Technology update

Alternative fuels and improved logistics in Airbus' future

The need to develop alternative fuels for all transport systems is becoming increasingly important, and **Airbus** is taking part in the French CALIN (Carburant alternatifs et systèmes d'injection innovants) research project. Launched in July this year, it is scheduled to continue for another 20 months. Airbus is working within CALIN together with major research institutions, among them **ONERA**, **IFP**, **CNRS**, and industry partner **Safran**.

Airbus is aiming to improve manufacturing efficiency with major changes to its logistics system and a greater involvement of suppliers in managing inventories.

Airbus stated that as part of the company's commitment to reduce the impact of aviation on the environment it is now focusing its Research & Technology effort on developing "green" aviation technologies aimed at contributing to further improving aircraft fuel efficiency, reducing CO_2 and NOx emissions, and cutting noise. Finding suitable alternative fuels to kerosene is one area of research Airbus is focusing on, and it expects that promising kerosene and biofuel blends will be identified by 2010.

The CALIN research work aims to identify and evaluate a number of alternatives to kerosene for the short, medium, and long term and is looking at what kind of fuel could be both suitable and available, and what modifications would be required to the engine, aircraft fuel systems, and aircraft configuration. In the coming months, Airbus plans to extend this research program with European and worldwide research and industry partners.

For CALIN to achieve a meaningful success, it is necessary to concentrate on achieving an integrated technology input. In addition to its research into alternative fuels, Airbus is working with fuel producers, engine manufacturers, airlines, and airport authorities to develop a standard approval process for alternative fuels. This effort will resolve the issues of qualification, certification, and the potential introduction of alternative fuels at an industry and worldwide level. This work is being carried out within the U.S. Commercial Aviation Alternative Fuel Initiative (CAAFI) as well as with the IATA Alternative Fuel Project that was initiated in 2006.

The reduction of overall aircraft mass is a central requirement in this integrated effort, and since the double-decker A380 program was launched in December 2000, Airbus has filed more than 380 patent applications for technologies, including several that have contributed to weight reduction. The use of carbon fiber reinforced plastic (CFRP) for the large primary structures of the A380 is a very significant weight saver, and Airbus has patented a new joining process for producing the world's first carbon fiber composite center wing-box for commercial aircraft. About 25% of the A380 structure uses composites. Airbus quotes a figure of 15 t as the weight savings CFRP has provided, regarding it as a highly meaningful contributor to reduced fuel burn.

Its patented technologies represented "significant breakthrough innovations," according to Airbus. As well as lightweight materials, they apply to aerodynamics, cabin design, engine integration, flight controls, aircraft systems, and manufacturing techniques. The Zero Splice Inlet integrated into the engines' nacelles is a single 360° piece that obviates the need for separate spliced panels, bringing benefits in reduced noise levels.

Airbus' filed patents also cover the A380's avionics data communication network, which it says supports the increasing inter-system communication needs with the benefit of further improving data integrity and transmission speed. "Brake-to-Vacate" is another novel technology that optimizes the amount of energy used for braking and reduces runway occupancy time, with the added bonus of providing improved passenger comfort during runway landing-run deceleration.

Patent applications also cover the electrical back-up hydraulic actuator, which is part of the A380's new two-energy, four-channel flight controls architecture. The architecture increases the performance and reliability of the flight control system due to its energy source (electrical and hydraulic) and reduces weight by suppressing one hydraulic circuit.

