THE OFFICIAL MAGAZINE OF **AEROSPACE TESTING, DESIGN & MANUFACTURING EXPO EUROPE**

AEROSPACE TESTING INTERNATIONAL

DECEMBER 2009

Emergency exit
The development program of NASA's Constellation launch escape system

Get the XWB factor
Chief test engineer for the A350 XWB, Thomas Nielsen, discusses the latest crucial phase

Express trainer
The upgrade of the USAF Hawker Beechcraft AT-6 from a trainer into a fighter

INDIA'S IJT • MILITARY BIOFUELS • COMAC 919 • SAAB SK60 • UAV DIGITAL PARACHUTE

www.AerospaceTestingInternational.com

Contents

FREE ONLINE SUBSCRIPTION AND READER ENQUIRY SERVICE

Request more details about advertisers in this issue of *Aerospace Testing International* online at:
www.aerospacetestinginternational.com

In the September 2009 issue of *Aerospace Testing International,* I discussed the complete lack of government support given to the British troops fighting in Afghanistan, particularly with regard to the supply of Chinook helicopters for frontline troop transport. Without wishing to labor the point, something has emerged that qualifies this completely.

A couple of years ago, we reported on the crash of the RAF Nimrod in Afghanistan, and its aging system failures. Well, now it is fact: a fuel leak on an old Nimrod caused an explosion that killed 14 British service personnel. The fuel had leaked into the fuselage of the plane and ignited. The cause of ignition is still disputable, but it is thought most probably to be due to an electrical fault. The crew put out a Mayday call but they never stood a chance. The crash, in September 2006, remains the worst single loss of life suffered by British forces in Afghanistan.

An unpredictable accident? No. Charles Haddon-Cave, QC, leader of the inquiry into the incident, blames the UK government, MoD, and contracted companies, stating that the equipment was blatantly unsafe. It appears, through various inquiries and reports, that it was an accident waiting to happen.

As an ex-serviceman, I feel very passionate that nearly seven years into a war, whether justified or not, the troops in the air and on the ground do not have absolute and total support. It seems to me that, because of rapidly shrinking budgets, the government has been sending soldiers and aircrew to war in vehicles and aircraft that were not fit for service.

The scenario is made more complicated with the involvement of numerous manufacturers, outsourced suppliers, and contractors, including BAE Systems and QinetiQ.

In July 2007, UK newspaper *The Sunday Times* reported on the loss of the Nimrod, and said that, after a previous fuel leak, the station commander at RAF Kinloss had warned that an "unexpected failure" was likely with an airplane already 10 years past its out-of-service date. Heads should roll.

One very senior British infantry officer sent correspondence a few months ago complaining that, due to a lack of air transport, troops were being sent forward along lengthy and vulnerable road lines of communication. Three weeks later he was killed by an IED. I reiterate, heads should roll.

On a different subject, I wish to cast some new light through old windows: Amelia Earhart was, without a doubt, one of the most inspirational aviators (aviatrix) and test pilots in history. Although she did not succeed in her around-the-world expedition, Earhart flew into legend. I quoted her words, "Flying may not be all plain sailing, but the fun of it is worth the price," as the opener for my book, *Trailblazers*, as it encapsulates everything that test pilots seem to be accomplishing.

Now it seems that, 72 years after her disappearance over the Pacific on July 2, 1937, halfway to achieving her record attempt of circling the globe at the equator, some strong new evidence has finally come to light. Artifacts recovered by TIGHAR (The International Group for Historic Aircraft Recovery) suggest that Earhart and her navigator, Fred Noonan, made a forced landing on the island of Nikumaroro. According to Richard Gillespie, TIGHAR chief executive, the two became castaways and eventually died there.

"We know that in 1940, British Colonial Service officer Gerald Gallagher recovered a partial skeleton of a castaway on Nikumaroro," Gillespie said. "Unfortunately, those bones have now been lost."

Discovery Channel reported that a woman's shoe, an empty bottle, and a sextant box with serial numbers consistent with a type known to have been carried by Noonan were all found near the site where the bones were discovered.

"Propagation analysis of nearly 200 radio signals heard for several days after the disappearance make it virtually indisputable that the airplane was on land," added Gillespie.

Forensic anthropologist and author of a book on Earhart, Karen Ramey Burns believes that the strongest of the amassed evidence comes from the report on the partial skeleton found by Gallagher.

"The evidence is plentiful, but not conclusive yet, to support the hypothesis that Amelia landed and died on Nikumaroro. The skeleton was found to be consistent in appearance with females of European descent in the USA today, and the stature was consistent with that of Amelia Earhart," Burns told Discovery News.

Maybe a case finally solved?

Christopher Hounsfield, editor

TECHNOLOGY PROFILES

PRODUCTS & SERVICES

NEWS FEATURES

REGULARS

EDITOR Christopher Hounsfield (c.hounsfield@ukintpress.com)
CHIEF SUB-EDITOR Alex Bradley
SUB-EDITOR William Baker
PROOFREADERS Christine Velarde, Frank Millard
EDITORIAL ASSISTANT Bunny Richards

ART DIRECTOR James Sutcliffe
ASSISTANT ART EDITOR Louise Adams
DESIGN CONTRIBUTORS Andy Bass, Anna Davie, Craig Marshall, Nicola Turner, Julie Welby, Ben White
PRODUCTION MANAGER Ian Donovan
PRODUCTION TEAM Joanna Coles, Carol Doran, Lewis Hopkins, Emma Uwins

SALES MARKETING DIRECTOR Colin Scott (colinscott@ukintpress.com)
PUBLICATION MANAGER Cheryl Flanagan (c.flanagan@ukintpress.com)
AUSTRALASIA BUSINESS MANAGER Chris Richardson Tel: +61 4207 64110 (c.richardson@ukintpress.com)
MANAGING DIRECTOR Graham Johnson
CEO Tony Robinson

Aerospace Testing International is published four times per year by UKIP Media & Events, Abinger House, Church Street, Dorking, Surrey, RH4 1DF, UK. Tel: +44 1306 743744; fax: +44 1306 742525; editorial fax: +44 1306 887546. The views expressed in the articles and technical papers are those of the authors and are not endorsed by the publishers. While every care has been taken during production, the publisher does not accept any liability for errors that may have occurred. Distributed by US Mail Agent, Clevett Worldwide Mailers LLC, 7 Sherwood Ct, Randolph, NJ 07869, USA. Periodicals postage paid at Dover NJ, 07801. POSTMASTER: Send address changes to: Aerospace Testing International, 19 Route 10 East, Bldg 2 Unit 24, Succasunna, NJ 07876, USA. Printed by Nuffield Press, 21 Nuffield Way, Ashville Trading Estate, Abingdon, Oxfordshire, OX14 1RL.

