RAeS Loughborough Branch

Lecture synopses - 2005/06 Season

18th October 2005 - The Schneider Trophy by Derek James

Jacques Schneider inaugurated the Schneider Trophy in 1909. He believed that the seaplane should be developed as the future universal means of transport. He wanted a particularly reliable aircraft which could operate over open sea. In this respect the Schneider Trophy was a failure as it only resulted in a series of high speed single seater aircraft.

In the early years the host nations were mainly Italy and the UK. UK entered successive variants of the Supermarine Sealion whilst Italy entered their Savoia Flying Boat. The USA won in 1924 with their Curtiss CR3. In 1926 Mussolini dictated that Italy must win. The result was a Macchi/Fiat design called the Macchi M39 which won with an average speed of 250 mph. 1929 saw the UK win with the Gloster 6. Successive versions of this aircraft led to wins for the UK until 1931 when the UK won with the Gloster S6B which incorporated a Rolls-Royce engine developing 2,300 hp. At that point the UK retained the trophy for good having won it three times in succession.

The experience gained by the UK provided valuable technical background for the Spitfire and Hurricane fighters which were to become the main UK fighter aircraft throughout WW2.

8th November 2005 - The Marketing and Operations of BMIbaby by David Hodge, Marketing Director, BMIbaby

The concept of a "low cost airline" was started by South West Airlines in the USA in the late 1980s. This spread to Europe in 1990 when Ryanair repositioned itself as a low cost airline.

At first Ryanair struggled to achieve the necessary load factor and hence yield. Easyjet started operations in 1995 but the big change did not occur until 1997 when European airspace was deregulated. This was the so called "open skies agreement". The expansion was aided in 1997 by the start of booking via the internet. Typically the costs per booking are £7.11 via a travel agent and £1.15 via the internet. To-day 97% of bmibaby's bookings are via the internet.

Bmibaby entered the scene in 2001. Its start was quite maverick – create a brand, i.e. bmibaby, "the airline with tiny fares". Bmibay's low cost business model is:

- Use of a single aircraft type (Boeing 737) coupled with high utilisation;
- Web based distribution system;
- Single fare structure;
- One class;
- Ticketless system
- Single integrated reservations system.

High utilisation is achieved by having fast turnaround times - 30 min although South West Airlines achieves 20 min. This leads to an extra 2 hours flying per day compared with a "premiun" airline.

There is one cabin class and the rule is the earlier you book the cheaper the price.

In the year 2000 low cost airlines carried 26 million passengers. This is expected to increase to 100 million in 2005 and 50% of all European travel by the year 2010.

To-day bmibaby has 19 737s. It obtained the Daily Telegraph Travel Award in 2003, 4 and 5. It continuously tracks satisfaction levels and most people place it in the category "extremely/very satisfied". The main threat to bmibaby is the price of jet fuel which has risen from 200 $/ton to 700 $/ton over the last year or so. This threat is greater for low cost airlines than for "premium" airlines. Obtaining new aircraft is also a problem because China is purchasing so many from the aircraft manufacturers.

The scheduled/premium airlines are fighting back. At present there are too many airlines in the market place leading to too much supply.

Growth will be achieved by a combination of means: organic, aquisitional, franchise, routes, frequency, "joining the dots" i.e. linking routes together and new routes. Additional revenue streams will also add to income. To the flight ticket and charges add insurance, parking, baggage, on board sales, car hire and hotels. Often the value of the add-ons exceeds the value of the flight ticket.

Costs are being cut by economies of scale, fuel minimisation, contracting out and innovation.

Bmibaby is totally customer focused. It:

- Identifies its customers need and habits
- Establishes the demographics/postcodes of its customer base and hence decides where to focus its advertising;
- Has identified the hybrid customer – cash rich and time poor;
- Has confirmed the importance of the whole cost (including parking) of a flight.

Bmibaby uses TV advertising and aims to create a national brand which feels local. It is developing "electronic consumer market place management" and is looking into a loyalty programme. But overall, people are the most important.

Joint meeting with Inst. Logistics and Transport.

22 November 2005 - Engineering for the Future with the Pilatus PC-21 all New Turbo-prop Basic/ Advanced Trainer by Mr Bruno Cervia and Edward Burdak, Pilatus Aircraft Ltd.

Pilatus has 1000+ employees at its development and production facility in Stans, Switzerland. In addition it has agencies in USA, Far East, Australia and various other locations throughout the World.

