ROYAL AERONAUTICAL SOCIETY
Loughborough Branch

13th June 2017
Group Design Project Presentations
Joint event with Loughborough University
Department of Aero and Auto Engineering

In what is becoming established as a popular element on the branch programme teams of final year MEng Aeronautical Engineering course students gathered to present on a public platform. As in previous years only four teams could be accommodated on the timetable with full presentations, but a fifth team did bring hardware to the pre-session foyer show. (They had to publicly demonstrate their UAV and its systems in a national competition a few days later). A review of their work is included in these notes.

Departmental summaries and illustration of each project are included with comments from the evening in these notes.

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“Nemesis” Autonomous Fighter Aircraft

Nemesis is an autonomous next generation fighter aircraft which has been designed for entry into service by 2060. Since the introduction of aircraft into the theatre of war, controlling airspace in combat zones has been a major priority for all parties. Nemesis is able to achieve this while also reducing the risk to human life

The team raised many questions about the way that an autonomous vehicle could be expected to be cheaper than a manned aircraft and won approval for many examples of clear thinking – a runway-less operation, massively greater manoeuvring-G capability, and much more. There was some concern that with just 4 ASRAAM or 2 AMRAAM missiles it had not been portrayed with a flexible battle capability, but the team won over sceptics with their explanations, and citing innovative rather than repeating well-worn mantras. There was almost no evidence of the team being over-influenced by modern design concepts, they had been ‘blue-sky’ thinkers, but the bill of $839bn for 3,000 aircraft just had to draw a sigh that surely reflected the majority view of modern-day tax-payers.

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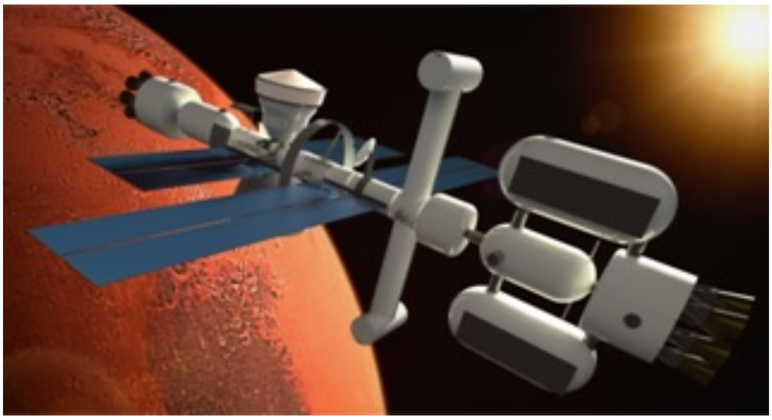
“Casius” Mission to Mars

Casius is a concept for a manned mission to Mars. Many space agencies are planning manned missions in the 2030s, as Mars could be the key stepping stone to further human exploration of the solar system and beyond. The Casius mission will send three astronauts to Mars and return them by 2038, with a total mission time of 912 days, including a 524 day surface mission. Commercial launch vehicles will deliver the total mission mass of 1,054 tonnes to low Earth orbit for assembly. The transit vehicles will depart in 2035 on their 197 day journey to Mars. Descent vehicles will carry the crew and equipment to the Martian surface, where the crew will use a rover to gather surface samples. The crew will launch from the surface to return to their transit vehicle in mid-2037, returning to Earth 174 days later.

This was an almost topical project, with the recent ‘The Martian’ book and film centred on a very similar mission, but nothing fictional in this case and it was a well though-through, and well justified, design concept. The team was able to field questions with a generous amount of hidden



information revealed as they compared their work, very objectively, with existing US-based concepts. There were questions on safety that relied on acceptance of safety through redundancy that were difficult to enumerate in the forum, but that is not to be critical: the benchmarks were there, and the solutions were questionable – and will remain so until such time as such a scheme is genuinely tested. It was a taster of what modern-day students might be involved with in the next couple of decades.

