RCEA

(SUSSEX)

An Association for Retired Professional Engineers

NEWSLETTER December 2012

PROGRAMME OF EVENTS 2013

Tuesday	**8th January**	**Talk, Field Place, Worthing, "Cecil Pashley - Pioneer aviator and joint founder of Shoreham Airport."**
Thursday	**17th January**	**Coffee - at Spotted Cow, Angmering**
Thursday	**31st January**	**Coffee - with Partners the Swallows Return, Worthing**
Tuesday	**12th February**	**Talk, Field Place, Worthing,"Capturing the sun - the thermal story."**
Thursday	**21st February**	**Coffee - at Spotted Cow, Angmering**
Thursday	**28th February**	**Coffee - with Partners the Swallows Return, Worthing**
Tuesday	**12th March**	**Talk, "Longevity of the Portsmouth - Gosport Ferries built between 1895 and 1960." , Field Place, Worthing,**
Thursday	**14th March**	**Lunch at Northbrook College, 12.00 for 12.30**
Thursday	**21st March**	**Coffee - at Spotted Cow, Angmering**
Thursday	**28th March**	**Coffee - with Partners the Swallows Return, Worthing**

Wednesday	**10th April**	**Visit: Network Rail Electrical Control Centre, Brighton (11.00am)**
Thursday	**18th April**	**Coffee - at Spotted Cow, Angmering**
Thursday	**25th April**	**Coffee - with Partners the Swallows Return, Worthing**
Thursday	**16th May**	**Coffee - at Spotted Cow, Angmering**
Wednesday	**22nd May**	**Outing: 14.00, St Mary's House and Garden, Bramber**
Thursday	**30th May**	**Coffee - with Partners the Swallows Return, Worthing**
Wednesday	**19 June**	**Outing, 12:00 – 15:00, Pub Lunch and Skittles, Henfield**
Thursday	**20th June**	**Coffee - at Spotted Cow, Angmering**
Thursday	**27th June**	**Coffee - with Partners the Swallows Return, Worthing**
Wednesday	**17th July**	**Outing: The Royal Pavilion, Brighton**
Thursday	**18th July**	**Coffee - at Spotted Cow, Angmering**
Thursday	**25th July**	**Coffee - with Partners the Swallows Return, Worthing**
Thursday	**15th August**	**Coffee - at Spotted Cow, Angmering**
Thursday	**29th August**	**Coffee - with Partners the Swallows Return, Worthing**

All Talks and Meetings will commence at 2.30 pm and be held in the Chichester Room, Field Place, Worthing, unless another venue or time is indicated.
Timings for visits and outings will be as printed in the detailed description of the activity.
Coffee mornings commence at 10.30 a.m.

Website for the RCEA

For latest information, log into **www.rceasussex.org.uk**

How many of you actually visit our website and what do you think of it? Does it tell you what you want to know? Did it answer your query? Could we do better and how do we compare with other sites that have similar objective?

The association's website has been essentially the same in both format and content for many years and there is a view that it is time to "modernise" to bring it in to line with others with similar objectives. In this respect our website has two main aims, to keep the membership informed of our activities and to attract new members.

In a renewed bid to make our presence known we are looking to encourage our professional engineering institutions and others where interest is likely to exist to provide links to our site. This will generally be listed under activities for retired members.

It is important that, what is likely to be the first port of call for potential new members, we make an impact that will encourage them to look further. To help us in our quest we would ask any member with experience or knowledge in the production and presentation of websites to provide us with some assistance in this important area.

You could also help by letting us know your views on the present website. Comments on the current contents and facilities as well as suggestions for other desirable attributes would be welcome. You may do this by personally contacting any member of the committee or by email to deltabravothomas@gmail.com

Membership

Subscriptions 2012/2013

These were due on 1st October; if you have not already done so, can you please send your cheque for £12 to the Hon. Treasurer,
Tony Tomkins, 2 Badgers Drive, Haywards Heath, RH16 1EP

New Members

I.J.Wetherell, MICE, I.Eng
27 Westland Avenue, Worthing, West Sussex, BN14 7LB
Ian & Janet 01903525117
Ian.wetherell@ntlworld.com
BR Engineering apprentice, Railway traction & electrification, Electrification system design, Chairman, private consultancy
Interests : Sailing, History

P. J. McHugh, C.Eng, MIMechE
33 Chiswick Staithe, London W4 3TP 02089955333
Patrick
John Thompson Group - graduate apprentice 1957-1960, London office 1960-1962, New York office 1962-1964, Dublin office 1964-1968, Saab Scania 1968-1981, Own company Weir Engineering to 2000.
Interests : Golf, cycling, DIY

NOTE !
Can all members please check your own entry in the new Members Handbook, which you should have received by now, to ensure the entry is correct in every detail i.e. address, telephone number, e-mail address, etc. Any errors or omissions should be communicated to **Malcolm Hind, Membership Secretary** so that the appropriate corrections can be made to the master copy.

RCEA Insurance.

Members need to be aware that the insurance policy that the Association holds is solely for the protection for the assets and liabilities for the Association as an entity. The policy does not provide cover for personal injury or loss to individual members. Members therefore attend any of the Association's events at their own risk; although under some circumstances there may be some cover from the insurance arrangements of the venue owner.

Newsletter Entries

If you would like to provide an article for inclusion in a future newsletter it would be most welcome. We are always looking for new material. As a guide an article should be prepared as a Microsoft Word document, preferably in font size 10 and font style Times New Roman but this is not essential since all text will be 'standardised and formatted' when composing the newsletter. Pictures can be incorporated into the newsletter and are best supplied as JPEG images as separate files and separately from the text. (Word documents incorporating pictures can sometimes be very large files and are often not easy to manipulate into a suitable format for the newsletter.)

Brief Detail – Talks, Outings and other activities January - April

Talk:

Tuesday, 8th January, Field Place, Worthing,
"Cecil Pashley - Pioneer aviator and joint founder of Shoreham Airport." by Mr Alan Readman, WSCC County Archivist and Mr Mike Wooldridge RCEA.

Contacts: Mr Alan Readman – alanreadman@westsussex.gov.uk – 01243 753614
Mr Mike Wooldridge – (mike.wooldridge1@btopenworld.com) –
01273 857322

Talk:
Tuesday 12th February, Field Place, Worthing
"Capturing the sun - the thermal story." by Mr Tony Lord RCEA.
Tony will give an illustrated talk on how he achieved the energy efficient conversion of a 1930s bungalow using insulation, heat recovery, solar thermal panels and heat storage.

