

# Technology update

## Sizing up the A380's wings

Manufacturing the A380, now undergoing its flight test program, has seen Airbus and its suppliers having to tackle many difficult and complex challenges. Some of them have centered on the size of components, including the machining of 35-m long aluminum alloy billets for the aircraft's wing skin panels.

Airbus UK, with factories at Filton and Broughton, is responsible for the design and build of all Airbus wings. For the manufacture of the A380's wing, the company needed two new, high-speed milling machines for 18 of the 20 upper and lower wing skin panels of the aircraft. Handling such huge lengths of material is not easy, and the company found few machine tool companies capable of building equipment sufficiently large to carry out the task.

But Canadian company **Machine-Outils Henri Liné** was able to develop outsize skin milling machines to meet the needs of Airbus for the A380. "We believe machines of such advanced design to be the only ones installed anywhere in Europe," said Mike Brown, Managing Director of **M-TECH**, Henri Liné's UK agent. "Achieving the final specification involved highly detailed consultation with the A380 team at Airbus' Broughton facility regarding productivity, accuracy, process assessment, and longevity of the machines," which are gantry-type high-speed milling machines with twin heads for the concurrent machining of pairs of wing skin panels.

Brown explained that a major innovation is the application of "carpet milling." "The machine bed is at floor level, which provides ease of use and added safety," he said. "Each head comprises three axes of movement. Upgrade to five-axis milling is easily achieved to meet any future component design changes." The aircraft and its variants could be in production for at least 20 years, and refurbishment of the milling machines is not planned for 10 years.

One special feature of the machines is the location of its operator in a cabin



Checking a billet on the bed of the A380 wing skin milling machine at Airbus UK.

remote from the gantry. "Closed-circuit TV ensures that the operator has a clear view of the machining action, and the air-conditioned, soundproof cabin offers a level of comfort and safety not normally associated with such machines," said Brown.

Starting with 25- to 35-mm thickness billets of aluminum alloy (2000-series for bottom skins and 7000-series for top skins), the machines takes some 100 h to mill a pair of skin panels, reducing about 85% of the material volume. When roughing out, a 75- x 5-mm router tool is used, turning at 12,000 rpm, with a feed rate of 7 m/min while using the full capability of the 85-kW spindle. Most skin panels have little machining on the outside face, but the inside face of the A380's panels incorporates machined features including stringer ramps, facets, and strip surfaces. The extreme outboard skin panels demand particular accuracy as they also have the ribs machined as integral features.

Production demands for the A380 already dictate that the two machines operate 24/7 on a two-shift pattern. However, to get to this stage took a three-year project to specify the machines; get approval for the design; and have them built, installed, and commissioned.

While the number of potential machine tool suppliers was limited by the special nature of the machines, so too was the number of suppliers of control gear. To help decide on the best package, the production engineers at Airbus created a comprehensive decision matrix. Each prospective supplier was scored against various factors, and then the weighted scores were compared. **Siemens' Sinumerik 840D NC** was chosen.

"The market for CNC equipment is developing rapidly, which makes it tough for companies such as Airbus to select suppliers. For example, the Sinumerik 840D now benefits from many facilities, features, and add-ons that were not available three years ago when Airbus first started the procurement process," said Dirk Rabeneck, Senior Aerospace Business Manager for Siemens Automation & Drives MC (Motion Control). It is essential that suppliers of CNC equipment can work in conjunction with the machine tool manufacturer, its agent, and the end user, to ensure that the optimum solution is provided to meet immediate and long-term needs."

The Sinumerik 840D incorporates a Siemens S7 PLC (programmable logic controller) and separate microprocessors



**An Airbus A380 wing leaves Airbus UK's Broughton factory en route for Toulouse and final assembly.**

for communications. Functions such as "look ahead" and "smoothing" help to enhance productivity and quality, especially when coupled with spindle power monitoring.

