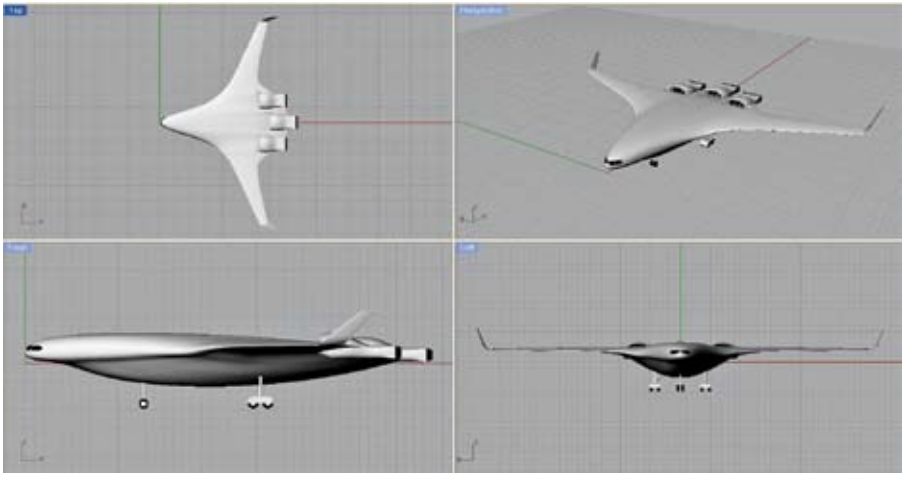
Technology update

Beyond 2030: the Silent Aircraft Initiative

Following the formal completion of the **Cambridge University-MIT** Silent Aircraft Initiative (SAI), elements of the research are being continued by some members of the teams involved. The concept design created as a result of the SAI incorporates its findings and requirements for a generation-after-next airliner in service beyond 2030 to meet emerging environmental requirements—with low noise as its main *raison d'être*.

The SAI projected aircraft is a blended-wing-body (BWB) design. Originally conceived for its major noise-reducing capability, the aircraft concept is also claimed by the Cambridge-MIT team to offer a potential 25% reduction in fuel burn on a "typical flight."

The BWB approach provides for added lift and slower approach speeds than that of today's large airliners. It has no slats or flaps, a simplified undercarriage design with emphasis on improved aerodynamics, and three top-rear mounted engines. The engines are ultra-high bypass but with variable nozzles to reduce noise at takeoff and in the climb, opening widely for the cruise. The project's supporters include **Boeing** and **Rolls-Royce**.



The concept design for the Cambridge-MIT Silent Aircraft Initiative is based on a blended-wing configuration that would emit noise nearly imperceptible outside the perimeter of an urban airport.

An airliner for 2030? The Cambridge-MIT Institute's concept for the SAI features an "all-lifting" design, producing lift on the center body as well as the wings.

"A radical approach to the challenges of the future comes more naturally from academia than industry, but the outcome will carry credibility only if the team is sufficiently strong and if it has the support of industry and access to modern design methods," said John Green, Chairman of the Science and Technology subgroup of the **Greener by Design** organization.

The researchers formed a Knowledge Integration Community (KIC) which included staff and students from Cambridge and MIT, together with participants from other companies and organizations involved in the SAI.

According to Colin Smith, Director of Engineering at Rolls-Royce, "The study has confirmed that the solution for extremely low noise must be a highly integrated combination of engine and aircraft design and operation."

Ann Dowling, leader of the UK research team, said, "This project has brought industry, academia, and other stakeholders together around a 'grand challenge' that has captured the enthusiasm and imagination of all partners."

True collaboration and teaming occurred in essentially all aspects of the project, according to Ed Greitzer, Dowling's peer at MIT. "The SAI has been very much an enterprise in which the whole is greater than the sum of the separate parts," he said.

Boeing Vice President of Engineering and Manufacturing, Jim Morris, has stated that some noise mitigation ideas from the project would be studied for future use.

Other companies and organizations collaborating in the project included **British Airways**, **BAA**, **Brüel & Kjaer**, **CAA**, **Cranfield University**, **DHL**, **easyJet**, **Eurocontrol**, **HACAN Clearskies**, **Lochard**, London Luton Airport, **Marshall of Cambridge Aerospace**, **National Air Traffic Services**, and the **Royal Aeronautical Society**.