Talk:
Tuesday 12th March, Field Place, Worthing
"Longevity of the Portsmouth - Gosport Ferries built between 1895 and 1960." by Mr Philip Simons.

Contacts: Mr Philip Simons – (p.simons102@btinternet.com) - 01273 418474
Mr Mike Wooldridge – (mike.wooldridge1@btopenworld.com) – 01273 857322

Spring Lunch
Thursday 14th March, Lunch at Northbrook College, Worthing, 12.00 for 12.30
There will be a bar for pre-lunch drinks, the cost to be settled individually by Members and guests. The cost is £12.00 per head including a tip, for a three course meal which in the past has proved to be very good value. The occasion is not only an opportunity for new and existing members to meet socially but will also help to give "work experience" to chefs and waiters.

Because of college "lead times" required applications MUST be made by 14th February.

Should the numbers exceed the maximum seating allowed there will be a waiting list made, as in previous years. So please book early to avoid disappointment. The committee look forward to seeing you there.

Booking form at the end of this newsletter.

Contact Ms Brenda Whitmell, 01903 762918, e-mail bcwhitmell@talktalk.net

Visit:
Wednesday 10th April, Network Rail Electrical Control Centre, Brighton (11.00am)
This visit is for RCEA members only and the numbers will be limited so early application is advised. Members who apply will be informed if successful or if they are on the reserve list.

(If demand for places exceeds allowable number a reserve list will be prepared. We are trying to arrange for another visit on the same day but at a slightly different time. If the second visit is approved members who are on the reserve list for the first visit will be offered places first.)

Contact: Derek Webb Tel: 01903 52569 or email derek.webb2@ntlworld.com

REPORTS

Visit:
High Salvington Tuesday 11th September
Visit to High Salvington Windmill
A party of twenty five members and ladies enjoyed an interesting visit to the High Salvington Windmill on a very pleasant afternoon.

The present mill, a Post Mill, was built in1740 but records show that there has been a windmill on the site at least since1615. The mill was in use until 1897. In 1907 a new concrete base was built which was used as a café until the 1950's.

The mill suffered some storm damage and Worthing Council purchased it in1959 and employed a millwright to restore it, but not to working condition. In 1976 the mill was made over to the present

Preservation Trust and as a result of their mainly volunteer effort, milling re-commenced in 1991and has been going on ever since.

Unfortunately, visitors are not allowed in the mill when milling as we had hoped and the promise to us to have the sails turning was not possible on the day because of lack of wind. It was explained that the wind conditions have changed completely because of the houses and trees which now surround the mill.
For the visit we were split into four groups and each guided by one of the Trust members, all of whom were qualified millers. Not only did we see the mill but also the preserved wind pump and granary which have been moved to the site from other locations in Sussex.

At the end of the tour we enjoyed tea and cake in the open outside the new café and those who wished could purchase wholemeal flour from the mill.
R Norton.

AGM followed by Talk.

Worthing Tuesday 18th September

Talk, "Jetliners – Why do they look alike?"

Mr Ken Wheeler RCEA

Do jetliners look alike? At least to me the current crop do and there are good reasons for this. At this time the Boeing 787 Dreamliner is being portrayed as representing the state of the art. Externally it looks conventional except for the raked wingtips but compared to older planes from the same stable it is dramatically different as for one thing it is almost entirely made from plastics in an effort to substantially reduce structural weight with enhanced aerodynamic performance. For this aircraft, 50% is made from load bearing plastic composites. Steel takes 10%, titanium a further 15% and aluminium just 20%. This great act of faith in plastics is closely followed by its marginally larger and possibly superior competitor, the Airbus A350.

There have already been problems with the first in service models of the 787 in that the wing roots have needed to be stiffened by the onsite introduction of tailored titanium plates on both the top and bottom surfaces. The solution of all problems involved with the introduction into service of both these aircraft is of prime concern to the UK as substantial manufacturing outsourcing for both Boeing and Airbus is placed here in the UK sometimes surprisingly with SME's having CadCam facilities making quantities of complicated very expensive components to Boeing or Airbus "drawings". This is additional to major proprietary items such as wings, undercarriage systems, electronics etc.

The prime elements of the jetliner, the wings and the engines, have been driven by history.The hull ,or fuselage as it is properly called is a circular tube which is best suited to cutting holes for windows, doors and hatches for a structure subject to internal pressurisation.

Wing design has been influenced by the utterances of the great George Schairer, Chief Engineer of Boeing in 1964 who said " it is by the wing design you will fail". A modern transonic wing is far removed from what Schairer could have imagined in 1964; he had been influenced by swept wing data captured from Germany at the end of WW2 which has historically proved to be a palliative at best surpassed by what is known as a "supercritical aerofoil section" of which more later.

Sir Frank Whittle in 1947 had already forseen that for his turbojet engine " the addition of a fan section to the front with the main flow bypassing the core engine will considerably improve the fuel economy"

Historically, this has resulted in the High Bypass Engine now common to all jetliners.

The almost universal use of the wing mounted podded engine suspended under and forward of the wing leading edge giving at the time unforeseen benefits for engine interchange ability in spite of horrendous design difficulties resulted from a US Airforce directive cira 1954 that " the Air Force will not accept future bombers having jet engines mounted within or directly on the wings" thereby setting in motion the engine configuration for what was to become the Boeing 707.

The constant driver over the years since around 1970 has been fuel economy with modern engines using 70% less fuel. There are other influences such as pollution and noise which have also been addressed.

In searching for other percentage changes which have a major influence on fuel saving is the reduction in tare weight and the reduction in aerodynamic drag, specifically the wings ,for aircraft which are required to fly much faster.

A jetliner does not operate in isolation but is contained in a series of subsets with three primary constraints . One subset is the atmosphere which means operating at the correct speed and altitude. Another is the aircraft subset which involves its aerodynamics,its structure and its engines. The remaining subset is the business model for the airline.

The aerodynamics of the aircraft subset are controlled by the "Flight Management System" for the structure, the "Flight Envelope Management System" and the engines the "Engine Condition Monitoring System".

You could say by way of example that a motor vehicle is designed by experts to be driven by idiots where the kinetic energy of impact is absorbed by the strain energy of a progressively collapsing structure.