Airbus is employing the latest release of the CAM-POST Sinumerik

840D CNC post-processor from **ICAM Technologies**. The ADVANCED model is a five-axis mill post-processor, specifically designed for the aerospace industry, permitting tangential arc fitting, NURBS (non-uniform rational B-splines) fitting and interpolation, CIP (circular

interpolation) oblique circular interpolation, and standard canned cycles. It supports RTCP programming based on the 840D TRAORI (transformation orientation) function and local co-ordinates system programming. A key function is the support of the 840D customizable HSM (high-speed machining) feature, based on the Sinumerik CYCLE832.

Siemens offers its own WinBDE software for the acquisition of production data, but the flexibility of the 840D also enables other packages to be integrated. Airbus has opted to use its own Tacoma package that collects production data as well as monitoring spindle power for the dual roles of optimizing the machining efficiency and protecting the spindle from overload. Similarly, rather than use the Siemens SinTDI tool data information software, Airbus chose to use the Henri Liné tool data package.

Siemens also supplied Airbus with **Weiss** high-speed spindles (Weiss is part of the Siemens Group), Simodrive 611-D drives, servo motors for the axis control, panel-mounted and handheld HMI's (human-machine interfaces), and industrial PCs.

Stuart Birch

## Managing projects more effectively

Controlling the budget and timescale of large and complex aerospace projects is a highly demanding discipline. Now, **ACSIAN**, a UK university spin-out company has announced a new software package designed to provide greater control and effectiveness.

Formed by Jim Scanlan, Professor of Engineering Design, **University of Southampton**, and Ian Poccachard, Engineering Systems Developer, **Rolls-Royce** Defence Aerospace, ACSIAN has been established to help major companies achieve success for large-scale projects and to support delivery on time and to budget using its new software, Plexus Manager.

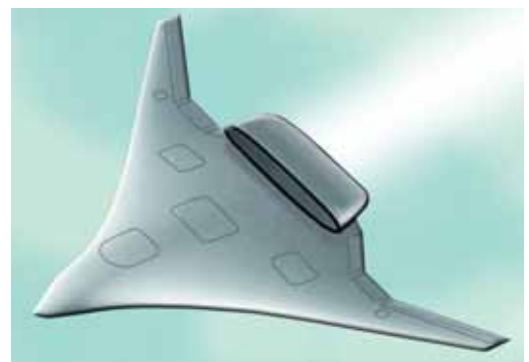
"As an illustration of the problem, of the UK's top 25 weapons programs, 23 have missed, or are forecast to miss, their in-service dates," said Scanlan. "In all, they are almost \$5 billion over budget. Plexus Manager is designed to be flexible, to allow for the inevitable changes that are made within active

projects. The project manager then has a much better feel for the likely impact of changes and problems encountered during the project and can make appropriate decisions to affect best use of time and resources."

ACSIAN has been established with funding of more than \$700,000 from early stage technology transfer specialists and intellectual property company **IP2IPO** and from the SULIS Fund, owned by the Universities of Southampton, **Bath**, and **Bristol**.

Scanlan and Poccachard, together with six other engineers and academics, have spent many years developing the software, described as the product of the team's extensive experience in working with large aerospace organizations.

"The founders of ACSIAN have a great deal of firsthand experience of what to do—and what not to do—when managing large, complicated engineering design projects," said Scanlan.



**Aerospace projects are highly complex to manage and are likely to become even more so with the increasing importance of environmental issues. ACSIAN may help the project manager's task.**

"We have built on this experience to produce a powerful and radically different new software tool that enables organizations to combat the principal causes of project failure."

Stuart Birch

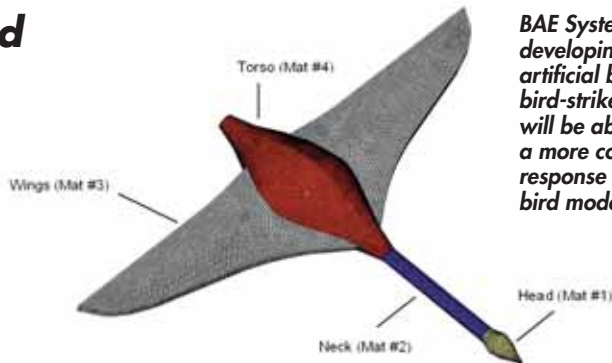
## BAE breeds a new bird

The financial cost to the aviation industry of bird strikes is huge in terms of damage to aircraft and lost revenues caused by delays, which is one reason why bird-strike testing is a vital part of aircraft component design. Nowadays, euthanatized birds are fired from a gas cannon for certification testing of windshields, radomes, engines, leading edge structures, and other airframe elements. But during the development phase of new aircraft components it is more convenient to use artificial birds made from gelatin formed into a representative shape of the torso of a bird—its principal mass.