The company specialises in single engined turbo-prop aircraft including the PC-12 passenger aircraft, the PC-7, PC-9 and now the PC-21 trainer aircraft. To date the company has sold 1850 aircraft.

In January 1999 Pilatus launched the development programme for the PC-21 . The objective was to meet the expectations of modern air forces over the next 30 years both in terms of capability and life-cycle cost. With this in mind, the PC-21 development specification focused on three core objectives:

- A superior aerodynamic performance when compared with any other turboprop trainer on the market.
- A more powerful, flexible and cost effective integrated training system than any other jet or turboprop trainer in the world.
- A life-cycle support cost not to exceed current turboprop benchmarks.

There have been significant changes to the aircraft industry in recent years; military aircraft are no longer being replaced on a one to one basis and civil aviation is becoming ever more dominant. This means consolidation in industry for the production of military trainer aircraft. Market drivers for the new PC-21 have been to reduce the time to market, a large investment in technical design and a focus on life cycle costs. The latter is because customers are placing the entire through life risk on the aircraft supplier. For these reason Pilatus have used a Concurrent Design Process to develop the PC-21 which commences with the "digital aircraft set-up". This has removed the need for a mock-up and reduced the flight testing programme. The digital mock-up is the heart of the concurrent design process.

The digital mock-up relies on the Product Data Manager (PDM) for data storage and retrieval and also to provide full data traceability, essential for qualification purposes. A Computer Aided Design/Engineering software package is used in association with the PDM. Other elements include a Finite Element/Master Model Design Analysis software package for stress analysis and other computational fluid dynamics packages (6 degrees of freedom (6DOF)) for flight simulation. This includes an analysis of the effects of bird strike on the cockpit canopy.

The use of simulation packages has not obviated the need for full scale fatigue testing which will ultimately extend to 45,000 hours, three times the normal fatigue life of the airframe.

Reliability and maintainability has also been assessed using the digital prototype.

The PC-21 is designed to cover more training missions than any other training aircraft and hence to reduce the number of missions which need to be conducted using jet trainer aircraft which have much higher life cycle costs.

The aircraft uses a 1600 shp PT6A-68B turbo-prop engine coupled to a five blade carbon composite propeller. It has an 8G wing and is therefore fully aerobatic. The aircraft has full flat screen cockpit displays to cover both military and civil flight requirements.

The development process has made due allowance for all add on options right from the start which has enabled these options to be incorporated in the most space efficient manner.

The PC-21 aircraft was certified at the end of 2004 using the civil certification process with "add ons" to cover the additional requirements for military use.

6 December 2005 - Over Hundred Years of Submarine Technology by Tim Roberts, Ship Safety and Operability Manager, BAE SYSTEMS

The first "real" submarine was Bushell's "Turtle" of 1776 which was use during the US War of Independence to sink HMS Eagle. The UK's first submarine was the "Resurgam" designed by Rev. George William Grant in 1879 but the real history of the UK submarine service starts with the Holland 1(A1) built a Barrow in 1901.

Main requirements of a modern submarine are to resist hydrodynamic forces, achieve best depth and greatest speed and to carry as large a weapon load as possible. The dilemma is the trade between speed and endurance. The maximum depth depends on the hull shape; the ideal is a sphere but the compromise hydrodynamic shape is an elongated pear shaped section.

The Holland led to the "D" Class diesel powered submarine (1907-1919). This was slow and had no periscope. The successor was the "K" Class which was steam driven and had a surface speed of 20 knots which enabled it to keep up with the fleet.

The late '30s saw the development of diesel engined submarines with more power and better fuel economy. These were further improved by using a full diesel-electric drive with batteries for under water operation. The snorkel was developed, initially by Germany during WW2 to allow the man diesel engines to operate whilst the submarine was just below the surface.

Post WW2 development in welding techniques resulted in an hull shape offering improved hydrodynamics; the "Albacore" hull (US).

The first nuclear submarine was the USS Nautilus (1955) which used a pressurised water reactor. Its ability to remain dived for long periods led to new requirements for hotel services, air purification, water production (reverse osmosis) and power production. UK nuclear submarines included HMS Vanguard and HMS Renown.

Modern submarines are subject to a full Ship Safety Case (SSC) analysis; bottom up hazard based deterministic approach and a top down fault tree analysis approach.

There will be a demand for submarines for the foreseeable future. These could include non-nuclear fuel cell powered submarines. The drive will be to reduce manufacturing, operating and regulatory costs.