Stuart Birch

UAVs help decentralize data

A further advance in UAV capability is the application of Decentralized Data Fusion (DDF). **BAE Systems** has announced that it has successfully networked ground and surveillance radars with UAVs, fusing the information from dispersed ground and airborne sensors into a single image of the battlespace visible across numerous systems in real time. The company believes that it is a "first" in the development of UAV technology.

It has demonstrated the capability of the system via trials at Puckapunyal, Victoria, Australia. "We effectively networked eight separate pieces of equipment," said Brad Yelland, Integrated Autonomous Systems Manager with BAE Systems Australia. "Two UAVs operating autonomously; a ground surveillance radar; a weapons-location radar, which detected live artillery firing at fixed and mobile targets; two soldiers in the field with electronic binoculars and palm-top computers; and two soldiers moving through the battlefield in 4x4 vehicles."

When weapons-location radar detected artillery firing, the information was immediately available to the UAV, which then flew to investigate. If the UAV flew over a fresh sensor, it would bring it into the network to create a new picture of the battlespace and would also share that information with the rest of the network regardless of location.

Traditionally, data fusion has been centralized, with all information coming together at a central point before being disseminated, explained Yelland.

"If you attack that central point you can effectively bring down and jam the whole system," he said. "With DDF there is no single point of failure because the fusion takes place at every point in the network; take out one, and all the other elements continue to function and share information."

BAE Systems has networked ground and surveillance radars with UAVs, demonstrating its Decentralized Data Fusion capability, in which there is no single point of failure in a network.

Stuart Birch

RCV goes backpacking

RCV Engines has produced a demonstrator power unit for **Honeywell**'s MAV (micro air vehicle) that is currently scheduled for flight test in the U.S. RCV's patented rotating cylinder valve technology contributes toward a high power-to-weight ratio and has multi-fuel capability.

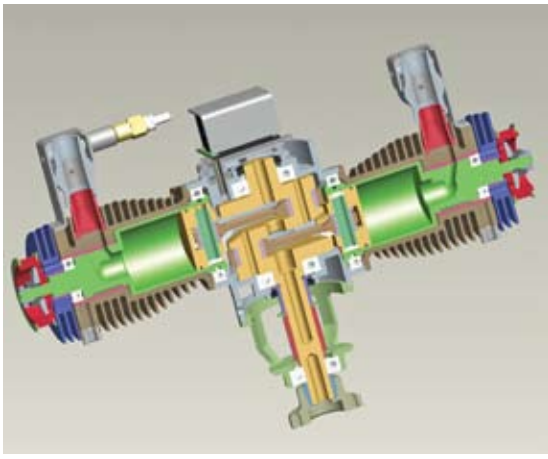
The unmanned, autonomous surveillance MAV has been developed as part of **DARPA**'s MAV Advanced Concept Technology Demonstrator program.

Honeywell's MAV, sufficiently small to be carried as a backpack, has been designed to provide ground troops with improved situational awareness capability. The MAV has horizontal forward and vertical scanning video cameras, able to relay information to a remote ground station terminal.

RCV's engine has a nominal capacity of 60 cm^3 with a target output of 4.2 hp at 8200 rpm using JP8 fuel. It has been designed to run efficiently on heavy fuels, typically generating the same power as with gasoline, thanks to its compact combustion chamber, high internal turbulence levels generated by a large swirl area, sharp valve edges, and rotating cylinder. According to Eric Hill, Managing Director of RCV Engines, rotating cylinder valve technology provides some unique benefits for UAVs "in terms of performance, efficiency, high power-to-weight ratio, and multi-fuel tolerance."

It is 10 years since RCV was formed to develop its technology, which also has claimed emissions and specific fuel consumption benefits over conventional two- and four-stroke engines and is particularly suitable for small vehicle/equipment applications. The company also builds model aircraft engines with capacities of 9.5 to 20 cm^3.

Honeywell selected RCV to produce a demonstrator engine for its backpack-size MAV designed to improve situational awareness to ground troops.