While this method is generally effective



**Bird-strike damage can endanger aircraft, and a consortium of industry and academic institutions is involved in finding ways to improve testing methods.**



**BAE Systems is developing a new artificial bird for use in bird-strike test work that will be able to provide a more complex impact response than previous bird models.**

in achieving an acceptable substitute for a real bird's body in terms of impact pressure and impulse, **BAE Systems'** specialists felt that in some situations it was not satisfactory. To improve the efficacy of artificial test birds and introduce a higher level of standardization, the company's Advanced Technology Center (ATC) is developing a new example. The project is part of the work of the **International Bird Strike Research Group (IBRG)**, which is investigating methods to improve and standardize the artificial bird for certification tests using novel material systems to replace those of current artificial birds. The IBRG is a consortium of aviation and academic institutions that includes along with BAE, **Honeywell, Pratt & Whitney** (U.S. and Canada), **QinetiQ, Rolls-Royce, the University of Dayton**

**Research Institute, Oxford University, the UK Civil Aviation Authority, and the Central Science Laboratory.**

Advanced computer simulation is central to the analysis of bird-strike events. The BAE ATC has investigated the influence of bird shape for large bird species. The Canadian goose is a typical example and is part of the simulator work, and the bird is of particular importance because of its high mass and increasing population growth.

According to BAE, using a more detailed representation of the bird in a bird-strike model (including the neck and wings) provides results that indicate a more complex impact response than was obtained from earlier bird models. The significance of these effects is being investigated in ongoing work.

Stuart Birch

## Harmonic's mini servo

Precision gears and actuators specialist **Harmonic Drive** has developed what the company believes to be the world's smallest, hollow-shaft servo actuator, providing 1.8 N·m from an integrated ac motor, gearbox, and 50-mm<sup>3</sup> encoder that has a mass of 0.4 kg. It is part of the FHA-C mini servo actuator range that features a choice of gear reduction ratios, including a 30:1 ratio, claimed as another first for a hollow shaft type. Three gear sizes are available.

The FHA-C range has been developed to meet the needs of demanding applications, where highly accurate control and high torque capacity are required and/or where there are space or weight constraints on equipment. Applications include pick-and-place

mechanisms used in the production of electronics; precision machine tools; and automation equipment for aerospace systems.

The new range incorporates technology to eliminate the effects of backlash, while the integrated ac-servo motors provide smooth torque curves with output speeds of 60 to 200 rpm. Harmonic Drive states that a specially developed cross-roller output bearing provides enhanced resistance to axial and radial loads and to high tilting moments. Each FHA-C mini servo actuator has been designed to interface directly with all industry-standard servo controllers.

Harmonic Design claims that integrating a motor, gearbox, output bearing, and encoder into a single compact and lightweight unit offers design and



**Harmonic Drive is claiming to have developed the world's smallest hollow-shaft servo actuator, which it says offers time and cost advantages to design and manufacturing engineers.**

manufacturing engineers the opportunity to reduce both the time and cost associated with system design, specification, and construction.

Stuart Birch

## DayStar offers LightFoil for UAVs

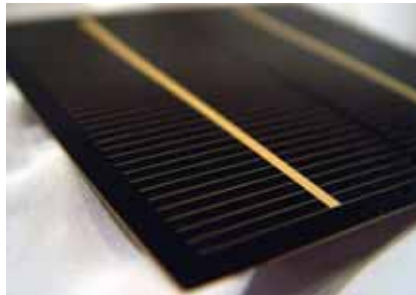
Earlier this year, **DayStar Technologies**, a developer and manufacturer of silicon-free solar cells on specialty metal foils, began offering its LightFoil photovoltaic product for military and homeland security applications, including high-altitude airships (HAA), winged UAVs, and orbital applications for next-generation satellite craft. The product meets the low-weight, high-power, and form-flexibility metrics required by onboard power generation systems for these weight-sensitive applications.