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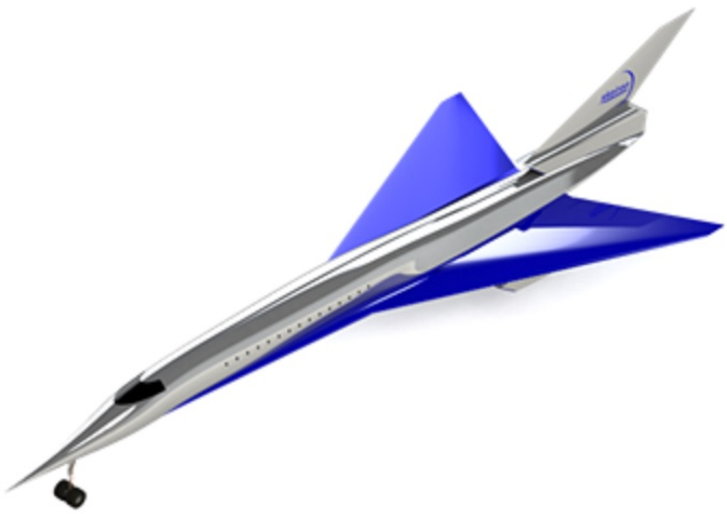
"Skeiron" Supersonic Trans-Pacific Airliner

Skeiron is a supersonic civil air transport aircraft capable of carrying 60 passengers across the Pacific. Current civil airliners can fly from Los Angeles to Hong Kong in 16 hours—Skeiron can do it in just 5 hours. Cruising at Mach 2.5 for up to 6,000 nmi makes this aircraft the longest range supersonic aircraft ever. New and existing technology is used all across the aircraft, including bespoke variable cycle engines, over 50% composite structure and an augmented reality system to aid pilot vision. Skeiron is bringing supersonic travel back to the public.

The Aeronautical and Automotive Engineering department at Loughborough has routinely conducted a joint design project with the Kevin T Crofton Department of Aerospace and Ocean Engineering at Virginia Polytechnic Institute and State University in the USA, and this year chose to address the desire to revive SST operations. With current generation long-range airliners already conducting flights of up to 18 hours duration (largely cross-Pacific) the possibility of reducing the flight-time by 2/3rds was a tempting objective. The team acknowledged the fine balancing act that SST design requires in terms of reserving mass for an economic payload and the necessary fuel load within an airframe capable of accommodating all the essentials, as well as being an uncomplicated and viable aircraft. They addressed compatibility with infrastructure and the innovation technologies they could foresee, and the list was considerable: included innovations were a variable-cycle engine, a cruising speed of Mach 2.5 cruise, and the specification of a synthetic vision system (that alleviated the need for a droop nose). Commercial attributes were outlined too, and operations were planned around a 6hr operation that would allow an out and back cycle daily: an objective that would ensure utilisation was adequate to meet the seat-cost targets.



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“Pegasus” Military Flying Car

Pegasus aims to save lives on ground-based forward patrol missions. In current operations, improvised explosive devices (IEDs) or other unforeseen obstacles can cause patrols to halt making all crew vulnerable to attack. Pegasus can use flight to quickly overcome this. The vehicle has two very unique features: The first is a co-axial rotor system used to provide lift which is retracted behind the vehicle to reduce the packaging dimensions during ground operations. The second is the cockpit controls which are designed in line with ground vehicles which reduces both the training time and training cost.

This project incorporated a very fresh view-point, essentially saying that compound-wing aircraft such as the V-22 Osprey are aircraft supporting ground troops, and they wanted a more Army-compatible, and much cheaper, solution. The requirements they promoted called for a ground vehicle that could integrate at bases and on roads, but that might fly short periods to save time, and avoid places where an improvised explosive device (IED) was suspected. Their design was distinctly conceptual, but they had taken a look at preliminary design stage issues, including disposition of engines and fuel, crew control and display requirements, and the attainment of speeds of 20kts on the ground and 90kts in the air. Debate in this project commented on the difficulties and probed in areas that were explained in ways that left no doubt that difficulties had been addressed faithfully, and the solutions found were never easy to promise as being fully supportive of desired outcomes.