For a jetliner ,these are designed by experts to be driven by experts which these days includes “ expert” electronic systems. Fundamentally, jetliners are designed not to crash because such an incident invariably leads to substantial loss of life. The flight management system is basically programmed prior to a flight to perform all the flight manoeuvres through the autopilot including automatic take off and landing monitored by the pilots.The flight envelope management system ensues that under all conditions of normal operation and emergency the actions of the pilots are over ridden by the system to ensure that the pilot cannot apply a control command which would overstress the structure. Airbus have fully implemented this system whereas Boeing at this time still allow a measure of manual over ride and they have” bent” a few planes in the process which has meant in some cases taking the aircraft out of service.
Engine condition monitoring is typified by all Rolls Royce Trent engines flying are able to transmit 24/7 the condition of the engine determined by transducers to a central analysis Centre at Derby where engineers on duty can discuss with the pilot any apparent concern. The transducers also produce a continuous time log of an individual engine’s parametric data.

Typically, Rolls Royce don’t sell you an engine these days but instead a complete package including monitoring and servicing for the life of the engine. Revenues from service contracts exceed those for basic engines.

Regarding economics, the business model subset, this relates to the airline operating jetliners and involves computer generated algorithms predicting outcomes from normal day to day and forecast activities.(algorithms you will recall are just recipes for solving problems and of particular value for unitised quantities with airlines as you cannot sell half a passenger seat). The business model also includes outsourcing of maintenance and the leasing rather than outright purchase of aircraft, with a list price of some $200 million each beyond the resources of even the biggest airline. The business model is a whole story in itself.

Our initial subset entitled atmosphere I have left until last as it is involved with the aerodynamics of the wings in which crucial conceptual changes have been made. The atmosphere made up of molecules starts to behave in a compressive manner ,rather like a log jam, at velocities near the speed of sound resulting in density compression. As the speed of sound depends solely on the ambient temperature, comparative aircraft speeds are best expressed as a ratio to the speed of sound known as the aircraft’s Mach number and in order that we all sing to the same hymn sheet an International Standard Atmosphere(ISA) has been agreed.

Between 36000 and 65000 feet altitude the temperature remains constant at 214K (-56C) and the speed of sound is 295 m/s (660 mph) which means that aircraft travelling at the same speed within this altitude range have the same Mach number. For example, an aircraft travelling at 574 mph at between 36000 and 65000 ft has a Mach number of 574/660 = 0.87. Although temperature is constant , air density and pressure do change. Therefore, we always talk of speeds in terms of Mach number and the structural integrity of the aircraft is vouched in these terms and a Machmeter forms part of the flight management systems.

You may well ask at this stage where this is leading us .Because aircraft manufacturers in the initial stages offer guaranteed performance and fuel consumption for models frequently tailored to an airline specific requirements on an agreed delivery schedule at a fixed price, prescriptive design is used. This means that improving what you have entails less risk so the aircraft tend to have similar configurations. Circa 1997 defines the jetliner as “ wide bodied aircraft with high aspect ratio super critical wings and winglets powered by two high bypass ratio turbo fan engines mounted in pods under the front of the wing giving exceptional range and economy manned by two crew on the flight deck. Cruising speed Mach 0.86 at 36000feet”. Little has changed since then apart from this love affair with plastics.
The efficacy of the high bypass engine where it is more efficient to pass a large volume of air through an engine at low speed than a much lower volume at high speed emphasises the difference between the older turbojet and the modern high bypass turbo fan is illustrated by the Rolls Royce Avon of the 1950’s and the current Rolls Royce Trent 1000.

The use by Airbus of the supercritical wing on their A320 series aircraft came as a nasty shock to Boeing with their competing 737 which had a conventional sub critical wing section. The word supercritical is unfortunate viewed in a layman’s context but it is a technical expression related to specific values of the negative pressure coefficient on the forward top surface of an aerofoil.(Don’t forget that an aerofoil is a cross section through the wing). It is this negative pressure coefficient that is related to the lift generated by the wing. Broadly speaking, the rate of change of curvature over the top leading edge of an aerofoil produces an increase in local velocity of the air passing over and this produces an increasingly negative value of pressure coefficient such that at the point on the aerofoil section where this local velocity is just sonic the value of pressure coefficient at this point is called " Cp crit". Imagine a Cp crit line running spanwise along the top of the front of the wing where the airflow passing over is just sonic. Thus at high speeds on conventional aerofoils the local airspeed over the wing can be just sonic along a particular span wise line in spite of the fact that the free stream velocity of the air approaching the wing will always be less . For example, a wing having a local airspeed which is just sonic at Mach number of unity could have a free stream Mach number of 0.61.

As you have already surmised, this is where the trouble starts. The wing is a prime energy conversion system in providing lifting forces and in doing so produces consequent drag forces. These drag forces have serious implications for fuel economy It is the aerodynamic equivalent of there being no such thing as a free lunch. Increase in free stream Mach number means density compression of the airflow over the wing and consequent increase in the value of the drag force and the wing's nowhere near flying at Mach 1. At Mach 0.61 the freestream compression is already up by around 18% over the static value.

For example, increasing the free stream Mach number with a conventional sub critical wing can mean that at values less than M 0.61 there is no sonic flow present over the wing .Increasing it to M0.61 produces the Cp crit situation a small supersonic bubble starting to appear behind the Cp crit line until say M 0.74 is reached when a strong shock wave occurs known as M div (drag divergence) on the surface of the aerofoil just aft of the Cp crit point resulting in substantial increase in drag due to separated flow.

So it looks as though a Mach number of 0.74 could be a limit but as the Germans did, you can cheat by sweeping back the wing such that aerofoil section sees only the resolved angle of the flow normal to the wing's leading edge ,the other component sliding spanwise down to the wing tip. In this way the Boeing 707 managed M 0.84 but not very economically. The Comet managed a thirsty M 0.74 with little effective sweepback.

I expect you are wondering about what happened to the supercritical wing and now the moment has arrived. The objective is to reduce the magnitude of the shockwave and to delay the onset of drag divergence to a more acceptable free stream value of around M 0.86 with the substantial benefits of reduced fuel consumption this gives and at an enhanced speed.

