electric Aircraft Corporation

With existing battery technology and simple controller/motor combinations it is possible for a single seat ultra light to fly for in excess of an hour.

This particular manufacture claims up to 2.5 hours duration . A complete conversion kit costs between $9,000 and $14,000 depending on battery capacity and choice of reduction, unit propeller etc.

Alternatively, in a very light and costly airframe: The Fuel Cell Demonstrator. A project lead by Boeing that uses a Diamond Super Dimona HK-36 motor glider as a test bed for a fuel cell 2 seater.

E430 specification

Or again in a very light and costly airframe that should be described as a motor glider:

With a glide ratio of 25:1 this is a motor glider requiring relatively little power to take off and very low power to maintain level cruise. Rumours have it that a quick kit will cost $100,000, however the company is reported to have made a statement that is very telling on the current state and cost of available battery technology. *"It is hoped that by the time the batteries have to be changed, far cheaper and lighter batteries will be available".*

Power specification for our hypothetical Electric system

Firstly I looked at a typical flight envelope for a 912 in a typical permit aircraft. The 912 produces a max of 80HP which is 60 Kilowatts (1HP = 746 watts) (It's worth reminding ourselves that Horsepower and watts measure the same thing).

Maximum power is only required for 10 mins (take off and climb), with a further 10 mins of maximum power every hour for manoeuvring/climbing, while cruise typically requires 40Kw (53Hp). It is important to remember that the engine supplies all the power for parasitic requirements, alternator, cooling system, oil, fuel pumps etc. The alternator of course supplies power to the electrical system, radio nav aids, lights etc, so we don't have to add an allowance for radio etc as it is already accounted for in the total.

Advantages of the electric motor over the petrol engine.

Aside from the oil running out and environmental issues electric motors have a number of advantages.

- Reliability: compared to a petrol engine the number of moving parts is very low, operating temperatures are very low, this combines to give a reliability far in excess of the petrol engine.
- No complex cooling issues.
- No carb heat problem
- No altitude effect on power, a non-turbo combustion engine will lose 30% of its power by 8000ft.
- Depending on the design max torque can be available down to zero rpm. Petrol engines produce their maximum torque usually in the range 4000-7000 rpm, well above the ideal for the propeller. Hence the requirement for complex reduction units.
- Weight: the hi-pa drive (a wheel hub motor designed and built in the UK for cars) produces 160HP for a weight of 25Kg . This weight includes all the control electronics, DC to AC conversion, regeneration and braking.
- Price: producing a comparable power electric motor is a fraction of the cost of a combustion engine, 50Kw multiphase motors are available for under $2000 including the DC-AC and control electronics.
- With the right design close to zero power-pulse.

Weight specification for our hypothetical Electric system

Breaking down the various components that make up a UK 450Kg permit aircraft.

Passengers	170Kg
Airframe	30Kg
Engine, prop, fuel tank-system, fuel etc	150Kg

It is this 150Kg that we have to get a viable 4 hour capacity propulsion system into, this includes the prop spinner, motor, power source etc.

Motor choice - AC or DC, as usual weight is the important factor.

A typical DC motor will produce at best around 2HP per Kilo, but iron-less DC motors have been demonstrated that produce 7-10Hp per kilo. Certain types of AC motors can produce as much as 10Hp per kilo.

Batteries, capacitors, fuel cells and solar panels produce direct current (DC), at first glance it seems the DC motor is the simpler and obvious choice. However not only are these available DC motors heavier than AC they are far more costly and it's more inefficient to control high current DC than controlling the same AC current.

Available motors

Leaving aside the more conventional shaft motors, such as the ones used in the Boeing Fuel Cell Demonstrator, good examples of development are the hub motors such as the Hi-Pa. Designed to fit in the hub of even the smallest car wheel (they have been fitted to a mini, achieving 0-60mph in under 4 seconds) this may lend them to being fitted into a spinner.

Available in 40,(60HP) 80 (105HP) and 120Kw (160HP) versions giving very high torque at low rpm and weighing 18, 21, 25kg respectively.
The weight includes the control circuits and DC to AC conversion, all that is necessary is to connect the DC direct from the source and a control signal.

However it cannot be assumed a high power version of a washing machine motor can be used. Conventional shaft motors designed for vehicles are in fact very complex multiphase motors designed to achieve high torque from zero to 8000rpm. A typical 50Kw shaft motor will cost anything from £2k upwards in small quantities. Prices will come down significantly as mass production starts for cars, however if significant redesign for aviation use is required prices are not likely to fall much.

In the next section we will look briefly at the current state of available technology.

Batteries Fuel Cells Super Capacitors

However before we move on, at this point its worth looking at the energy density of petrol, the car industry usually quotes the following:

> "In automobile applications gasoline contains around 12Kwh/kg, which operates at 15% tank-to-wheel efficiency giving an effective energy density of 1.8Kwh/kg".

I could not find a figure for aircraft but with lighter engines and without the gearbox drive train etc I would guess a figure of around 20% is probably more realistic, this gives a tank to prop energy density of 2.4Kwh/Kg.

Batteries

Currently available rechargeable batteries can just about achieve 400watt hours per Kg (0.4kwh), a 172Kwh battery pack would weight 860Kg.

In practice even this is not achievable as many other factors affect choice of battery type including efficiency, max number of charging cycles, density of cell packing and not least safety. In practice the best compromise choice is the Lithium ion at 0.3Kwh, as this cell type can be closely mounted in packs without over heating. However Lithium Polymer packs are starting to appear but require forced cooling.