 ISSN 1478-2774 Aerospace Testing International

ANNUAL SUBSCRIPTION £42/US$88

COVER IMAGE: The Hawker Beechcraft AT-6

ABC Average net circulation per issue for the period 1 January 2008 to 31 December 2008 was 10,462

Published by UKiP MEDIA EVENTS

Flying the flag

THE UNVEILING OF A SCALE MODEL OF THE C919 BY CHINA'S COMAC HAS CREATED HUGE ANTICIPATION FOR THE LARGEST PASSENGER JET PROGRAM EVER UNDERTAKEN IN THE COUNTRY

China unveiled the COMAC C919, the largest airliner built in the country, during the Asian Aerospace 2009 air show

BY JOHN CHALLEN

China is keen to end the dominance of Boeing and Airbus in the passenger jet industry, and thinks that it will have just the product to compete. That's the message from the Commercial Aircraft Corporation of China (COMAC), which, having nearly reached the point of production of its ARJ21 regional airliner, is preparing to take another step up.

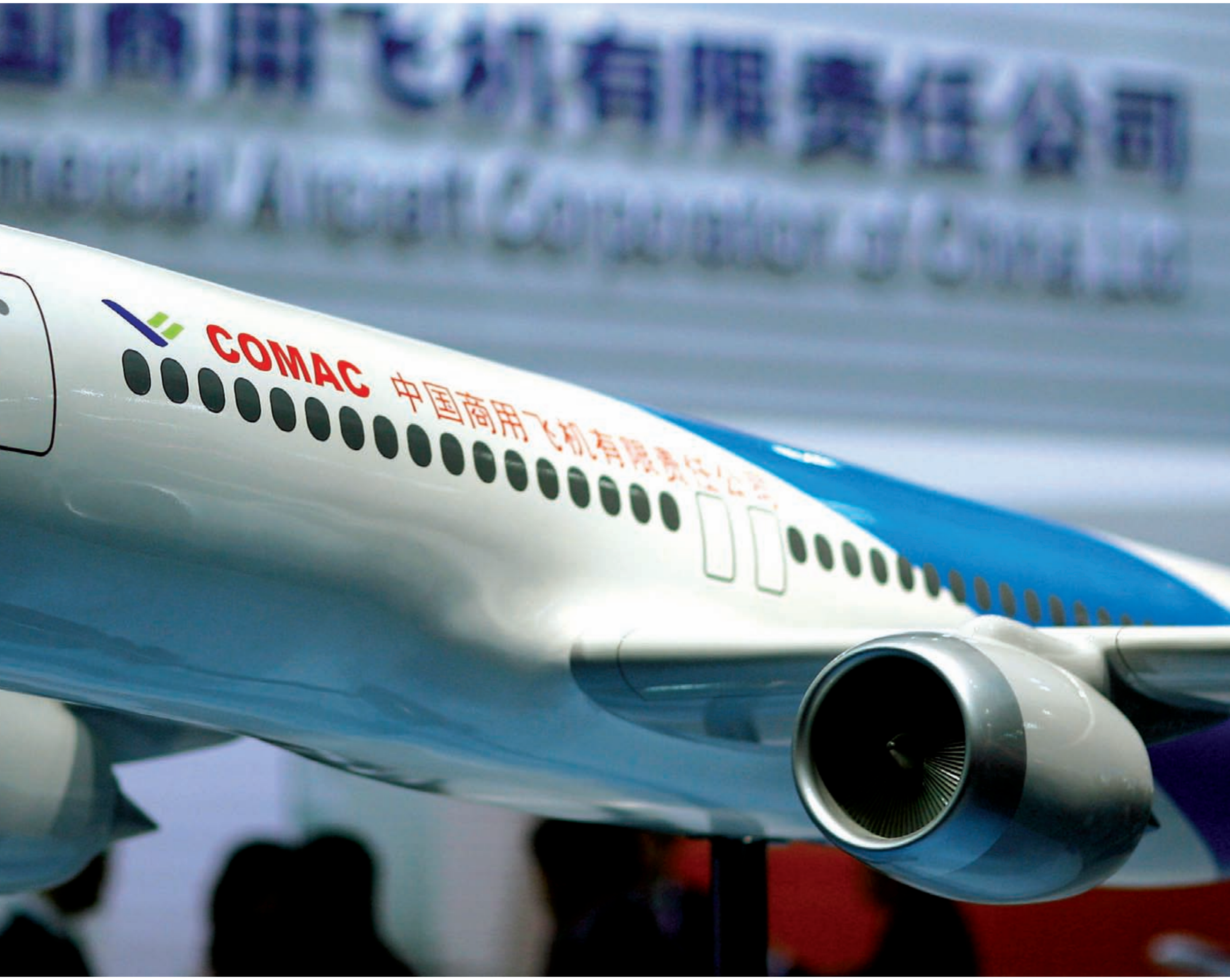
COMAC's airborne portfolio will be strengthened by the middle of the next decade when the C919, a narrow-body airliner that will seat between 158 and 190 passengers, takes to the skies. As a major shareholder, the Chinese government is firmly behind the company's plans and sees aerospace development as a key part of the country's industrial output: "To develop a large-scale airliner is a strategic decision of the Chinese government and one of the major programs for building up an innovation-oriented country," Chinese vice premier Zhang Dejiang said on the announcement of the new aircraft.