Joint meeting with I. Mech. E.

24 January 2006 Air Power and the Future by Air Marshal Sir Peter Norriss, Past RAeS President

The end of 2003 was the 100th anniversary of powered flight. Long distance travel by air is now common place, both for passengers and freight. This, together with the development of navigation systems, has had a dramatic effect on air power. The promises of air power are now closer to being realised than ever before. That promise is to allow air forces to create the environment in which other forces can operate.

Bleriot's Channel crossing in 1909 was the turning point; the Navy could no longer guarantee to defend our shores. In 1912 an Italian mixed force of bombers, airships and aircraft provided support to the Italian invasion of Libya. The Royal Flying Corps became fully fledged during WW1 both in air-to-air combat and reconnaissance. Fokker produced the first fighter with the machine gun synchronised to the propeller thereby enabling the pilot to aim the whole aircraft at a target. This soon became true for all fighter aircraft. By the end of WW1 the DH4 had oxygen, electric crew heating and a ceiling of 22,000 ft.

Smutts memo from 1917 recommended the formation of the RAF as an independent force. Air power was seen as the means of preventing the future loss of life which was the hallmark of ground forces during WW1. During the inter–war years most RAF activity was concerned with policing, e.g. NW frontier of India.

In 1934 the expansion of the RAF was agreed by a narrow margin in Parliament. But for this we may not have been ready for WW2. During WW2, Harris developed the concept of strategic bombing. This was also developed by Mitchell in USA. By the start of WW2 the RAF had the Hurricane, Spitfire, Blenheim and Wellington. They had also developed a systematic plan for the defence of the UK which relied on the use of the newly developed tool, Radar.

The lesson from 1940 was that it is vitally important to control the air. This was brought home at Pearl Harbour in 1942. Other techniques developed during WW2 included: System G Loran; the Pathfinder Force: Night Operations; use of Night Fighters; use of "Window". Bombers were used strategically to interdict communications networks, but with the possible exceptions of Pearl Harbour and the use of the atomic bomb, strategic use of air power did not live up to expectations.

During the Korean War the quality and effectiveness of crewing gave the F86 a 10:1 advantage over the Mig15. Vietnam saw the use of laser guided bombs for the first time, thereby greatly increasing the effectiveness of bombing targets such as bridges. Laser guided bombs were first used by the RAF during the Falklands conflict, again to considerable affect.

The Berlin Airlift was the primary example of strategic success; delivering 8,000 tonnes of materials each day ensured that Berlin remained in Western hands.

The last 15 years have seen the RAF used primarily in its classical support role. Operation Desert Storm lasted 43 days for the participating air forces followed by 2 days for the ground forces.

In recent times the major change has been to move from low to medium level attack. This requires a combination of suppression of ground fire, use of stealth technology and the extensive use of precision guided weapons.

The main lesson learnt from recent conflicts is that we need faster and faster information flow.

The 2003 invasion of Iraq resulted in "shock and awe" on the ground and hence a bloodless war. Need total knowledge of the enemy to know best what influences their will.

So far the Harrier has been the only successful VTOL aircraft. Both Harrier and Tornado have been through a series of mid-life updates.

Space will increasingly feature in warfare as a means of enhancing operational effectiveness.

To-day's core capabilities are:

1. Information Exploitation (e.g. Airborne Stand- Off Radar (ASTOR), Data Analysis and Fusion) leading to Total Information Superiority.
2. Control of the Air, including the freedom to operate wherever we wish, e.g. by the use of aircraft carriers.

3. Strategic Effectiveness – on an independent basis or with other forces.
4. Superiority in the Land and Maritime Battlespace.
5. Combat Support Air Operations – air transport and air-to-air refuelling.

For the Future:

1. The core capabilities will be augmented.
2. Space will grow in importance, e.g. use of low cost satellites.
3. Humans will continue to play a part.
4. Aim will be to deliver controlled force.
5. Directed energy weapons will be fielded.
6. There will be an enhanced requirement for greater surveillance.
7. New concepts for engine design will be adopted.
8. Aircraft likely to follow civil aircraft developments, e.g. blended wing bodies.
9. Increased reliability and survivability.
10. Aircraft will become increasingly uninhabited and take on more and more dirty and dangerous tasks – unmanned combat vehicles. Such UAVs will be boxed up and stored and be ready to be brought out in time of need.
11. There will be fewer platforms, more flexibility in platform design, more logistics support.
12. There will be "bandwidth discipline" to optimise data flows without the resultant signal saturation.