You will recall from before that an aerofoil is a cross section through a wing where due to the curvature of the top area just aft of the leading edge the local velocity of the airstream always exceeds the forward speed of the wing (the wing's freestream Mach number) and where in this area there is a point of maximum negative pressure where the local velocity is at its greatest ,this point being denoted as Cp and if the local air velocity is just sonic the point is called Cp crit. Further modest increases in the freestream Mach number results in a severe shockwave just aft of the Cp crit point ,known as the point of drag divergence (Mdiv). The flow is supersonic in front of the shockwave and always subsonic behind accompanied by severe air turbulence causing a rapid increase in drag.

A distinctive feature of a super critical wing is a more bulbous leading edge followed by a flattening of the top such that as little change in curvature exists, the local air flow velocity remains constant resulting in a much reduced shockwave with the Mdiv point much further aft and occurring at a higher local air velocity and a reduced level of turbulence. In essence you can fly the super critical wing up to M 0.86 before the Mdiv value occurs compared to M0.68 for the conventional sub critical aerofoil. The super critical wing also has higher lifting capability which leads to fuel savings of around 15%. The profiles of the new supercritical wings are surrounded by commercial secrecy as they represent a proprietary advantage to the manufacturer but in general maintain the above concept. The modern super critical wing also incorporates extensions called winglets or raked tips which reduce induced drag (discussed later) with consequent further fuel savings of up to 6%. Winglets are beyond the scope of this presentation.

Finally, we need to consider the major influence of the high aspect ratio wing. Aspect ratio which is the slenderness of the wing is expressed as the span squared divided by the wing area. This is the same as saying the aspect ratio is the span divided by the average chord (width). The wing has higher pressure on the lower surface and lower pressure on the top surface with an airflow trying to equalise this leading to trailing edge vortices particularly from the wing tips. This gives rise to another coefficient, that for induced drag (Cdi) which is a function of the aircraft's weight divided by the aspect ratio ,all squared so that increasing the aspect ratio has a considerable influence on Cdi.

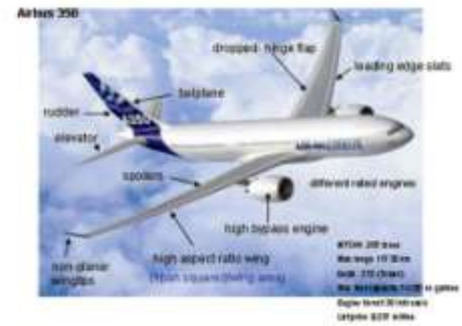
Summarising, we see that the jetliner has three prime elements which effect its efficacy and these are the wings ,the engines and the need to save weight to match the principal driver which is fuel economy and as a result of prescriptive design has produced similar configurations.
The historical technological progress to the super critical wing, the high bypass turbo fan engine and the massive use of plastic composites is typified by two current new builds, the Boeing 787 and the Airbus 350. When you consider that around 40% of your airline ticket is to pay for the fuel this gives an element of perspective to this presentation.

Ken Wheeler CEng

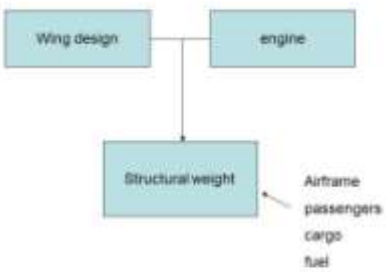
Footnote : Much aerodynamic theory and attendant mathematics has been bypassed with a slight massaging of the facts in order to produce hopefully a tractable text. Any member is free to correspond with me by e-mail should they wish to discuss this topic at -k.wheeler865@btinternet.com

Disclaimer: this text and graphics constitute the report of the talk given to the Association on the 18th September 2012 and is the intellectual property of the author. It contains modified images of the Boeing and Airbus aircraft extracted from the internet from a public domain. This text and graphics is solely for distribution to members of the Association for their personal study and not for communication to any outside agency or person.

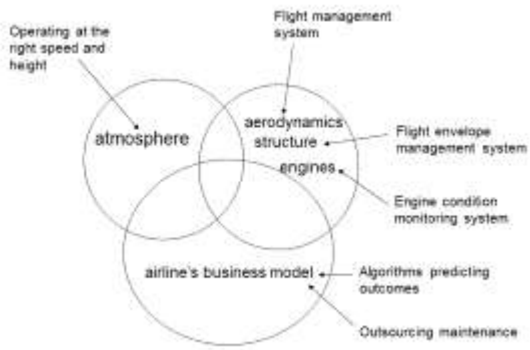
Boeing 787 an example of prescriptive design



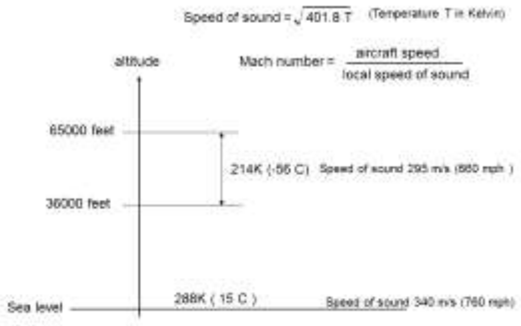
3 variants 270-314-350 passengers (different length fuselages)



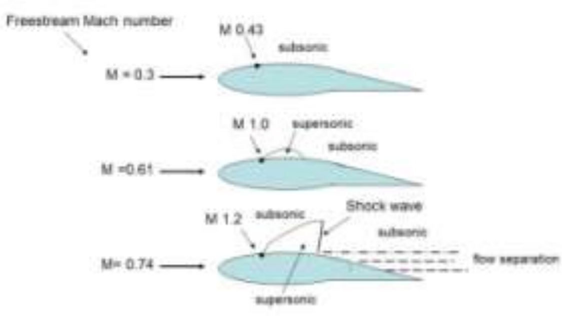
PRIME ELEMENTS driven by history



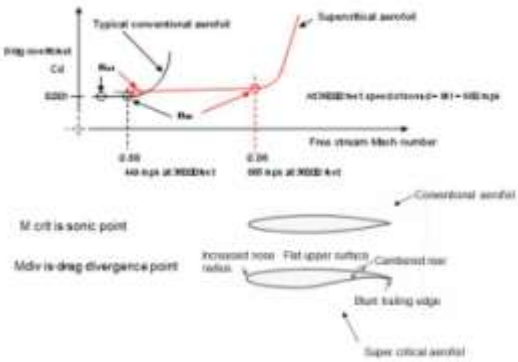
VENN DIAGRAM primary constraints & operating controls