Unsurprisingly, the C919, the first large aircraft produced by a Chinese company, will be the biggest and most expensive such project undertaken in the history of Chinese aerospace. The official budget is US$4.4 billion, but sources suggest some US$29 billion has been set aside to ensure the project is a success. The C919 will make its inaugural test flight in 2014, with the first customers taking delivery of their aircraft in 2016. At its peak, annual production will reach 150 units, and the total output will be 2,300 units.

At this very early stage, development details of what is referred to in China as 'big plane' have proved very hard to come by, but there are many details that have been confirmed by the company. A prototype of the nose cone is already in the works, and the core test team is evaluating the cockpit layout and electronic equipment in the cabin. Open riveting of certain components for the prototype began in October 2009, while a manufacturing network has already been established in Shanghai, the assembly home for the aircraft. Nine domestic airframe suppliers have signed memorandums of understanding (MoUs) with COMAC to supply parts throughout the test program.

Supplier integration

Although many domestic suppliers to the C919 program have already been selected (see table), a large proportion of the 47 institutions that are involved in the project will come from



C919 statistics

The twin-engined, single-aisle C919 aircraft is designed for short- to medium-haul trips, with a standard-range model flying 2,200 nautical miles (4,000km) and an extended-range model offering a distance of 3,000 nautical miles (5,555km). The range comparison puts the performance of the C919 slightly below that of the comparable narrow-body offerings from Airbus and Boeing.

The dimensions of the C919 are similar to those of the Airbus A320: the fuselage will measure 3.96m wide and 4.17m high. The wingspan will total 33.6m (35.4m if winglets are included). Payload will be 20.4 metric tons, and the aircraft will have a cruising speed of Mach 0.785, at a maximum altitude of 12,100m.

> “Our goal is to design an efficient, high-performance structure that will compete in the global aerospace market”

beyond the country’s borders, says COMAC. The company has also confirmed that preliminary technical planning and a commercial feasibility study have been undertaken ahead of finalizing the complete list of development partners. “Our goal is to design an efficient, high-performance structure that will compete in the global aerospace market,” says Wu Guanghui, chief designer of the C919 program and vice president of COMAC. “Therefore, it is imperative that we look at design alternatives and collaborate with innovative materials technology leaders such as Alcoa.” COMAC and Alcoa recently announced a collaboration to jointly explore potential new technologies for the C919, with the aluminum supplier looking for “a tailored solution to help meet COMAC’s goal of creating a high-performance, ecological commercial airliner”, according to

Where it all began

The ARJ21 is the project that ultimately made C919's development possible. This twin-engined regional airliner was the first passenger jet developed by the Chinese and was supported by 19 European and US aerospace component suppliers. Key technology providers included General Electric, Honeywell Aerospace, and Rockwell Collins. Scheduled for 2005, the maiden flight of the ARJ21 eventually took place in November 2008, and development has continued since then, with first deliveries set to arrive with customers in late 2010. Production of the aircraft is expected to peak in 2015, when a total of 30 units a year will be produced in Shanghai.

The ARJ21 was the first passenger jet produced by COMAC

Pratt & Whitney is hopeful of securing a contract to supply the PW1000G for the C919

executive vice president Helmut Wieser. "We have made the preliminary selection for materials, and for the main structures we will still select metal materials at the first [development] stage," confirms COMAC's Wu. "We will consider advanced aluminum alloys such as aluminum lithium alloys, and other advanced alloy materials. For some secondary structures such as the control surfaces and doors, we may consider composites."

Quality is a key factor in the development of the C919, especially if COMAC is to meet its price target of sub-US$50 million per unit. Harry Kiskaddon, Alcoa's director of aerospace, is confident of finding solutions from the previously mentioned joint venture. "Alcoa brings new technology and leading-edge materials to the table," he says. "COMAC needs to take weight off the wings, and to address the most efficient designs in order to compete in the marketplace and supply an efficient aircraft that customers will want to buy. Advanced alloys will provide density savings, and give COMAC a weight advantage that they're looking for with the design of the C919's wing and fuselage."

Efficient development

As well as the highest possible quality, efficiency plays such an important role in the forthcoming aircraft that COMAC is prepared to experiment throughout the initial stages of the eight-year program with non-metal products. Part of the reason for taking such a risk – Airbus and Boeing initially investigated the use of composites on their aircraft before deciding against it – are ambitious fuel savings that will be demanded by the Chinese. COMAC says the C919 needs to be – and will be – 12-15% more fuel efficient than the models currently on sale. Wu confirms that if carbon composites are used

Western collaboration

Shares of Alcoa Inc gained 9% after the company said it was working with China on the development of a commercial jetliner that would compete in the international aviation market.

The USA-based aluminum maker said it was "examining advanced aluminum structural concepts, designs, and alloys" that will be used to build the 190-seat aircraft.

China hopes the narrow-body, single-aisle C919 will boost its fledgling aviation industry and help it to compete with Boeing and Airbus. Chinese officials claim the C919 will be cheaper for airlines to operate and will use 12-15% less fuel than comparable jetliners.

instead of steel, the company could reach that 15% reduction, thereby making a C919 cheaper to operate than the competition. COMAC is using Boeing's experience with the 787 Dreamliner as a benchmark, an aircraft that promises savings of up to 20% due partly to non-metal materials. However, the Chinese are only too aware of the structural problems the Boeing team ran into in development.