14 February 2006 - Defence Technical Undergraduate Scheme (DTUS) and Aircraft Weapons and Armaments by Wg Cdr Keith Pearce, Loughborough Univ. Defence Technical Undergraduate Scheme (DTUS) Support Unit

Defence Technical Undergraduate Scheme (DTUS)

This is in two parts; the Defence Technical Officers Engineering Entry Scheme (DTOEES) centred on Welbeck College, Quorn, Loughborough and the Defence Technical Undergraduates Scheme centred on the 5 universites of Cambridge, Southampton, Newcastle and Nothumbria, Loughborough and Aston. The aim of DTUS is to provide 40-50% of the engineering officers for all 3 services and 70% for the MoD Civil Service. In total this amounts to 200 graduates each year. Welbeck is a purpose built, tri-service Sixth Form College.

Whilst at university students receive a bursary of £4,000 p.a. and training/bounty payments of between approx. £1,600 and £3,500 p.a. Currently there are 37 DTUS students at Loughborough University.

Aircraft Weapons and Armaments

Up until 1900 the main explosive was gunpowder made at the Royal Gunpowder Factories. Since 1900 gunpowder has been progressively replaced by nitro based explosives.

Current applications for explosives and nitro compounds include:

- Quarrying
- rocket actuators
- signalling (light and sound)
- decoys
- counter-terrorism, e.g. for controlled explosions to clear explosives
- riot control
- time delays, e.g. for clearing oil drilling pipes
- medical, e.g. for heart and kidneys
- automotive (HNS explosive for crash bags)
- demolition
- power actuator devices
- offensive weapons
- document and electronic media destruction

Offensive weapons for use by the UK armed services are qualified by DOSG who are also responsible for overseeing the lifing and disposal of explosives/munitions.

Current air-to-ground RAF weapons include:

- Maverick - an enhanced Paveway guided bomb with GPS and laser guidance. N. B. Lasers do not function in presence of debris etc. hence GPS desirable.
- Paveway III for penetrating bunkers.
- Paveway IV due n service in 2007 and with GPS and INS guidance.
- 1, 000 lb Mk 20 bombs and 600 lb cluster weapons. Both of these are being phased out because of political considerations, i.e. no more free fall bombs leading to collateral damage.
- Brimstone - a stand-off rocket propelled anti-armour weapon.
- Alarm anti-radiation radar homing weapon.
- Storm Shadow – a long range (250 km) stand-off weapon.

Current air-to-air RAF weapons include:

- AIM9/Sidewinder
- ASRAAM
- MRAAMS – replaces Skyflash AMRAAMS.

28 February 2006 - From Comet to Harrier by Duncan Simpson OBE FRAeS Ex CTP Dunsfold

Duncan's career in aviation started in 1945 when he joined the deHaviland Company as a student apprentice. Like every other apprentice he started in the woodworking shop but was later posted to the experimental department. Here he worked on the Mosquito, Hornet, Vampire, Venom and the prototype Dove. Later he also worked on the DH106 which became the Comet 1, the world's first pressurised passenger aircraft. As everyone knows, this suffered from metal fatigue failures about which little was known at the time.

He then joined the RAF to become a pilot. There his first operational aircraft was the Meteor Mk 8 which he flew on a regular basis out of Leuchars. A herring gull strike on the cockpit canopy showed the devastating effects of bird strikes. His second tour was at the Central Fighter Establishment at West Raynham where he flew Venoms (50,000 ft and 0.84/0.85 Mach No.), Swifts (useless as an interceptor fighter as no manoeuvreability margin hence assigned to low level fighter recce.), Sabres (for comparison with UK aircraft) and Hunters (functional, manoeuveable, high rate of climb). Many of the latter were sold outside the UK hence Duncan spent time training and demonstrating the aircraft in a number of countries including Switzerland and Peru. Duncan then left the RAF to accept a position with Hawker Siddeley Aviation as a test pilot.

The UK government's 1957 White Paper envisaged the end of piloted aircraft but, fortunately this did not prove to be the case. Sir Sidney Camm, Chief Designer Hawker Siddeley Avaition, had idea for a supersonic Mach 2+ strike fighter as a Hunter successor. This was called the Hawker P1121 and was to incorporate a Gyron jet engine with full re-heat. The P1121 developed into the P1129 which was very similar to the Vickers TSR2. Both the TSR2 and the P1129 were later cancelled.