INTERNATIONAL STANDARD ATMOSPHERE (round figures)



CONVENTIONAL SUB CRITICAL AEROFOIL



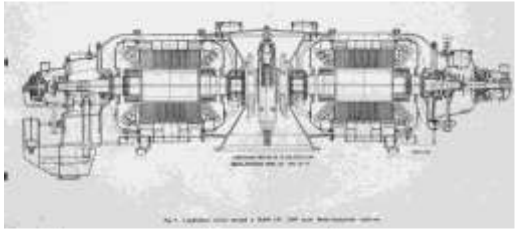
Talk.
Worthing Tuesday 9th October
"Brighton Power Station Installed Plant 1954 - 1978." ,
Ray Parsons RCEA
The talk covered Brighton 'B' Power Station construction; harbour modifications to take 3,500 ton colliers in place of 1,500 ton ships; 'B' Station eleven 320 Klb/hr pulverized fuel boilers; type of flame; milling and dust collection plants, including the 50kV mechanical rectifiers for precipitators. The talk also covered the arrangement of the Richardson Westgarth axial flow turbines with four 55.5 MW sets having air cooled alternators plus two 60MW sets having hydrogen cooled alternators.

Ray then continued by covering 'A' Station. The boilers comprised two 350 Klb/hr boilers, four 210 Klb/hr PF boilers, two 180 Klb/hr chain grate boilers and two 180 Klb/hr retort stoker boilers. The Turbine House comprised four axial flow turbines. One Parsons 30MW with 6MW overload features; and two low pressure RW axial flow 14 MW turbines supplied through a 4 MW passout set. It also housed three Brush Ljungstrom radial flow turbines - two 37.5 MW and one 50 MW. The 50MW being the largest turbine of this type installed in the UK at the time.

Mention was made of means of 'black start' systems for both stations and how a mechanism failure on the 33 KV switchgear caused a serious earth fault. This resulted in the loss of generation from both stations and caused a blackout of an area from Lancing to East Brighton and for about 15 miles inland.

The talk concluded with shots of the demolition of the brick and concrete chimneys.

R Parsons



Talk.

Worthing Tuesday 27th November

Cooch Memorial Lecture: "The Mary Rose"

Mr Trevor Sapey and Mrs Cheryl Price, Mary Rose Trust

Trevor and Cheryl conducted the talk dressed in reproduction Tudor working class clothing of the period – more on which will follow. TS started by looking back at the events leading up to the stand-off between the French Fleet off the Isle of Wight and the English Fleet positioned off Portsmouth.

Background events: In 1544 Henry V111 undertook a campaign in France which culminated in the capture of Boulogne. In the spring of 1545 the French King Francis 1 began to assemble a Fleet for the invasion of England (along with a land army campaign to simultaneously retake Boulogne). The plan was to attack Portsmouth, the premier Naval Base on the south coast, and cut off essential supply lines to Boulogne. The French Fleet, 225 ships, fully equipped and loaded with 30,000 men, dropped anchor in St Helens Roads in the north east corner of the Isle of Wight on Saturday 18th July. Henry had good intelligence reports of the planned invasion and by 15th July he was in Portsmouth as Commander-in-Chief of his defending army and navy.

The Mary Rose: TS then looked at the history of the *Mary Rose* - a firm favourite of King Henry VIII who prior to her sinking had a long and successful career, serving for 33 years in several wars against France, Scotland, and Brittany.

The *Mary Rose* was a carrack-type warship with high "castles" in the bow and stern with a low waist of open decking in the middle. She was built between 1509 and 1511 in Portsmouth and was then towed to London where she was fitted with rigging and decking, and supplied with armaments. She was substantially rebuilt in 1536, turning a ship of 500 tons into one of 700 tons including adding an entire extra tier of broadside guns to the old carrack-style structure.

She was one of the largest ships in the English navy and was one of the earliest examples of a purpose-built sailing warship. She was armed with new types of heavy guns that could fire through the recently invented gun-ports. She was also one of the earliest ships that could fire a broadside, although the line of battle tactics that employed it had not yet been developed.

Constructing a warship of the size of the *Mary Rose* required large quantities of high quality material. In the case of building a state-of-the-art warship, these materials were primarily oak. An estimate for the number of trees needed is around 600 mostly large oaks, representing about 16 hectares (40 acres) of woodland. These timbers were brought in from all over southern England.

The sinking: After a few skirmishes, on the 19th July 1545, on a calm and still day, the *Mary Rose* whilst getting underway to lead the attack on the French galleys suddenly heeled (leaned) while going about. Her gunports were open and her guns run forward ready for action. As soon as this happened water began to pour through the gunports and the loss of stability with the additional weight of the insurging water causing her to capsize. The *Mary Rose* sank rapidly and embedded herself deeply into the soft upper sediments of the seabed until her keel rested on intractable geological clay 2 to 4 metres below. Of the 700 souls on-board only around 40 were saved.

What turned the sinking into a major tragedy in terms of lives lost was the anti-boarding netting that covered the upper decks in the waist (the midsection of the ship) and the sterncastle. With the exception of the men who were stationed in the tops in the masts, most of those who managed to get up from below deck were trapped under the netting and were dragged down with the ship.

Although this was a great loss to Henry, the sea battle was inconclusive. The French then withdrew to the Isle of Wight where they entered Brading, Sandown and Bonchurch. There was great loss of life but the defending militia were able to defend efficiently, and what might have been an invasion became a skirmish. The French Fleet then withdrew from the Isle of Wight without affecting a fully manned landing, attacked Seaford, and finally sailed back across the Channel.

Several theories have sought to explain the demise of the *Mary Rose*, based on historical records, knowledge of 16th-century shipbuilding and modern experiments. However, the precise cause of her sinking is still unclear, because of conflicting testimonies and a lack of conclusive physical evidence.

Discovering the wreck: TS then described the discovery and raising of the *Mary Rose* - seminal events in the history of nautical archaeology. Already here had been several attempts to recover the sunken ship, the initial one only 12 days after the disaster! Gradually over the next 150 years the structure above the seabed collapsed and the site was forgotten. In 1836 after reports of fishing nets being snagged, the Deane brothers, using pioneering diving gear, recovered some guns. Again, the site was mostly forgotten until 'Project Solent Ships' started in 1965 with the aim of discovering and surveying several known and well documented wrecks which lay beneath the Solent.