COMAC director Chen Jin states that the C919's design team is working on a "much more aerodynamic shape of aircraft to make better use of advanced materials to reduce weight". The company says it will rely on external support in this area to help reach its targets. "We will choose foreign-manufactured products such as engines at the beginning phase," reveals Wu. One of the international suppliers could be Pratt & Whitney, which opened the Shanghai Pratt & Whitney Aircraft Engine Maintenance Company in late September. The aircraft engine designer and developer believes that its PW1000G jet engine suits the C919, despite the company facing competition from rival bids from Rolls-Royce and General Electric. The PW1000G has an advanced gear system that enables the fan to operate at a slower speed, helping to cut fuel as well as noise. The C919 could, however, require a new member of the engine family as 30,000 lb of thrust is required from each engine.

CFM International's Leap-X engine, a conventional direct-drive fan, is also being considered, despite being in development itself. The company says that the COMAC timeframe offers no problem, despite previously saying the Leap-X would be "ready in 2016", the same year as deliveries are expected to commence.

Chen says that the engine that powers the C919 will need to meet strict criteria set by COMAC. "The plane will be much more advanced compared with the current operating aircraft of the same size," he promises. "It will use less fuel than those aircraft, and help to reduce carbon emissions." ■

Table: A selection of key suppliers confirmed for the C919

Nanchang Aircraft	Aft fuselages
Harbin Aircraft	Fairings and moving surfaces
Shenyang Aircraft	Empennage, vertical stabilizer
Chengdu Aircraft	Nose
Xian Aircraft	Cockpit, wings and main fuselage
COMAC	Horizontal stabilizer

When will the Dreamliner come true?

Boeing's troubled 787 Dreamliner project continues to stagger from one crisis to the next to such as extent that its trials and tribulations are becoming a regular fixture in the V-Rotate section of *Aerospace Testing International*.

Hopes of a June 2009 first flight for the carbon fiber Dreamliner were dashed by the need to reinforce an area of the airliner's fuselage and develop a product to fix it. The modifications are being worked on by Boeing engineers in Seattle and initial testing has been completed. A period of static testing then needs to be undertaken and the results analyzed before the Dreamliner can take to the skies. These tests will also include fatigue testing to determine the long-term validity of the fix.

On August 27, Boeing announced that it intended to fly the Dreamliner One (ZA001) by the end of the year, which would make possible first deliveries at the end of 2010. This would allow production to ramp up to 10 a month by late 2013, the company hopes.

The fix was installed in the initial flight test 767 air frame and the static-test airframe in mid-September.

The extensive modification of three of the six flight test aircraft during the convoluted development program means that it is not now considered cost-effective by Boeing to return them to production standard so they can be sold as airliners, as was originally envisaged. Confirming a US$2.5 billion write down because of the problem, Boeing said the aircraft, "have no commercial market value beyond the development effort due to the inordinate amount of rework and unique and extensive modifications made". This further adds to the financial pressure on Boeing to get the 767 flying and generating sales revenue to re-coup the billions of dollars spent to date on the ill-fated development phase.

If Boeing's problems were

Taking account of Apache

Future upgrades to the UK's fleet of AgustaWestland Apache AH.1 attack helicopters are unlikely to gather momentum until the second half of the next decade.

Senior UK Ministry of Defence and industry Apache program managers have told *Aerospace Testing International* that the funding issues and the need to keep helicopters in frontline service in Afghanistan in the near future means the UK will not immediately follow the US Army to convert its 67 Apache to the Block III standard, particularly the incorporation of an open-architecture computer systems to allow plug-and-play integration of new weapons and systems.

This illustrates the problems nations face when they select a US product and do not have the financial resources to fund their own integration effort for new weapons and sensors. The UK is clearly finding that moving away from the US sensors and weapons currently integrated on the Apache comes with a large price tag.

"There is no doubt that we will have to do a detailed review of how we sustain the Apache to its out-of-service date of 2030 and beyond," said defense equipment and support (DE&S) Apache program team leader Air Commodore Doug Whittaker. Speaking at the Apache Integrated Operational Support (AIOS) contract award ceremony at Wattisham Flying Station in Suffolk on October 6, 2009, Whittaker added that an "open-architecture system is one area we are look to incorporate in any upgrade." He said that while the current computer hardware and software that drives the UK Apache was "adequate" for the immediate future, it would become increasingly expensive to support over the next decade and predicted that an upgrade would be needed mid-decade.

A major factor in any future upgrade path for the Apache is the selection by the UK of a next-generation guided weapon to replace the current Lockheed Martin AGM-114 Hellfire missile. While the USA is pressing ahead with the development of the joint air-to-ground missile (JAGM) to replace the Hellfire on its Block III Apache, the UK government is funding the development of a 50kg-class missile as part of its team complex weapons effort, which is potentially a rival to JAGM.

Other DE&S officials said a divergence of weapons away from those used by the US on the Apache might offer industrial benefits to the UK not enough, negotiations with the International Association of Machinists and Aerospace Workers to open a second 767 assembly line at Everett in Washington state came to a dead-end. As a result in August 2009, Boeing announced that it was moving to set up a second final assembly line at North Charleston, in trade union-free South Carolina, as the site of its second 787 final assembly line.

"Establishing a second 787 assembly line in Charleston will expand our production capability to meet the market demand for the airplane," says president and chief executive of Boeing Commercial Airplanes Jim Albaugh. Until the second line is up and running, the company say it will surge production at the Everett line to meet its increasingly tight delivery schedule.

The North Charleston site is currently responsible for the fabrication and integration of the 787's aft fuselage, as well as the integration of the center fuselage, as part of a joint venture with Alenia Aeronautica.

The primary production line at Everett became operational in May 2007 with the commencement of final assembly operations for ZA001.

For regular news updates:
www.AerospaceTestingInternational.com

but this could carry large additional integration and support costs.

"There is a worldwide fleet of 900 Apache and you have to think carefully about walking away from all the money the US spends on integrating weapons and other systems on the platform," said one official. Whittaker said any decision on future weapons would be "done nearer the time."

"Diverging from the US is a strong option," said AgustaWestland's head of Apache, Tim Clifford. "I don't anticipate any upgrade starting before 2017-19."