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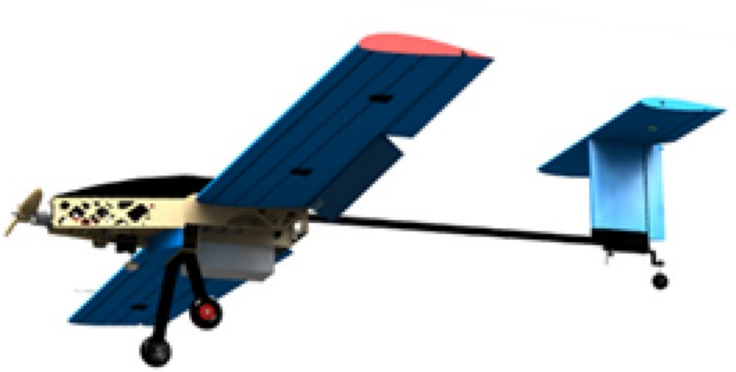
“Atlas” Unmanned Aircraft System
(Poster and aircraft only)

Project “Atlas” is Loughborough University’s entry to the IMechE UAS Challenge 2017. The system has been developed to complete a representative humanitarian aid mission, and will be assessed on Payload Delivery, Reconnaissance and Endurance. The aircraft operates with complete autonomy, performing take-off, target identification and landing without any operator input. Key features of the design include its topologically optimised fuselage, T-tail configuration for maximum aerodynamic efficiency, use of the latest generation of the Pixhawk flight controller and high-speed ground-based optical character recognition (OCR). With an MTOM of 6.9 kg, the aircraft can deploy two 1 kg bags of flour to any target within a 10 km range. Flight testing has begun and the aircraft has already successfully completed an autonomous mission in preparation for the competition in mid-June. An extensive test programme has been developed to ensure the system performs to the maximum of its ability during the competition.

This team has taken on the mantle of last-year’s successful entry by the University in the IMechE UAS challenge, which this year has presented newer and more complex tasks to test the systems as well as the airframe presented by participating teams. The aircraft is illustrated here, and it was exhibited in the pre-presentation part of the evening. They have been hampered by limited access to workshops throughout recent months, due to issues beyond team and supervisor control, and that impediment, plus the imminence of the competition trials just 5 days after our meeting, exonerated the team from providing a formal presentation.

On 22 June the IMechE published a winner in each category in which teams were assessed, these are the full results:

Design	– Bath University
Innovation	– Bath University
Most Viable Business Proposition	– University of Dundee
Safety and Airworthiness	– Huddersfield University
Autonomous/Automatic Operations	**– Loughborough University** ☺️
Manufacturing	– Istanbul Technical University
Navigation Authority	– Southampton (Valkyrie)
Environmentally friendly	– Queens University Belfast
Most Promise	– University of the West of England
Endurance	**– Loughborough University** ☺️
Payload Delivery	- Southampton (Olympus)



The final results of the competition saw Bath University crowned as overall grand champions, and whilst not winning the most prestigious award Loughborough's Atlas team clearly were amongst the most capable of the entrants, and can be congratulated on an excellent result. We have been informed that they completed both flights conducted within the autonomy/automatic operations category with 100% autonomy.

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Once again, the Branch membership attendance was broad in its perspectives and expressed comments, in the Q&A session and in passing, which left no doubt that scepticism was balanced with a sense of pride. It was refreshing to see daring requirements that would not be amiss in the most advanced enterprises put under scrutiny by students whose skills as presenters as well as designers were evident and enviable on the night.

It is pleasure to take this opportunity to thank the students, and to wish them well for the future. We have to thank too Chris Harvey, Gary Page and James Knowles who oversaw the students' projects throughout the year and rounded them up on the night, and John Newton who coordinated the presentation arrangements.

Presentation notes © Mike Hirst