LightFoil consists of high-efficiency CIGS (copper, indium, gallium, selenium) solar cells deposited on thin titanium foil. Less than the thickness of common household aluminum foil, the design allows for high power production from sunlight without excessive weight.

Engineers have achieved a specific power level of 1440 W/kg (15.2% AMO efficiency) in a laboratory setting, which according to the company is approximately 50% more energy dense and 60% lighter than thin-film alternatives. Manufacturing development of LightFoil based on the laboratory benchmark is currently under way with a specific power target that will exceed 1000 W/kg.

In addition to high specific power, LightFoil is also flexible both physically and in form factors. The product molds to curved surfaces and can be cut to shape to conform to complex geometric requirements.

To achieve cost and quantity benchmarks, the company produces its photo-



**DayStar's LightFoil photovoltaic technology consists of high-efficiency CIGS solar cells deposited on titanium foil that is thinner than common household aluminum foil.**

voltaic foil products using proprietary, high-volume manufacturing processes adapted from commodity computer component manufacturing.

Shortly after the product's debut, a memorandum of understanding was signed between DayStar and **Auxilia** regarding the design, development, and systems integration of LightFoil photovoltaic power in unmanned airships. The agreement focuses on developing lighter-than-air vehicle (LTAV) solutions for homeland security, defense, and commercial applications. The objective is to develop plug-and-play architecture for existing and future products of both companies that could enable diverse airship configurations for low, middle, and stratospheric altitude applications.

According to the companies, low cost, serviceability, and range of coverage make airships suitable for a variety

of communications, surveillance, data relay, and broadband applications for military and commercial telecommunications. Airship platforms offer a solution for addressing a range of military and homeland defense needs, including force protection, port security, border monitoring, surface surveillance, enemy target acquisition, and beyond line-of-sight communications.

The companies will focus on integrating DayStar's proprietary LightFoil with Auxilia's products by using the Auxilia Airship Simulation Center (AASC). The AASC is a repository of LTAV and communications systems engineering data and expertise. The center offers users the ability to minimize project time, cost, and risk by modeling airframe, payload, and communications-linked applications. Upon completion of modeling and simulation, which should be within a year, the companies will launch pilot configurations on airships.

"Generating power for optimized LTAV payload and propulsion systems remains a problem," said Don DeVito, Auxilia's President and CEO. "DayStar's LightFoil has...performance and low-weight characteristics that can produce the required power without adversely affecting airship buoyancy."

The companies believe that their plug-and-play product concepts will minimize complex airship power systems challenges, thus substantially accelerating introduction of advanced airship systems.

Ryan Gehm

## Low-noise valve

**Dunlop Equipment's** contribution to lower aircraft noise levels includes a low-noise bleed valve to replace an earlier design for the **IAE V2500** engine. It is said to provide a reduction in the overall noise output of the engine of 3 dB. Dunlop engineers are developing further noise-reduction technologies.

The new valve, developed under a contract from **Rolls-Royce**, is a poppet design. Its function is to reduce engine torque when starting and idling by

controlling the internal air pressure. Dunlop cites it as an example of the added value that can be brought to an already successful and long-established platform via technology developed since the engine's launch.

Currently, there is a worldwide fleet of some 2000 V2500 engines powering **Boeing** and **Airbus** aircraft, and they have accumulated more than 20 million flying hours with 80 operators.

Stuart Birch



**Dunlop's noise-reduction bleed valve replaces an earlier version for the IAE V2500 engine and provides an overall noise reduction of 3 dB.**

## Finding faults

The wiring looms of avionics systems can be highly complex and often need to run through very confined areas of an aircraft. If damage is caused by vibration or moisture ingress, location of a fault may be a difficult and time-consuming process.

To help cope with such situations, 3M has announced a new tester it believes to be the first handheld, integrated unit designed to locate all types of open circuit, short circuit, and intermittent faults in the wiring classes used on most military, commercial, and private airplanes.