He continued that any future weapon selection for UK Apache would be made after a "cost/benefit analysis" and "it was not a forgone conclusion" that a US-successor weapon system would be selected by the UK. Upgrades to the Apache would be driven by the helicopter's out-of-service date and the opportunity to link into Block III build program.

The only major upgrade of the UK Apache force since it entered service in 2001 has been the incorporation of the Lockheed Martin M-TADS/PNVS (modernized target acquisition designation sight/pilot night-vision sensor) along with TEDAC (TADS electronic display and control) systems.

Rolls-Royce, which has its main UK defense plant in Bristol, and manufactures parts and assemblies for the Apache, has warned it sees no signs of a sustained recovery in either the commercial or military markets. As a result the group, employing around 3,500 people at its giant Patchway site, said it is not expecting an increase in profits this year. Rolls-Royce reported pre-tax profits of £872 million last year on sales of £8.7 billion.

For regular news updates:
www.AerospaceTestingInternational.com

Pirate-hunting Reapers

General Atomics MQ-9 Reaper UAVs from a previously secret US Navy unit have begun anti-piracy patrols over the Indian Ocean from a base on the Seychelles islands.

Improving weather in the region is leading to a dramatic increase in the number of pirate attacks, including the seizure of a British couple and their yacht in October. US, NATO and European Union navies are patrolling the pirate-infested waters off Somalia and are keen to get more airborne surveillance support to provide coverage of greater areas of the Indian Ocean. UAVs such as the Reaper have 18 hours of endurance, and offer greater persistence over areas of interest than manned maritime patrol aircraft.

Operation Ocean Look began in the last week of October 2009, according to US Africa Command, which is directing the first public deployment of the US Navy-owned Reapers. The service purchased four air vehicles in 2007 and 2008 for sensor integration trials at China Lake Naval Air Station, according to a US Navy spokeswoman.

The US Navy says during the early phases of this deployment, the UAVs will not carry weapons, even though

Nimrod crash report fall out

October's publication of the QC's report into the fatal crash of a Royal Air Force Nimrod MR2 reconnaissance aircraft over Afghanistan must have led to some severe discomfort in the UK Ministry of Defence and two of the country's leading defense companies.

The defense aviation barrister's report into the loss of Nimrod XV230, and its 14-strong crew, paints a depressing picture of avoidable errors, as well as "a general malaise" in airworthiness procedures in the Ministry of Defence and the contractors BAE Systems and QinetiQ, who were helping to keep the Nimrods in service several years after they should have retired.

Charles Haddon-Cave QC was critical of the culture in the Ministry and the RAF that put saving money above safety and airworthiness. The Ministry's policy of increasing the role of industry in the maintenance and provision of other support services for RAF aircraft is central to Haddon-Cave's investigation. This policy was fatally undermined by failings by the two main companies supporting the Nimrod fleet. He said BAE Systems produced "seriously defective" safety case documents, and QinetiQ "failed to properly carry out is role as independent advisor" to the Ministry on the airworthiness of the Nimrod fleet. The Ministry's own Nimrod integrated project team is described as "sloppy and complacent" and "outsourced its thinking". Ten current and former RAF, Ministry, BAE Systems and QinetiQ employees were named in the report as being to blame for the disaster. He described the incident as a systemic breach of the military covenant by the current British government, and declared, "that it must not be allowed to happen again".

To turn around this lamentable state of affairs, Haddon-Cave proposes that the Ministry build a new military airworthiness regime under the control of an independent military airworthiness authority. It must be "effective, relevant and understood, which properly addresses risk to like, and which drives new attitudes, behaviors and a new safety culture." He recommended a new approach to safety cases, new attitudes to aged aircraft, improvements to airworthiness personnel, and new procurement strategies.

the USAF, CIA and RAF routinely arm their Reapers.

The Seychelles government requested the UAV mission after Somali pirates started to attack civilian shipping in the island's economic zone. The Reapers will operate from Mahé regional airport on the Seychelles and be occasionally supported by US Navy Lockheed P-3C Orion maritime patrol aircraft.

About 75 US military personnel and civilians, believed to be contractors from General Atomics, the Reaper's manufacturers, will be deployed to the Seychelles to set up the UAV forward-operating base. To date, the US Navy has not revealed that they had purchased the MQ-9s.

US Navy sources said that the Reapers were purchased as part of a US Navy/SOCOM (special operations command) project and were based at China Lake to facilitate the training of pilots and other personnel. It seems the effort was carried out at China Lake to facilitate easy access to experts from the US Navy's test and evaluation community, as well as provide access to the large training range complexes in the southwest USA.

The emergence of news about the Reaper came as a surprise, after the US Navy rejected the maritime version of the MQ-9, the Mariner, in its contest to select the unmanned component of the broad area maritime surveillance (BAMS) in April 2008. It will come as a major boost for the Reaper's manufacturer, General Atomics, who now have Reaper or derivatives in service with the USAF, US Army, RAF, Italian Air Force, CIA and US Department of Homeland Security, as well as the US Navy.

For regular news updates:
www.AerospaceTestingInternational.com

UK Defence Secretary Bob Ainsworth apologized for the loss of the aircraft and immediately accepted liability. He also ordered the setting up of a team to implement the finding of Haddon-Cave's report as fast a possible. BAE Systems acknowledged, "that there were a number of failings in our application of our internal processes and procedures during the course of work undertaken as part of the Nimrod safety review which took place between 2001 and 2004. We accept full responsibility for these failings and apologize unreservedly for them."

Graham Love, chief executive officer of QinetiQ, resigned the day after the Haddon-Cave report was published, although the company said his departure was not linked to the criticism of the company in the Nimrod report.

For Ainsworth, the challenge he faces clearly goes beyond just setting up the new airworthiness authority. Haddon-Cave clearly identifies the pressures on the Ministry and the RAF from treasury-imposed financial targets as being a major contributing factor. The same pressures remain in place and are likely to get worse as the Ministry is forced to cut billions of pounds from its budget, and at the same time, fight a war in Afghanistan. It remains to be seen if any more military officers will stand up to the politicians and say, "enough is enough".