The *Mary Rose* wrecksite was rediscovered in 1965 by Alexander McKee, a historian and amateur diver. The site was surveyed with side scan sonar in 1967-68, and the first loose timber was located in 1970. The buried wreck of the *Mary Rose* was finally located on 5 May 1971. Throughout the 1970s volunteer divers and archaeologists surveyed the ship and conducted some limited excavations. In January 1979 the Mary Rose Trust was formally inaugurated and the recovery of the wreck took on a more formal approach, with the archeologist Margaret Rule directed the underwater excavation. On 11 October 1982 the *Mary Rose* was successfully salvaged.

Raising the wreck: Once the marine archaeology had been completed, a tubular steel frame was set on the seabed over the hull then the hull was attached to the frame using steel cables. A prefabricated steel cradle designed to conform to the lines of the hull was then placed next to the site. The hull of the Mary Rose suspended from the steel wires was then lifted from the seabed using hydraulic jacks in the legs of the tubular steel frame. The tubular steel frame, complete with the hull, was lifted by a crane barge on to the steel cradle. The space between the hull and the cradle was filled with a series of water filled bags to support the structure. The cradle was then lifted from the sea bed and the hull transported to Portsmouth Dockyard where she was put in storage. During this time the wooden remains of the hull were continually sprayed with filtered, recycled water that was kept at a temperature of 2 to 5 °C (35 to 41 °F) to keep it from drying out.

Preservation: The preservation of the *Mary Rose* and her contents was an essential part of the project with archaeologists and conservators working in tandem from the start. After almost ten years of small-scale trials on timbers, an active three-phase conservation programme of the hull of the *Mary Rose* began in 1994. During the first phase, which lasted from 1994 to 2003 the wood was sprayed with low-molecular-weight polyethylene glycol (PEG) to replace the water in the cellular structure of the wood. From 2003 to 2010 a higher-molecular-weight PEG was used to strengthen the mechanical properties of the outer surface layers. The third phase will consist of a controlled air drying that will last three to five years,

After recovery, all artifacts were placed in passive storage, which prevented any immediate deterioration before active conservation, which would allow them to be stored in an open-air environment, could commence. Passive storage depended on the type of material that the object was made of, and could vary considerably. Smaller objects from the most common material, wood, were sealed in polyethylene bags to preserve moisture. Timbers and other objects that were too large to be wrapped were stored in unsealed water tanks. Growth of fungi and microbes that could degrade wood, were controlled by various techniques, including low-temperature storage, chemicals, and in the case of large objects, common pond snails that consumed wood-degrading organisms but not the wood itself.

Other organic materials such as leather, skin and textiles were treated similarly, by keeping them moist, in tanks or sealed plastic containers. Bone and ivory was desalinated to prevent damage from salt crystallisation, as was glass, ceramic and stone. Iron, copper and copper alloy objects were kept moist in a sodium sesquicarbonate solution to prevent oxidisation and reaction with the chlorides that had penetrated the surface. Alloys of lead and pewter are inherently stable in the atmosphere and generally require no special treatment. Silver and gold were the only materials that required no special passive storage.

The artefacts: Along with remains of about half the crew members, over 26,000 artefacts and pieces of timber were salvaged, many objects that belonged to individual crew members. This included clothing, games, various items for spiritual or recreation use, or objects related to mundane everyday tasks such as personal hygiene, fishing and sewing.

Many of the cannons and other weapons from the *Mary Rose* have provided invaluable physical evidence about 16th century weapon technology. The surviving gunshields are almost all from the *Mary Rose* and the four small cast iron hailshot pieces are the only known examples of this type of weapon. TS had a selection of reproduction artifacts that he handed round, Including: Yew Longbow and arrows, Plane, Stave-built drinking vessel Medical equipment including an amputation saw and a copper syringe for wound irrigation. Personal items including lice combs, shaving brush, open shaving razor, - and a multitude more.

Tudor Clothing: Cheryl described the clothes of the time and we even managed to get our president to don Henry V111's hat and coat!! Tudor clothes and fashion varied according to whether the person was a member of Royalty, the Nobility, Upper Class or one of the poor, working class. Colours, styles and materials were dictated by class and rank. The higher the rank the more choice of materials, styles and colours could be worn. Buttons were usually for decoration with clothes often held together with laces or pins. Upper-classes had ties at the back (they could afford servants!!); lower classes had ties at the front.

Wool and Linen were the main materials used by the lower classes with linen being used for shirts and underwear. However only the rich could afford cotton and silk clothes, often elaborately embroidered with silk, gold or silver thread. Women who could afford it would hang a container, called a pomander, of sweet smelling spices on their belt to disguise the horrid smells on the street.

The basic garment worn by all men, women and children was the smock or chemise, a long T-shaped linen garment worn next to the skin. Wool stockings, known as 'hose' were worn by all but the very poor.
Working men also wore short trouser-like garments called breeches and tight fitting jackets called doublets. Another jacket called a jerkin was worn over the doublet. However, instead of a doublet many working men wore a loose tunic - it was easier to work in. Some working men wore a leather jerkin called a buff-jerkin. Daggers and purses were hung on leather thongs from the belt.

Lower class women also wore a thick woollen 'kirtl', a square-necked ankle-length dress with a fitted laced bodice and full skirts made of linen or wool. Sleeves were tied or pinned onto the bodice, showing the smock underneath and probably an apron over the top to keep the dress as clean as possible. Women kept their heads covered at all times, often with a tight-fitting linen 'coif', which could be worn under a bonnet.

R Keir
(Information courtesy of - The Mary Rose: The Excavation and Raising of Henry V111's Flagship by Margaret Rule and Wikipedia.org)

Outing.

Wednesday 28th November, Tangmere Military Aviation Museum.
Twenty six members and guests, including two aeronautical students from Brighton University, attended the visit to Tangmere Military Aviation Museum. The visit took the format of a talk and conducted tour of the indoor exhibited aircraft by Mr Iain Mackinnon a member of museum staff. Following this we were free to peruse the remainder of the exhibits. Members of museum staff were on hand to answer questions and expand on the information on show.

The talk covered the history of the following aircraft:

***Supermarine Spitfire**:* The Spitfire is a British single-seat fighter aircraft that was used by the RAF and many other Allied countries throughout the Second World War. The Spitfire continued to be used as a front line fighter and in secondary roles into the 1950s. It was produced in greater numbers than any other British aircraft and was the only British fighter in continuous production throughout the war.