The 900AST (advanced systems tester) has time domain reflectometer (TDR) and resistive fault location (RFL) functions, plus other test capabilities,

to categorize and locate problems. The unit has a mass of 1.8 kg including batteries, test leads, and case; is moisture resistant; and can withstand a 1.5-m drop onto concrete. It has a 192 x 192 pixel black-and-white display. An IR port allows stored data to be uploaded to a PC for added analysis.

TDR sends a pulsed signal down the line under test, an echo being sent back from any fault site. The fault's position can be determined by timing the echo's return. RFL is used to detect ground faults, measuring resistance at various points in the conductors under test and using these measurements, together with data on the size and material of the conductor, to fix the position of the fault. The 900AST can con-



*3M's handheld 900AST uses a number of test capabilities to help locate wiring faults in awkward places on most military, commercial, and private aircraft.*

duct soak (extended period) tests, which may be apposite for identifying faults caused by corrosion or moisture.

Stuart Birch

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## Longer life for aircraft braking systems

Enhancing aircraft braking systems' service life may make a significant contribution to safer and more economic operation. To help achieve this, **Dunlop Aerospace Braking Systems (DABS)** has developed a range of antioxidant treatments to provide protection for carbon-carbon composites (CCC) used for the heat packs of aircraft brakes.

Treatments have been applied to the non-rubbed surfaces of the stators and rotors of the braking systems of the **BAe 146** and **Avro RJ** that DABS claims allows the brakes to operate for considerably longer periods in airport environments that use aggressive runway and airplane deicers containing catalysts that promote oxidation.



**Dunlop Aerospace Braking Systems is helping to extend brake life of the BAe 146 and Avro RJ via the use of antioxidant treatments applied to the surfaces of the stators and rotors.**

According to DABS, as a result of its treatment, inspection intervals have been extended and average brake life across a fleet is considerably longer, although the improvement varies from case to case, depending on the aircraft's operating cycle. Carbon oxidation is an activated process in which the rate of oxidation climbs exponentially with temperature increase, becoming particularly pronounced above 500°C. Aircraft brakes can reach 550 to 650°C during a landing.

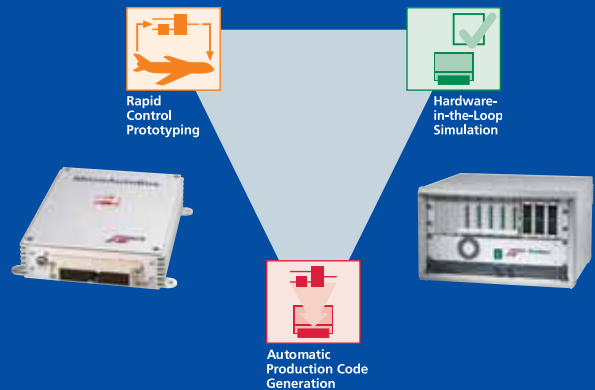
Below 520°C, inhibitors in DABS treatment technology work to slow down the reaction of the carbon with oxygen; while at higher temperatures, barrier-forming species within the antioxidants react with the surrounding oxygen to form a coating that prevents the ingress of oxygen into the composite.

DABS regards its antioxidants as particularly effective in counteracting the oxidizing effects of some deicing and anti-icing products based on carboxylic acid salts (including potassium acetate and sodium formate), which have been used extensively in Europe since the mid-1990s.

But the company also states that its technology will extend brake service life for airplanes operating in territories that do not experience severe winter weather, or where traditional glycol and urea-based deicers are used. Toby Hutton, DABS Carbon Technology Manager, believes that the DABS antioxidants will have applications not only on other high-wing aircraft but also with fuselage-mounted undercarriages where the nosewheel sprays water and deicer on to the rear wheels and brakes.

Stuart Birch

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## Controls Development with dSPACE

**dSPACE Prototyper:** Rapid Control Prototyping systems provide push-button implementation of controller designs done in a high-level modeling environment like MATLAB®/Simulink® on a robust, powerful, and easy to use real-time platform.

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