For regular news updates:
www.AerospaceTestingInternational.com

Cash crisis threat to flight safety

With the global financial crisis continuing to hit the civil aviation industry hard, it is no surprise that airlines and other players are trying to economize. The latest victim of the current hard times is the non-profit Flight Safety Foundation, which is seeing its members go bust and drop out or reduce their participation in the Foundation's activities.

As an independent, impartial and non-profit international membership organization, the Foundation is in a unique position to identify global safety issues, set priorities and serve as a catalyst to address the issues. With a membership of more than 1,200 organizations and individuals in 150 countries, the Foundation is well-placed to bridge cultural and political differences in the common cause of safety has earned worldwide respect. Its non-profit status gives the Foundation greater credibility to comment on safety issues. In times of economic downturn an independent voice is clearly more important than ever to comment on safety issues, as airlines, airports, and other aviation players try to reduce expenditure and staffing levels.

Flight Safety Foundation was formed in 1947 to pursue the continuous improvement of global aviation safety, and it meets this objective through research, auditing, education, advocacy, and publishing. These activities are now under threat because of the economic downturn, according to the Foundation's president and chief executive, Bill Voss. He says some 100 member companies or organizations have gone out of business over the past year and commented that, "their support is sorely missed.

"It is also understandable that companies have to make cost cutbacks where possible," he said. "We certainly do the same. But when companies cut back on attendance to safety seminars, or exhibits at a show, the little adjustments of 1,000 great companies add up to a pretty challenging situation."

Voss expressed concern that companies, organizations, and individuals participate in the Foundation's work on a voluntary basis, and in tight economic circumstances, 'essential only' travel restrictions hit its work hard. Although "the Foundation has cut costs to the bone like everyone else," it is impacting its ability to work effectively.

"Several years ago, we decided to create an endowment as a means of operational support, because in a cyclical industry such as this, the money needed to execute safety programs is rarely there when times are bad and the work is needed the most," said Voss. "A good endowment base would mean the FSF could respond to urgent needs without looking over its shoulder for the next downturn. We are working aggressively to grow the endowment, even during this economic slowdown. Ultimately, the industry will have to decide if a small investment in a group that puts safety work together still makes sense."

Those wishing to join or donate to the Fight Safety Foundation should visit www.flightsafety.org

For regular news updates: www.AerospaceTestingInternational.com

Emergency landing light

A 'digital parachute' leverages UAV technology to offer emergency automatic landings to civilian aviation. Frank Colucci looks at the team that put off-the-shelf UAV controls in a passenger-carrying Bonanza.

> As unmanned air vehicles (UAVs) grow more autonomous, their smarter, smaller, more affordable control technology may make manned aircraft safer. In June 2009, an experimental fly-by-wire Bonanza carrying two pilots and a flight test engineer flew itself to a waypoint, turned to a runway five miles away, captured a final approach, flared, and landed hands-off. The Hawker Beechcraft testbed used the same Rockwell Collins control package in production for the UK Watchkeeper Tactical UAV.

The collaboration opened the door to an emergency system that could land a civil aircraft with a disabled pilot safely, independent of instrument landing systems (ILS), differential GPS, or other runway aids.

"It's not like a CAT III auto-landing system for normal standard operating procedures," explains David Vos, senior director of control technologies at Rockwell Collins. "This is really an emergency function."

Automatic landings flown by modern airliners in poor visibility are airport- and runway-specific. A notional emergency landing system based on autonomous UAV technology could fly to the nearest airport using its onboard sensors and stored database. The test system referenced the Wide Area Augmentation System (WAAS) now being implemented around the USA.

"Our view of this system is that it's a last-resort system that will squawk an emergency code and say where the aircraft is heading," says Hawker Beechcraft engineering fellow and autolanding test pilot Dwayne Kimble.

Development of a civil-certified emergency landing system nevertheless requires broader business, technical, and regulatory decisions.

"We were trying to show the thing is practical and that it can be done accurately and safely," says Kimble.

Though the global recession put the 'digital parachute' on hold after a single automatic landing, the technology appears simple to integrate on a range of aircraft. Emergency landing technology could be implemented through common autopilots expanded to work throttles and ground brakes.

"It's not a dramatic augmentation to what autopilots already do," observes Kimble. "It wouldn't have to be through a fly-by-wire system."

Engineers at Hawker Beechcraft and other aircraft manufacturers were briefed on autolanding by unmanned systems supplier Athena Technologies in late 2007. Athena became Rockwell

The 411 UAV control uses MEMS technology to integrate the functions of an IMU, GPS, inertial navigation system, air data system, flight data system, and mission manager

"It's not like a CAT III auto-landing system for normal standard operating procedures"

The landing at Beech Field referenced only the WAAS to find a waypoint, turn to the runway, and fly to a touchdown

Collins Control Technologies in April 2008 and gained global presence in the general, business, regional, and commercial aviation marketplace.

"We had approached the Part 23 aviation industry at large, several of the players, and told them about the capability," recalls David Vos. "This is standard operating procedure for us in the UAV business."

In the box

The GuideStar 411 control on the Watchkeeper, and other unmanned platforms, integrates an inertial measurement unit, global positioning system, inertial navigation system, air data system, flight data system, and mission manager.

"It was a really good starting point from its heritage for qualification as well as its size, weight, and pricing for the markets we were looking at," says Vos.

Control software compliant with DO-160E and DO-178B standards met FAA, US Milspec, and UK MoD requirements. Micro Electro-Mechanical Systems (MEMS) technology fits the control functions in a 1kg (2.2 lb) box about the size of a large coffee mug and promised extended mean time between failures. The fused INS/GPS also reduced sensor costs.

The Watchkeeper vehicle integrated by Thales UK and Elbit uses two of the Rockwell Collins control boxes. The UAV package is available with either military or civil CA code GPS accuracy.