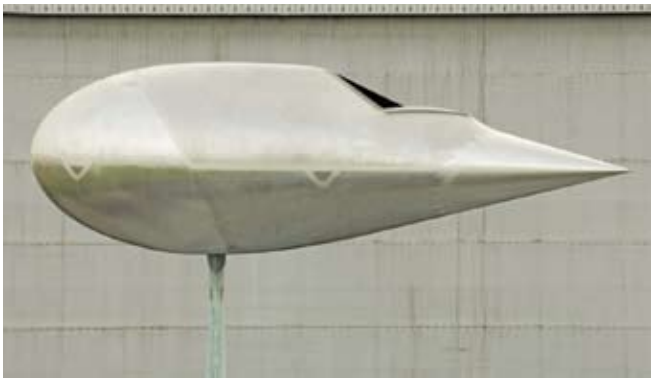
Cutaway of RCV's 60-cm^3 demonstrator engine for MAV applications. It takes advantage of rotating cylinder valves for a high power-to-weight ratio.

Stuart Birch

Shaping a new generation of aircraft

A major joint program to enhance design and manufacturing efficiency and capability for a new generation of aircraft has been completed by **BAE Systems** and the **UK Ministry of Defence** (MOD). Stretching over six years in two phases, the knowledge and data accrued during the previously classified Nightjar program are to be applied to the Taranis stealthy UAV technology demonstrator program (*Aerospace Engineering*, March 2007), for which BAE Systems is the industry lead and prime contractor.

Central to the Nightjar program was a special test body that was used to test a variety of features regarded as potentially crucial for the future of air vehicle design. Having a very low radar signature, the test body could be used for testing these features but without the body itself being part of the results.



The Nightjar test body has been central to BAE Systems' research into future air vehicle design.

The Taranis stealthy UAV technology demonstrator will benefit from the knowledge gained during the previously classified Nightjar program.

BAE Systems said in a statement that Nightjar had provided "valuable data" on issues surrounding design, aerodynamics, manufacturing, and in-service performance. Mounted on the radar cross-section measurement facility at its Warton site, the Nightjar test body was subjected to a range of tests that provided vital data on air induction systems (intake and ducts) performance. The team carried out a series of wind-tunnel tests in parallel on the same designs to assess performance and add to the overall project understanding.

Mark Kane, Managing Director, BAE Systems' Autonomous Systems and Future Capability, said the company had used its rapid prototyping and engineering expertise to deliver "value-for-money results." He added that "equally important was having the customer (MOD) and its technology advisors as an integral part of the Nightjar team. A build up of trust during the program resulted in a simplified MOD decision-making process and noticeable improvement in our ability to respond to their enquiries."

Part of the UK Government's Strategic Unmanned Air Vehicle (Experimental) Program, or SUAVE, the Taranis project will demonstrate emerging technologies and systems. Taranis will be about the size of a BAE Systems Hawk (**U.S. Navy** designation, Goshawk).

Stuart Birch

Hail CESAR

The Cost Effective Small Aircraft (CESAR) project, involving 35 commercial and academic organizations within the European Union (EU), is aimed at the development of less costly, lighter, and "greener" small passenger aircraft. Contributing to this is a team from the **University of Manchester**'s Power Conversion Group within the School of Electrical and Electronic Engineering, which is to investigate how current mechanical and hydraulic systems on business jets and small, short-haul airplanes could be improved by introducing more advanced electrical engineering.

All aspects of aircraft design and development are to be looked at during the EU-funded project. The aim is to produce a new concept for small aircraft having a capacity of between 10 and 50 seats, with lower development, operating, and maintenance costs than comparative aircraft today, and with reduced negative environmental effects.

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The University of Manchester's Nigel Schofield and his research team will focus on developing electrical systems to operate the landing gear, rudder, and flaps. The aim is to reduce both cost and weight to achieve lower fuel burn and subsequently reduced CO_2 emissions. It is believed that reduced mass and improvements in energy efficiency achieved by the introduction of electromechanical and electrohydraulic systems will lower the cost of aircraft manufacture and operation. Replacing mechanical and hydraulic systems with electric systems could also allow a small aircraft to carry more passengers and subsequently reduce the footprint of each traveler.

"Demand for smaller commercial aircraft is likely to increase in coming years," said Nigel Schofield of the University of Manchester.

Despite the emergence of the twin-deck **Airbus** A380, Schofield believes that "with the increasing popularity of air travel, the demand for smaller commercial aircraft is likely to increase in coming years. The view is that short-haul flights within Europe will become more extensive as the east European countries expand their trade with the west. This is an exciting project involving many partners—particularly from Eastern Europe—that could lead to cheaper, smarter, and more environmentally friendly aircraft taking to the skies."