Sir Sidney Camm, in conjunction with Sir Stanley Hooker, Bristol Siddeley, then developed the concept for a vectored thrust demonstrator which was later developed into the Harrier Mk 1. Duncan was lucky to survive the first ejection from the Harrier with a Martin Baker ejection seat when he was testing the two seater version of the Harrier near Boscombe Down. A supersonic version of the Harrier was also considered (the P1154) but was later cancelled. The success of the Harrier lay in its sale to the US Marine Corps.

Duncan's other experience included the Tom Tit basis trainer (a 1928 Hawker aircraft), a two seater Hurricane (for the Shah of Persia), Sea Fury trainer, Harrier (2 seater side-by-side) trainer and the Hawk trainer.

14 March 2006 - How Did They Think Of That? by Chris Clarkson, Future Systems Technical Director Air Systems – New Business, BAE Systems Operations Ltd.

Let us consider Innovation in Engineering. Has such innovation disappeared?

Frederick William Lanchester

F W Lanchester started life as a motor engineer but his later studies on Aerial Flight founded aerodynamics theory as we know it today. He was the inventor of the Vortical Lift Theory and many aerodynamical terms derive from him. He is also well known for his operational analysis. Overall he was tenacious and had an excellent problem solving mind.

Innovative Concepts in Aeronautics

Fuelled by the fight for military superiority during two World Wars and the Cold War, capability in aerodynamics continued to grow enormously through years of innovation. Examples of innovative concepts during this period are:

a) The challenge to allow aircraft to operate without an undercarriage. Such aircraft would be cheaper to manufacture and more efficient. Examples:
    i. Harrier operating with a stabilised crane "Skyhook".
    ii. Aircraft landing on flexible rubber decks on aircraft carriers. Disadvantage – lack of manoeuvrability once landed.

a) Landing low aspect ratio delta winged aircraft on carriers. The wings are designed for supersonic flight but the aircraft need to land at a comparatively slow ground speed. Solution blow air out of 6 x Spey engines to create a wind into which the aircraft can land. This is similar to the WW2 concept of landing on a bed of air.
b) Harrier replacement for the Navy. Use a W wing to achieve a 15% improvement in aerodynamic performance but all these gain are lost because the aircraft becomes impractical to manufacture.
c) Jumping Jeep – on a bed of air.
d) P127 leading to the Kestrel, Harrier and now the X-35 JSF. JSF twice weight Harrier, supersonic and with an internal weapons bay. The design process was so precise that it had a very successful first flight. Its Flight Control System is based Eurofighter flight control system. BAE Systems lead the FC IPT.
e) Buccaneer – Need to take off in hot/high conditions in South Africa. Used Hydrogen Peroxide rocket.
f) Hawk 100 Trainer development (1) – trailing plane vanes – Side Mounted Underwing Root Fin (SMURF) eliminated "phantom dive" – form of upside down wing.
g) Hawk 100 Trainer development (2) – Nose undercarriage door – trip airflow passing over ground air intake – create partial vacuum which aids door closing.

Future Innovation

The main problems will be cost and development timescales which result in a high development risk being carried by an aircraft developer. This has resulted in an Advanced Technology Demonstrator Centre being established at Warton; the "skunk works". The ATDC has so far developed a Generic Test System; Laser Projector Alignment System to aid aircraft final assembly (for Eurofighter); played a leading role in the cost effective development of the Type 45 Integrated Technology mast; developed "Replica" a very low radar signature vehicle of manned bomber size (radar cross section same as tennis ball) – need for very smooth surfaces, alignment of rivets etc.

ATDC has also developed a number of Affordable Autonomous Systems, i.e. UAVs. Kestrel, the first autonomous jet powered UAV, was developed and tested very successfully in 2002 (weight 140 kg).

Raven first flight 17/12/2003 (100th anniversary Wright Bros. flight) – very low observable vehicle. No fin therefore highly unstable – control laws as complex as for Eurofighter. Flies its own mission profile.

Technology also applied to low cost glider airframe – ISTAR work. HERTI 1A – prop. engine and to be used for maritime patrol/police work (replaces helicopter).

Challenge for future will be maintenance free unmanned combat air vehicles without conventional control surfaces: self repair structure; plasma-fluidic control; intelligent flight control system (neural networks?).