Each pack has its own charger, monitoring and control circuits. At present Li-ion has a life of around 1000 times before capacity degrades by more than 10%, a 172Kw pack would give 3000 hours of flying before needing replacement. Weight however would be over 1000Kg. Cell packs are available to order over the Internet, so leaving the weight issue to one side, is this economic compared to 3000 hours of fuel?

Taking a quote from Elithion Ltd a 172Kwh battery pack is £81,000

3000 hours of fuel (mogas) @ 15litres per hour @ £1`per litre =£45,000

From both the perspective of cost per hour and weight, batteries in their current state of development are no where near practical and worse still current Li-ion batteries have a life of only 2-4 years. So for a Permit aircraft only flying 200 hours a year, the batteries would have to be replaced after only 400-800 hours use, this would represent a cost of around £100 to £200 an hour.

Fuel Cells

At first glance the Boeing demonstrator looks as if the problem has been cracked, a closer look tells a different story.

The fuel cell only provides enough power for level cruise (at 3000ft) for 20mins at 54knots.

The battery provides the take off and climb boost

Even if all the limitations can be sorted out, the hydrogen fuel cell for transport, be it car or aircraft, will always be a fuel cell/ battery hybrid.

It's worth noting that if the fuel cell and associated components were replaced by an equivalent weight of currently available batteries, it would have almost certainly flown higher, longer and faster.

One good thing about this project is that a major part of the design and technology for the fuel cell came from a British company.

Super capacitors

Current commercial super capacitors range from 0.5 to 30 wh/kg

		This is a 21 volt 30 Farad super capacitor and costs around £70, it will store 6615 joules. 1 watt hour is 3600 joules....172Kwh would need 93600 capacitors!!!!!
		Commonly available capacitors from Maxwell technologies are rated at 6Wh/Kg. Ignoring the cost (which are dramatically falling) 172Kwh/Kg would probably weight more than your house. While 30wh/kg are starting to come on the market, at best they will match lead acid batteries.

Batteries in development

The most hopeful line of research and development is nano technology, around 2 years ago both Stanford University and MIT scientists demonstrated Lithium batteries constructed using nano technology. All the big names in battery development (with no notable exceptions) are now in various stages of prototype development. All have reported substantial progress, but as with most commercial development, they are keeping precise progress a secret.

Ignoring some of the more extreme claims, the original researchers and battery manufacturers are broadly claiming the same - that, compared to currant li-ion, there is equivalent efficiency, improved memory issues, better shelf life and lower degradation of capacity during charging. However most importantly capacity is increased by a factor of 10. Charging time improvements seem to be of a similar factor to capacity claims.

It appears some manufacturers are planning to introduce batteries in the near future exploiting some of the benefits, but it will be another 3-4 years before the full range of benefits are incorporated in a commercially available battery. Most are being cautious on price but it appears they are expecting an increase in cell production costs of between 0-50%.

If the promises are realised a 170Kwh pack will weight around 135Kg, be around 2-3 cubic feet in size, and be able to recharge around 1500-2000 times and cost between £15,000 and £25,000 per pack.

Fuel cell development

Compared to the combustion engine, fuels cells are more efficient, able to use 50%-60% of the potential energy in the hydrogen compared to a theoretical best 35% from petrol. However there are two significant issues hydrogen has to face while it has roughly the same energy Kilogram for kilogram as petrol, in its liquid form, it's 5 times less dense. It can be stored as a gas (under pressure) reducing the tank size, but the tank becomes very heavy.

The other approach being looked at is to produce the hydrogen on demand as part of the system.

Nissan produced a demonstrator (car) using sodium borohydride fuel mixed with Borax to produce hydrogen on demand, which was fed to a hydrogen fuel cell-battery hybrid. While it had a range of 300 miles at 60mph, it's over twice the weight of the petrol car, and even used some of the passenger space.

Fuel cells, like batteries, can not be scaled up easily they have to be used in a parallel series stack to get the voltage and power required. Depending on type they only produce around 0.5-0.7 volts, compared to batteries this means 4-6 times as many cells in series, greatly increasing the risk that one cell failure will take out a higher proportion of a stack compared to a battery pack. They also suffer from a loss of efficiency the higher the current demand and they operate best in a steady state. This makes them poor at acceleration and is why they have to be used in a hybrid with a battery.

Super capacitor current research and development.

Current commercial super capacitors range from 0.5 to 30 wh/kg, however capacitors utilising the all-hopeful nano technology has been demonstrated with between 100 and 1000 times the energy density.

If successful this could result even at the lower claim 3Kwh/kg.

Our requirement for 172Kwh would only weight 60Kg

It's worth at this point reminding ourselves that the best power density for petrol is around 2.4Kwh/kg.

We are now potentially at the stage where if this technology can be scaled up and economically produced without dependence on rare and expensive materials the source will weigh the same as the fuel in our existing tanks

Summary

Electric motors are by a substantial factor more reliable, smaller, lighter, simpler, run cooler, cheaper, wider torque range and quieter than comparably rated internal combustion engines.

The currant limitation is the 'fuel tank' the best available option is a factor of 10 away from delivering the same tank to prop power density as petrol.

Of the three options looked at, fuel cells look the most distant solution, and the most complex for the homebuilder to install and maintain. They also suffer from substantially higher reliability and safety issues as well as requiring complex refuelling infrastructure.

To give the energy density required while super capacitors have been demonstrated with higher energy densities than the best battery research, only nano engineered Lithium batteries have been scaled up and at commercial development stage. However at present they only just offer the energy density required.

None of the options looked at can be instantly refuelled and require costly infrastructure compared to petrol.

At best prototype fuel cells are no better than production batteries and it's interesting to note various governments who are providing funding for research don't expect a practical vehicle in less than 15-20 years.

Ian Tadd