Stuart Birch

Edgewater bus technology flies straight

Edgewater Computer Systems found success for its Extended 1553 (E1553) data bus technology in a December flight demonstration using a **U.S. Navy** A-3 jet aircraft operated by **Raytheon** at the latter's flight test operations center in Van Nuys, CA.

Also known as Mil-Std 1553B Notice 5, the technology previously has been demonstrated in a number of developmental and simulation environments including the C-130, F-16, and F-18.

For the flight test with the A-3, E1553 was coupled onto the internal 1553 navigation bus of the aircraft, which also hosted other legacy 1553 line replaceable units communicating concurrently on the same bus. Raytheon verified that no bus errors were reported on the legacy 1553 equipment during the flight.

Edgewater's EHS-SC601 compact PCI module allows customers to add high-speed 1553 bus connectivity into existing and future military and aerospace embedded computing systems. The EHS-SC601 offers MIL-STD 1553B Notice 5 compatibility in a single 6U compact PCI card format using Edgewater's Extended 1553 technology.

"Raytheon and Edgewater have made a significant statement to naval aviation by demonstrating this capability in such a rapid plug-and-play manner," said Gerard Walles, Director, Open Architecture AIR-4.5 and F/A 18 S&T Group Leader, PMA-265, NAVAIR. "This milestone provides confidence to government and industry, and further supports the government-led activity known as Naval Aviation's 1553N5-TWG (Transition Working Group), which is bringing together industry to collaborate, share experiences, reduce risk, and accelerate deployment of this enabling technology. Adding high-capacity networking across the existing 1553 bus without changing the legacy software or disrupting the legacy communications has tremendous implications vis-à-vis an open-architecture approach for cost-effective, robust networking, and promotes key interfaces that enable substantial increases in capability with minimal impact to the war fighter."

Edgewater reports that rate monitor maintained a consistent connection of greater than 100 Mbps throughout the flight. To use the available capacity of the E1553 network, the company ran live streaming video along with bidirectional, bulk-data transfers to maximize the network capacity of the bus while maintaining a 10E-12 bit error ratio.

Limited to about 100 Mbps due to field-programmable gate array performance restrictions, current-generation E1553 technology performed as expected, according to Edgewater. When released later this year, the company's application-specific integrated circuit solution will be capable of supporting substantially higher throughput.

"This technology delivers a cost-effective approach to incremental aircraft network upgrades while eliminating the proliferation of multiple disconnected networking interfaces," said Duane Anderson, President of Edgewater. "Furthermore, changes to existing operational flight programs are minimized, substantially reducing costly software development and verification cycles associated with the addition of new networks within the platform."

Patrick Ponticel

HMI in the cockpit

Almost every aspect of communication in the air is an essential element of flight safety. Human machine interface (HMI) is the most crucial, and an important element of it involves the autopilot.

On rare occasions, errors may be made in the cockpit due to inefficient collaboration between the autopilot and pilot. Usually, this would result in momentary confusion quickly resolved, but the potential for an accident may be present. Now, Peter Johnson and Rachid Hourizi at the **University of Bath** in the UK have designed and evaluated a prototype pilot-flight computer interface aimed at improving cockpit interaction. With funding from the UK Engineering and Physical Research Council, Johnson and Hourizi have tested their theory that misunderstandings between autopilot and pilot are, in part, a result of restricted interaction and low-level communication style of the autopilot rather than human error by the pilot.

Johnson explained that in the current generation of computerized cockpits, the autopilot informs the pilot what current action is being taken, such as the height at which the aircraft is cruising.

"The more explicit details—what action is going to be taken next, and the objective of a particular maneuver—are calculated by the pilot," he said. The prototype flight computer's software interface provides this activity and intentional information directly, *i.e.*, tells the pilot in real time, which activity is being undertaken and the objective that lies behind it.

"This makes the interaction between pilot and autopilot more explicit, so reducing the chances of mistakes being made," said Johnson, adding that it also freed up more time for the pilot to monitor situations, including the aircraft's track.

"The interface is based on the communication procedures used in a number of safety-critical domains, from fire fighting to military operations, where the current situation, action to be taken, and objectives are explicitly stated," said Hourizi. "Our new system brings the interaction between the autopilot and pilot onto a more robust level."

Following presentations of the system to aerospace companies, further work is under way. Johnson and Hourizi believe their research could lead to production applications within a decade.

Stuart Birch