4 April 2006 - A400M Wing and Engine Development by Roger Taplin Airbus UK and Lars Seumenicht, Rolls Royce

Current tactical transports such as the earlier versions of the C-130 Hercules are rapidly reaching the end of their useful lives. This has been reflected with the reduction in their availability at any one time to less than 75% of the overall RAF fleet. Most European air forces face a similar situation.

As a result the European air forces have developed a common requirement for a modern transport aircraft which is both reliable and offers rapid air mobility. The Staff Requirement for this aircraft was issued in 1996 and covers humanitarian operations, air delivery and air-to-air refuelling. The aircraft is required to:

1. Carry a payload weighing up to 35 tons, i.e. between that of the C-130 and the C-17;
2. Carry a payload volume of 4 m (W) x 3.85 m (H) x 23.2 m (L);
3. Have a wingspan which is broadly not greater than that of the C-17 ;
4. Be capable of rapid descents prior to landing and to land and take off from short soft landing strips and without ground support;
5. Conduct airdrops of both paratroops and stores;
6. Conduct low speed, low level tactical missions;
7. Incorporate built-in aerial tanking;
8. Fly at altitudes in excess of 30,000 ft., i.e. in the normal civil air lanes;
9. Have a strategic range sufficient to reach most of the world in a direct flight from Europe;
10. Provide a significant saving in overall lifecycle costs over earlier generations of transport aircraft.

The programme was formally launched in 2003 and the current order book is for 192 aircraft to be supplied to the majority of European air forces together with the air forces of Malaysia and South Africa. The contract is fixed firm price and, as a consequence, the resultant programme is low risk and based on available technology.

The combination of requirements set the aircraft configuration. Requirement (4) above resulted in a configuration using four turbo-prop engines being selected in place of turbo fans because of their higher power output at low speeds, especially at take-off. Their ability to provide the aircraft with a reverse facility allows the aircraft to be turned round on small air strips. In addition the use of turbo-prop engines results in a 20% fuel saving over turbo fans.

A high wing, high tail configuration was also selected provide high lift and hence to maximise the short take-off and landing capabilities. The resultant wing, tail and engine combination also provides minimum flying speed of 130 knots with a reasonable stall margin. The wings have an overall span of 42.4 m and an area of 221.5 m^2. Wind tunnel tests have been used to optimise the design of the engine nacelles in order to minimise vortex induced drag produced on the undersides of the wings.

The design makes full use of modern fly-by-wire technology derived from other recent Airbus aircraft. This is especially important to maintain stability during heavy load air drops at low level.

The power plant is being developed by Europrop International GmbH, a joint venture of a group of European engine manufacturers, including Rolls-Royce, ITP, SNECMA and Ratier Figeac. The power plant characteristics are:

1. 3-shaft engine based on Trent technology;
2. Power output 10,000 shp;
3. Pressure ratio 25:1;
4. 5 stage Intermediate Pressure Compressor;
5. 6 stage High Pressure Compressor;
6. Single stage unshrouded High Pressure Turbine;

7. Single stage shrouded High Pressure Turbine;
8. 3 stage Low Pressure Turbine;
9. Chin Air Intake;
10. Off-set power Gearbox.

In all cases the emphasis was on “available technology” with each member of the power plant joint venture team contributing “what he is best able to offer”.

Ratier Figeac are developing the propellers. Contra-rotating propellers were considered as one method of producing the high power output. They were rejected because of the lack of experience of such technology in the West and because they were unlikely to conform to European regulations governing aircraft noise. The chosen propeller design uses eight “scimitar” blades running at a constant speed. The inboard propellers on each side of the aircraft are driven such that their upsweep is closest to the fuselage. This minimises the amount of noise transmitted to the cockpit. Propeller induced yaw is countered by arranging the two propellers on each wing to rotate in opposite directions. This design results in a requirement for two separate gearbox configurations; clockwise and anti-clockwise.

Fiat Avio is producing the gearbox. The fact that it has to deliver so much power means that it requires a very efficient oil cooling system.

The power plant has the potential for a 10% “throttle push” power enhancement. Potentially a further 20% power may be gained by changes to the engine architecture.

The first engine run was in August 2005 and the first engine and propeller run on 28th February 2006.

The first aircraft flight is scheduled for 2007 with deliveries commencing in 2009. The aircraft will be subject to civil certification with additional qualification to meet the specific military requirements.

Fully sponsored by Midlands Aerospace Alliance