With work moving ahead on alternative fuels for greater environmental efficiency, and with its patented technologies bringing a wide range of benefits,

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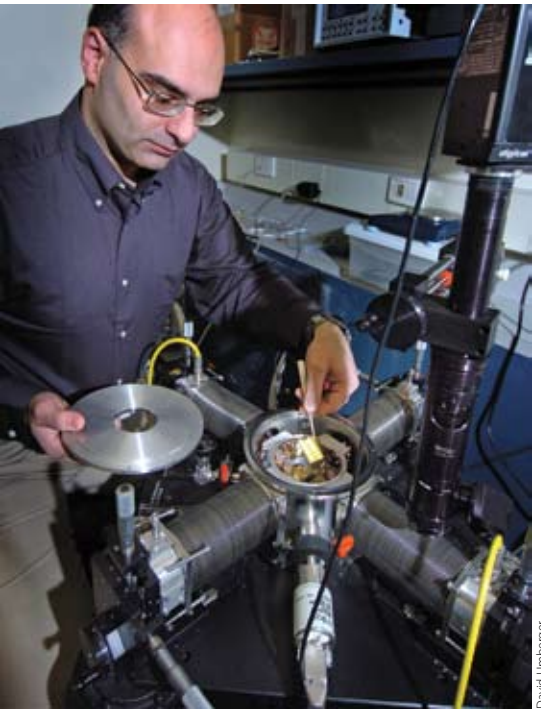
Airbus is also working with suppliers to improve its logistics system. It is introducing best practices applied within the automotive industry, and simplifying current processes in key areas of the logistics chain, including logistics centers, transport, and inventory to achieve enhanced leanness and greater cost efficiency. At present there are some 80 logistics centers at Airbus; the company wants to see this drastically reduced to less than eight. The changes are likely to take more than two years to achieve and will see a rationalization of inbound flows of parts and components, which it describes as being currently "a complex and fragmented process."

The aim is to have a single transport system for all incoming flows. Some management of inventory will be transferred to Airbus suppliers who will have a real-time view of Airbus' stock via the company's eSupplyChain system to achieve a just-in-time manufacturing system. A vendor-managed inventory system is to be introduced that will see suppliers conforming to a minimum or maximum inventory level that they will manage.

Stuart Birch

MEMS is the word for jet engines

Researchers at **Purdue University** have developed microelectromechanical systems (MEMS) that can survive the harsh conditions inside jet engines to detect impending temperature-induced bearing failure significantly earlier than conventional sensors. The new sensors directly monitor the temperature of engine bearings, whereas conventional sensors work indirectly by monitoring the temperature of engine oil, yielding



David Umberger

Dimitrios Peroulis holds a MEMS sensor at an "environmentally controlled probe station," which re-creates extreme conditions inside engines, enabling researchers to test the sensors. The wireless sensors are being developed to detect impending bearing failure in jet engines.

less specific data. Advance warning is critical so that an engine can be shut down before it fails.

MEMS combine electronic and mechanical components on a microscopic scale. "The MEMS technology is critical because it needs to be small enough that it doesn't interfere with the performance of the bearing itself," said Farshid Sadeghi, Professor of Mechanical Engineering at Purdue. "And the other issue is that it needs to be able to withstand extreme heat." Engine bearings must work reliably in environments that can reach 300°C.

Researchers say the sensors "could be in use in a few years" in military aircraft such as fighter jets and helicopters. The technology also has potential applications in commercial aircraft, cars, and other ground vehicles.

"Anything that has an engine could benefit through MEMS sensors by keeping track of vital bearings," said Dimitrios Peroulis, Assistant Professor of Electrical and Computer Engineering. "This is going to be the first time that a MEMS component will be made to work in such a harsh environment. It has high temperatures, it is messy, oil is everywhere, and you have high rotational speeds, which subject hardware to extreme stresses."

The work is an extension of Sadeghi's previous research aimed at developing electronic sensors to measure the temperature inside critical bearings in communications satellites.

"This is a major issue for aerospace applications, including bearings in satellite attitude control wheels to keep the satellites in position," said Sadeghi. The wheels are supported by two bearings. If mission controllers knew the bearings were going bad on a specific unit, they could turn it off and switch to a backup.

"What happens, however, is that you don't get any indication of a bearing's imminent failure, and all of a sudden the gyro stops, causing the satellite to shoot out of orbit," Sadeghi said. "It can take a lot of effort and fuel to try to bring it back to the proper orbit, and many times these efforts fail."