"The 411 was also on trajectory for several FAA-certificated applications," notes Vos. A commercial SensorPac air data attitude heading reference system (INS/GPS/ADAHRS) generates data for primary flight displays, multifunction displays, head-up displays, and electronic flight bags on manned aircraft.

Hawker Beechcraft Advanced Technology Group acknowledged the potential of autolanding technology and started work with Rockwell Collins on a fast-track demonstration. To provide a manned test platform for the unmanned vehicle control, the aircraft maker offered a Bonanza F33C previously outfitted with four-axis fly-by-wire (FBW) flight controls for the NASA Advanced General Aviation Transport Experiments (AGATE). The test aircraft has an experimental crew station on the left with FBW sidestick and power lever. A safety pilot on the right can take over with conventional controls. With the FBW servos declutched, "It feels like a normal Bonanza," says Kimble.

AGATE aimed for easy-to-fly aircraft traveling highways-in-the-sky. The NASA program concluded in December

2001, but the little-used Bonanza was updated in the summer of 2008 with new software and more powerful servo actuators from larger aircraft. Integrated with the FBW controls, the Rockwell Collins air data computer took inputs from a five-hole probe to calculate airspeed, angle of attack, slideslip, and altitude. The unmodified control generates pulse-modulated, serial, analog, or digital outputs. The AGATE Bonanza also retained a radar altimeter.

"Their unit is pretty versatile. It has all kinds of ways to control UAVs," says Kimble. "We had a serial interface with them. We would send them data, and they would send us data. We could just use it as a sensor to enrich the data in our sensor system."

In the loop

Interfaced with the Bonanza FBW system, the UAV box provided three control modes. An inner loop mode gave the left-seat pilot rudimentary response in pitch, roll, and yaw, and direct throttle control. Outer loop control gave the left-seat pilot a highly augmented response integrating climb and turn rates with roll and airspeed. Hands-off autopilot mode ultimately took the aircraft through approach and landing.

"It allowed us to evaluate the quality of the solution in the control laws for autopilot response," explains Kimble. "We did no handling qualities evaluation, although that mode was rather pleasant."

Hawker Beechcraft provided Rockwell Collins engineers vibration data to verify the Bonanza environment was within the limits of the control box. The aircraft maker also supplied an accurate flight simulation model of the aircraft for Rockwell Collins to develop control gains and optimize their control solution. A hot bench interfaced the control box with FBW hardware.

"Bench testing allows you to do the bulk of the debugging without a lot of expense," observes Kimble.

According to Vos, Rockwell engineers typically reuse about 95% of their software when adapting controls to new unmanned platforms. "We have a very standardized process that we have qualified over literally dozens of unmanned systems applications," he says.

> "We did no handling qualities evaluation"

Modified software drove extensive simulations with software and hardware in the loop. Monte Carlo simulations measured statistical accuracy of autolanding performance before first flight. The de-bugged control box migrated from hot bench to aircraft for hardware-in-the-loop simulations with servo-actuated control surfaces moving on simulated AHARS and GPS inputs.

"We're exercising everything in the system and ferreting out issues and see how the aircraft is going to perform," explains Kimble. "It all depends on having a good simulation of the system or you're leading yourself astray."

Rockwell Collins engineers assisted Hawker Beechcraft with integrating the control into the real airplane and pre-flight testing for flight readiness approval. Flying began with a calibration test the for five-hole air data probe.

"Those five-hole probes are pretty commonly used in the UAV world but not in the GA (general aviation) world," notes Kimble.

Subsequent flights validated inner and outer loop performance against the hardware-in-the-loop simulation. Autolanding flight tests were programmed in steps with automated flare and manual go-round at 1,500, 150, and 50ft before an automatic touchdown.

"For us, that's Category A flight testing. That's fairly high risk testing," acknowledges Kimble.

Flight tests were flown by Dwayne Kimble in the left front seat accessing the FBW controls, safety pilot Bill Vavra in the right front seat, and right test engineer Pia Salveson in the right rear cabin seat. The early glass cockpit left over from AGATE was supplemented with a large display to show flight path deviation with ILS-like needles, plus airspeed, altitude, ground proximity, and system health data.

The first autolanding attempt at Beech Field outside Wichita was made on a rough air day, and a problem with the throttle actuating servo caused three cancelled go-rounds before the test team gave up to adjust the servo on the ground. The next day, June 25, presented no wind and culminated in an accurate touchdown. "The deviation was nil for the system," recalls Kimble. "We took copious amounts of data. The system is quite accurate."

Landing accuracy was not tracked by the ground radar, and the autolanding system transmitted no telemetry to the ground station.

"The 411 has its own ability to record. We didn't add any other instrumentation to the aircraft," Vos notes. "The control box records the last two hours of GPS, IMU, and air data, plus control commands. That's a very standard function that's used in our UAS applications. We can replay entire flight segments and events with that data set."

"It's definitely new territory. In an unofficial way, it's cornered a lot of attention"

Close-up of the experimental Bonanza shows the five-hole air data sensing probe used to support the Rockwell Collins control system (below)

Technology certification

Certifying a digital parachute will nevertheless raise complex issues. An emergency autolanding system could be made more accurate and reliable by the local area augmentation system (LAAS) at select airfields, but it might also require a more detailed database of regional airports.

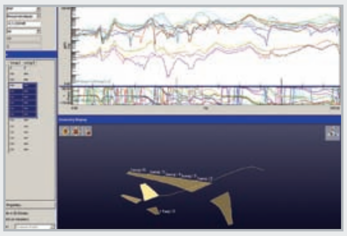
"As the product matures, we would determine what's needed," says David Vos. "None of this stuff we're talking about here is certification or has any heritage in the FAA domain. It was flown under an experimental classification with an aircrew on board. What we did here was very much a demonstration."

With the global business climate shaky and the fly-by-wire Bonanza committed to a NASA adaptive flight controls effort, further work on the digital parachute awaits a business decision. Rockwell Collins Business and Regional Systems Group has already begun an autolanding dialog with the FAA.