The Spitfire was designed as a short-range, high-performance interceptor aircraft by R. J. Mitchell, chief designer at Supermarine Aviation Works (which operated as a subsidiary of Vickers-Armstrong from 1928). The Spitfire's elliptical wing had a thin cross-section, allowing a higher top speed than several contemporary fighters, including the Hawker Hurricane. Speed was seen as essential to carry out the mission of home defence against enemy bombers.
The only Spitfire on show at Tangmere was a full size replica of Spitfire prototype K5054 (the original having been destroyed in the late 1930s). Unfortunately the other replica Spitfire, a Mk VB has age-related structural problems which require urgent attention, it has therefore been dismantled and will shortly be assessed for restorative work.

***Hawker Hurricane**:* The Hawker Hurricane is a single-seat fighter aircraft that was designed and predominantly built by Hawker Aircraft Ltd. Although largely overshadowed by the Spitfire, the aircraft became renowned during the Battle of Britain, accounting for 60% of the RAF's air victories in the battle, and served in all the major theatres of the Second World War.

The Hurricane on show at Tangmere is a replica of Hurricane L1679 an early production version , with fabric-covered wings and a wooden two-bladed, fixed-pitch propeller. L1679 was delivered to No 1 Squadron at RAF Tangmere in early 1939 and deployed with the unit to France on 9th September just 6 days after the outbreak of war. When Germany began its blitzkrieg through the Low Countries in 1940, the squadron became involved in daily combat whilst constantly withdrawing to the west as the enemy forces advanced. L1679 was in the thick of it. Badly damaged during a crash-landing at Mezieres on 10th May she was destroyed on the ground 4 days later. The museum's replica was built in the 1980s at Middle Wallop and, because it includes a Rover V8 engine that turns the propeller, has been used as a taxiable – though not flyable – film extra!

Gloster Meteor F4: The Gloster Meteor was the first British jet fighter and the Allies' first operational jet. Although the German Messerschmitt Me 262 was the world's first operational jet, the Meteor was the first production jet, as it entered production a few months before the Me 262. The development of the aircraft began in 1940 and work on the engines had started in 1936. The Meteor first flew in 1943 and commenced operations on 27 July 1944 with 616 Squadron of the RAF. Although the Meteor was not an aerodynamically advanced aircraft, it proved to be a successful and effective combat fighter.

The Meteor on show at Tangmere is on loan from the RAF Museum and is the World Speed Record breaking is the Meteor F4 Special. The RAF High Speed Flight was reformed in late 1945 at Tangmere in order to make an attempt on the world air speed record. In September 1946, Gp Capt E M (Teddy) Donaldson set a new world record of 615.78 mph off the Sussex coast at Rustington. On returning from the Paris Air Show in January 1947, the same aircraft set a new record time of 20 min 11 sec between Paris (Le Bourget) and London (Croydon).

Hawker Hunter Mk3: The Hawker Hunter is a subsonic British jet aircraft developed in the 1950s to replace the Gloster Meteor. The single-seat Hunter entered service as a maneuverable fighter aircraft, and later operated in fighter-bomber and reconnaissance roles in numerous conflicts. Two-seat variants remained in use for training and secondary roles with the Royal Air Force (RAF) and Royal Navy until the early 1990s.

The Hunter on show at Tangmere is on loan from the RAF Museum and was ordered in June 1948 as one of three prototypes and first flown by Hawker's Chief Test Pilot, Squadron Leader Neville Duke, in July 1951. In early 1953, one was fitted with side-mounted airbrakes, extra fuel tanks in the wings and a new reheated version of the Avon engine – at which point she became known as the sole Hunter Mk 3. On 7th September 1953, Neville Duke took off from Tangmere to set up a new world air speed record of 727.63 mph along a course between Bognor and Littlehampton.

Also on show was a Hunter pack of four 30mm ADEN cannon and four 150 round ammunition boxes. These are contained in a single pack that could be removed from the aircraft for rapid re-arming and maintenance. These were installed in the single-seat fighter version of the Hunter. Unusually, the barrels of the cannon remained in the aircraft while the pack was removed and changed.

English Electric Lightning F53: The English Electric Lightning is a supersonic jet fighter aircraft of the Cold War era, noted for its great speed and unpainted metal exterior finish. It is the only all-British Mach 2 fighter aircraft and has several unique and distinctive design features. Principally the use of stacked and staggered engines; a notched delta wing; and a low-mounted tailplane. The vertically stacked, longitudinally staggered engines was the solution devised to the conflicting requirements of minimizing frontal area, providing undisturbed engine airflow across a wide speed range, and packaging two engines to provide sufficient thrust to meet performance goals. The configuration allowed the twin engines to be fed by a single nose inlet, with the flow split vertically aft of the cockpit, and the nozzles tightly stacked, effectively tucking one engine behind the cockpit. The result was a low frontal area, an efficient inlet, and excellent single-engine handling.

The Lightning possessed a remarkable climb rate and was famous for its ability to rapidly rotate from takeoff to climb almost vertically from the runway. A Lightning flying at optimum climb profile would reach 36,000 ft. in less than three minutes. The official ceiling was kept as a secret, although low security RAF documents usually stated 60,000+ ft.

As the Lightning could fly to Mach 2 the expansion of the outer skin due to aerodynamic heating had to be overcome. The experience gained was used in the development of Concord.

Lightning Simulator: Following the aircraft talk several members went to a demonstration of the Lightning Simulator. This was 'flown' by a museum volunteer. The simulator was developed and constructed by a small project team of Museum volunteers and is based on the shell and associated parts of an original Lightning F1 simulator. Flying controls and flight instruments have been integrated with appropriate software - whilst the ‘outside world’ is projected on to a wall to reproduce as realistic a Lightning flying experience as possible.

The demonstration started with take-off from Tangmere; a flight around the area including a landing on an aircraft carrier off Portsmouth, a trip around Southampton Water and Portsmouth then east along the coast and overland across Arundel finishing with a landing at Tangmere. One Brighton University student and at least one RCEA members took a turn of flying – and crash landing the Lightning!!