The MEMS devices will transmit temperature data wirelessly, eliminating the need for batteries, which do not perform well in high temperatures. Power will be provided using inductive coupling, which uses coils of wire to generate current.

"The major innovation will be the miniaturization and design of the MEMS device, allowing us to install it without disturbing the bearing itself," said Peroulis. He added that data from the onboard devices will not only indicate whether a bearing is about to fail but also how long it is likely to last before it fails.

The research is based at the Birck Nanotechnology Center in Purdue's Discovery Park and at Sadeghi's mechanical engineering laboratory.

Jean L. Broge

Endurance is a breeze for QinetiQ

QinetiQ's Zephyr HALE (high-altitude, long-endurance) UAV was airborne for 54 hours during trials at the White Sands Missile Range in New Mexico. The flight trials were funded via a **UK Ministry of Defence** research program.

In a statement announcing the achievement, QinetiQ said: "The duration of the flight exceeded the current official FAI world record for unmanned flight, which stands at 30 hours 24 minutes set by **Northrop Grumman**'s RQ-4A Global Hawk on March 22, 2001. However, because there was no FAI official present at White Sands, it may not stand as an official world record."

Launched by hand, Zephyr is an ultra-lightweight, carbon-fiber aircraft with a wingspan of up to 18 m and a mass of about 30 kg. For diurnal operation it flies on solar power that is generated by amorphous silicon arrays, "no thicker than sheets of paper," that cover the aircraft's wings. By night it is powered by rechargeable lithium-sulfur batteries that are recharged during the day using solar power.

QinetiQ says the trials validated recent modifications that have improved the efficiency of Zephyr's power system, including new solar arrays supplied by **United Solar Ovonic**, a full flight-set of **Sion Power** batteries, and what QinetiQ described as a novel solar-charger and bespoke autopilot that it has developed. All were flown for the first time.

During the trials, the same aircraft was flown twice while carrying a surveillance payload—first for 54 hours to a maximum altitude of 58,355 ft, and then for 33 hours 43 minutes to a maximum altitude of 52,247 ft. Both flights were reported to have been achieved in the face of thunderstorms and debilitating heat in the hostile environment of the high desert.

QinetiQ has listed potential applications for Zephyr as including Earth observation and communications relay in support of a range of defense, security, and civil requirements.

Zephyr has demonstrated consistent progress during a series of flight trials at White Sands Missile Range. In December 2005, two aircraft achieved a maximum duration of six hours and an altitude in excess of 26,000 ft. The maximum flight duration was trebled to 18 hours and the maximum altitude increased to 36,000 ft at subsequent trials at the Missile Range in July 2006.

Stuart Birch

QinetiQ's Zephyr remained airborne for more than two days this past summer, proving that an autonomous UAV can be operated on solar-electric power for the duration required to support persistent military operations.

Pratt & Whitney opens facility for gear-system testing

Pratt & Whitney recently began performance testing the fan drive gear system of the next-generation geared turbofan (GTF) engine at the company's new $12 million test facility in Middletown, CT.

Tests are being conducted to validate the efficiency targets and durability of the gear system. Critical testing of the gear-system design will continue through February 2009.

Testing of the geared turbofan engine's fan drive gear system is under way at Pratt & Whitney's new $12 million facility in Middletown, CT. The gear system design will undergo critical testing through February 2009.

The fan drive gear system allows the fan to operate independent of the low-pressure compressor and turbine, resulting in greater fuel efficiency and a slower fan speed for less noise.

The dedicated gear-system test facility houses equipment capable of simulating in-flight conditions and operational characteristics. The gear-system test rig can handle loads up to 60,000 shaft hp and simulate flight altitudes of up to 45,000 ft. Operational loads that exceed the performance limits of the gear system also can be created to validate durability.

"Initial testing of the fan drive gear system has gone flawlessly," said Bob Saia, Vice President, Next Generation Product Family, Pratt & Whitney. "The fan drive gear system is what enables the geared turbofan engine to operate at optimum efficiency, delivering the environmental and economical benefits of this technology."

Pratt & Whitney states that the 30,000-lb-thrust GTF engine will deliver a fuel consumption reduction of more than 12% and a maintenance cost reduction of 40% while producing half the emissions of current-generation jet engines.

"The geared turbofan engine is a true game-changer, offering the environmental and performance benefits

airline customers are looking for," said Todd Kallman, President, Pratt & Whitney Commercial Engines. "We are making significant investments to demonstrate that the engine technology is ready for a program launch in 2008."

The engine will undergo full-scale testing late this year, and flight testing on Pratt & Whitney's flying testbed is slated for 2008. The engine is expected to be ready for service in 2012.

Other key technologies of the GTF engine have been tested over the past two years, including a scaled fan rig test in 2006. The high-pressure compressor is currently being tested as part of an agreement with **MTU Aero Engines** in Germany.

Matt Monaghan

Boeing test-drives a Ford

Boeing used a **Ford**-developed hydrogen engine to test the technical readiness of the hydrogen propulsion system for its HALE (high-altitude, long-endurance) UAV.

Artist's rendering of Boeing's HALE UAV, which recently underwent a simulated flight to test the capabilities of Ford's proprietary engine technology.

During the test, the engine ran for nearly four days in a controlled chamber at **Aurora Flight Sciences** in Manassas, VA, including a total of three days that simulated conditions at 65,000 ft. The propulsion system included a multistage turbocharged internal-combustion engine and its associated subsystems. The four-cylinder Ford engine earned better than expected fuel economy while demonstrating complete airflow and torque control across the engine's operating range. The gasoline version of the engine can be found in the Ford Fusion and Escape Hybrid vehicles.

Boeing's HALE aircraft is designed to economically maintain persistent presence over a specific ground location from stratospheric altitudes, providing increased potential for surveillance and communications applications. The test marked a key step toward proving that the essential technical elements are in place for full-scale development.

"This test could help convince potential customers that hydrogen-powered aircraft are viable in the near term," said Boeing Advanced Systems President George Muellner.

Boeing, as HALE's system designer and integrator, is working closely with Aurora Flight Sciences and Ford to develop the aircraft's propulsion system.

HALE is designed to stay aloft for more than seven days and carry payloads up to 2000 lb. Potential applications include battlefield persistent intelligence, surveillance, and reconnaissance; border observation; port security; and telecommunications. The long-endurance autonomous aircraft will be a propeller-driven, lightweight structure with a high-aspect-ratio wing.

Jean L. Broge

Electronic-warfare testers ensure aircraft evade missiles

Until the time that the military services can begin fielding standardized electronics system testers—prototypes of just such a system are now being tested by the **U.S. Army**, **Navy**, and **Marine Corps**—they are forced to continue adding to their stock of test hardware. In the latest deal, **EDO** was awarded a $44 million firm-fixed-price contract for AN/PLM-4 radar-signal simulators used to test the electronic defenses of military aircraft.

The indefinite delivery/indefinite quantity contract enables the **U.S. Air Force** to purchase approximately 491 AN/PLM-4 systems over the next five years. Initial funding has been provided for 279 units valued at $22 million.

Designed to test electronic-warfare capabilities, EDO's system simulates RF signals generated by anti-aircraft weapons.

The AN/PLM-4 radar-signal simulator generates RF signals, such as those used by anti-aircraft weapons. By simulating these signals, the aircraft's defensive electronics can be tested on the flight line before takeoff. The AN/PLM-4 allows flight-line testing of electronic warfare systems on a variety of USAF aircraft.

In addition to the flight-line version, the radar-signal simulator is available in configurations for laboratory, shipboard, and vehicle testing.

Barry Rosenberg

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