Around the museum there was a plethora of displays and equipment to view. The following give a flavor of what can be seen:

Battle of Britain Hall - Here the focus is mainly on the crucial air battles fought in the skies over Southern Britain in 1940. See the excavated and poignant remains of Sergeant Dennis Noble’s Hurricane, enjoy the many fine poems written by airmen during the conflict and retrieved remains of Merlin, Junkers Jumo and Griffon engines.

Here you will also find the signatures of many of the Battle of Britain pilots, an original searchlight and a display of a number of Luftwaffe artefacts as well as a feature on photo interpretation, an exhibition of photo reconnaissance cameras and the actual uniform worn by Flt Lt James Nicolson during the action for which he won RAF Fighter Command’s only VC during the Second World War.

Tangmere Hall - Here you will find many exhibits illustrating the history of Tangmere from 1917 to 1970. The Hall also contains a comprehensive exhibition devoted to the equipment and activities of the special SOE agents and the Lysander pilots who flew them to and from occupied Europe from Tangmere.

There are also special sections on the Royal Flying Corps – the forerunner of the RAF – a small art gallery containing a number of fine original aviation paintings, a section on the radio equipment used in the Second World War and displays of medals and uniforms from all periods of Tangmere’s history.

Tributes are also paid to the Women’s Auxiliary Air Force (the WAAF) and Air Transport Auxiliary (ATA) and a unique Bomber Command exhibit featuring a Lancaster raid on Berlin in 1944.

Middle Hall – Here you will find a fine collection of RAF Regiment armaments. Also a unique model of the Mohne Dam, the first dam breached in 617 Squadron’s famous raid in 1943 along with models of the dam busting Lancaster and a moving model of the mechanism (then highly secret) that was used to spin up the bombs before dropping. You can also see a display of life on the Home Front, and a host of other memorabilia including various wartime pilots’ logbooks.

Merston Hall - Here you will find the Museum’s two world airspeed record holding aircraft – Donaldson’s Meteor and Duke’s Hunter – which are on loan from the RAF Museum by courtesy of the Trustees, as is the Supermarine Swift which is displayed next to the Hunter.

R Keir (Information courtesy of Tangmere website and Wikipedia.org)

Talk.

Worthing Tuesday 11th December

“The Butterley Company of Ripley, Derbyshire 1792 to 2009 – The rise and fall of an industrial giant.”

Mr Gwylim Roberts RCEA

Established in 1790, the Butterley Company was located on an elevated site near Ripley, Derbyshire, under which the Cromford Canal had been built in tunnel, during the construction of which it had been discovered that the site was rich in iron and coal deposits. The Canal’s engineers, William Jessop (Senior) and Benjamin Outram, thereupon founded the company and were joined shortly afterwards by Nottingham banker John Wright and local gentleman Francis Beresford, whose combined skills and resources enabled the company to develop into the largest coal, iron and engineering concern in the East Midlands as well as, later, becoming a major brick maker. The remains of several of the company’s earlier buildings are now statutorily protected.

By the start of the nineteenth century the company was making a variety of rails, wagons, pipes and cannon, the goods being lowered by ingenious winches through shafts onto barges on the canal that passed under the site. A decade later, with William Brunton as the company’s engineer, steam engines were being manufactured, including his patented *Mechanical Traveller,* a steam engine with legs (to ensure adhesion to the rails). Major projects on which Butterley iron was used during the next decades included London's Old Vauxhall Bridge, (the first iron bridge over the Thames), a railway bridge over the Trent, a bridge at Lucknow, India, and the reconstruction of Sheerness Dockyard.

From the Victorian era until well after the Second World War, the company was owned and managed by members of the Wright family, most notably by Francis Wright (1806-73) who led the company during its Victorian heyday. A far sighted entrepreneur (and philanthropist) he appointed some of the leading industrial engineers of the day as the company's Chief Engineers. They included Joseph Glynn FRS and Sir John Alleyne, under whom the company pioneered a variety of civil and mechanical engineering innovations including manufacture and erection of St Pancras Station superstructure, mounting the largest iron exhibit at the 1862 London Exhibition, and inventing the *Butterley Bulb*, a wrought iron girder of novel design, which was used as deck supports for HMS *Warrior* and SS *Great Britain.* Many patents were granted for their inventions. Later projects included bridges in London, Australia and India.

The first half of the twentieth century saw a continuation of its engineering activities, albeit on a reduced scale, the development of its brick-making activities, and the nationalisation of its most profitable operation - the collieries – by the post-war Attlee government. Attempts to use some of the cash generated by coal nationalisation in diversification were mostly unsuccessful with the result that in 1968 the company was acquired by the Hanson Group, which was principally interested in the company's brickmaking division. After a period the rump of the company, essentially the engineering business, was sold on, a process which was repeated a number of times over the following decades. Despite manufacturing a variety of important structures such as the Falkirk Boat-lift and Portsmouth's Spinnaker Tower, and cranes and other machines for the petroleum, coal and power industries, there were financial problems which led to the company's liquidation in 2009.

G Roberts

Christmas Lunch

Worthing Thursday 13th December.
RCEA Christmas Lunch, . Windsor Hotel, Worthing




REPLY SLIP 1

To: Ms B C Whitmell, Inglenook, Old Salts Farm, Lancing, BN15 8JD
Tel 01903 762918, or e-mail bcwhitmell@talktalk.net

Please reserve me a place to attend the **Lunch at Northbrook College, Worthing, Thursday 14th March, 12.00 for 12.30**

Name:……………………………………………………………(Block capitals)
Address……
………………………………………………………
………………………………………………………………
………………………………………………………………
Telephone Number…………………………….Name of guest/s …………………………………….
E mail address…………………………………Seating Request ………………………………….

I enclose a cheque made payable to RCEA for **£……………..…(£12.00) per person**
(Separate cheque please)

Applications by 14th February 2012

…………………………………………………………………………………………………..

REPLY SLIP 2

To: Derek Webb, 6 Loxwood Avenue, Worthing, West Sussex, BN14 7QZ
Tel: 01903 52569 or email derek.webb2@ntlworld.com

Please reserve me a place to attend the **Visit, 10.45, Wednesday 10th April 2013 to Network Rail Electrical Control Centre, Brighton Station**. (No car parking is available for this visit).

Full Name... **Telephone No** ……………………
Address... **e-mail**.…….………………………….........
……………………………………………
……………………………….

Applications by 3rd March.

NB *The maximum number of visitors is limited so attendees will allocated on a first – come, first - served basis.*
………