"If the customers show interest, we're going to move forward," concludes Vos. "It's definitely new territory. In an unofficial way, it's cornered a lot of attention. There's a lot of enthusiasm across the board from the unmanned world to the manned world to see what would it take to get such a system certificated." ∎

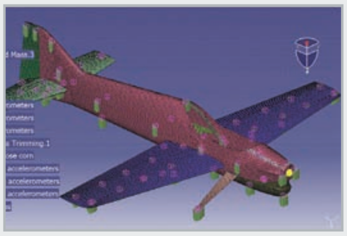
LMS Solutions for Ground Vibration Testing (GVT)

Achieve shorter testing campaigns while increasing the amount and quality of test data with LMS GVT Solutions.



→ Virtual and physical testing integration

Integrated CAE & TEST solutions for handling the structural dynamic test preparation, modal testing, modal analysis and finite element (FE) model correlation and updating.



→ Scalable data acquisition systems

Scalable and multi-application data acquisition systems supporting low and large channel count measurements.

→ Modal acquisition and analysis

Combined application of phase resonance and phase separation techniques seamless integrated with best modal package on the market.

→ Technology transfer

Experienced engineering services team to assist, perform and transfer methodologies to customers.

→ Surf to **www.lmsintl.com/gvt** for more information.

LMS®
ENGINEERING INNOVATION

Flights of passage

THE FIRST AT-6 PROTOTYPE FOCUSED ON MISSION AVIONICS INTEGRATION HAS ENTERED FLIGHT TEST AND A SECOND, MORE POWERFUL PROTOTYPE IS NOW IN PRODUCTION – TURNING A TRAINER INTO A FIGHTER

BY DEREK HESS

Hawker Beechcraft Corporation and mission systems integration partner Lockheed Martin have teamed together to integrate proven precision-strike and intelligence, surveillance, and reconnaissance (ISR) capabilities on the AT-6, a derivative of the US Air Force (USAF) and US Navy (USN) T-6 trainer. The AT-6 is an affordable, capable, and sustainable light attack and armed reconnaissance platform that seamlessly integrates with existing US combat air forces' core capabilities.

In addition, as a building partner capacity airpower asset, the AT-6 will enable partner nations who operate the AT-6 to meet the sovereign training and combat needs necessary to successfully execute counterinsurgency operations. With one prototype flying and a second

The 1760 capable stores management system can include a .50 caliber gun, 20mm gun, various bomb configurations, laser guided missiles, and rockets

prototype planned to enter flight test in early 2010, the integration and flight test efforts are proceeding on parallel paths in order to meet rapidly emerging needs for irregular warfare capabilities around the world.

Hawker Beechcraft has a rich heritage of meeting military-mission needs and has been delivering aircraft certified to military specifications for more than 50 years. Over the years, Hawker Beechcraft has delivered more than 12,000 aircraft to the US Department of Defense. Today, all USAF and USN student pilots train in aircraft made by Hawker Beechcraft. In addition to meeting US warfighter needs, Hawker Beechcraft has also been meeting the needs of foreign military customers with trainer, weaponized trainer, and special mission aircraft, which are currently in service in more than 50 nations around the world.

Hawker Beechcraft's mission system integrator partner, Lockheed Martin, is a global leader in the design, manufacture, and support of military aircraft. Lockheed Martin's airpower leadership is earned through relentless research and development of high-performance fighter, attack, air mobility, and ISR aircraft. Lockheed Martin Systems Integration developed the A-10C precision engagement modification program, which is the basis for the AT-6's combat mission capabilities. The company's advanced development programs, Skunk Works, are responsible for the integrated front-end development of new and innovative technologies, and new product and derivative programs in support of air power, which is also playing a major role in the AT-6 program.

Background

The AT-6 is a product of the combined heritage and expertise of the Hawker Beechcraft-Lockheed Martin team, leveraging the existing worldwide fleets of T-6 aircraft, which recently completed one million flying hours, and the A-10C, which has fielded modern precision-engagement capabilities into a long-proven platform. With more than 95% commonality with the T-6B and similar mission system avionics commonality with the A-10C, the AT-6 incorporates the best of the USAF's training and operational capabilities into a single versatile platform.

The AT-6 builds on the solid foundation of fielded USAF and USN T-6A/B programs and the USAF A-10C precision engagement modification program to meet the specific operational capabilities required to successfully carry out light-attack and armed reconnaissance missions while retaining baseline, intermediate and advanced training capabilities.

The AT-6 is a two-place tandem seat, pressurized, low-wing training aircraft manufactured by Hawker Beechcraft. The aircraft is powered by a 1,600 shaft horsepower (shp) Pratt & Whitney PT6A-68 free turbine turboprop engine, with a Hartzell four-bladed propeller optimized for heavy gross weight take-off and maneuverability during weapons delivery. A single-side opening, non-jettisonable canopy covers both cockpits, each equipped with a Martin-Baker Mk-16 zero/zero ejection seat. The landing gear is a retractable tricycle type, with the capability to operate from austere airfields. The primary flight controls are operated manually and feature electric trim and a patented trim-aid device that enables the AT-6 to fly like a jet.

The AT-6's advanced avionics suite is a sophisticated combination of CMC Esterline and Lockheed Martin Systems integration avionics. The CMC Esterline components provide the all-glass cockpit, primary flight avionics, head-up display (HUD), and upfront control panel, all from the USN's FAA-certified T-6B.

Lockheed Martin's components include the mission avionics from the A-10C and hands-on-throttle-and-stick (HOTAS) based on the A-10C

> "The AT-6 is a product of the combined heritage and expertise of the Hawker Beechcraft-Lockheed Martin team"

Genesis HIGH SPEED

Proven HBM accuracy
...now available in the megahertz range
...with Genesis HighSpeed

Up to 100 MS/s sample rate per channel

Ultra High-speed DAQ

See Genesis HighSpeed on our new website:
www.hbm.com/highspeed

HBM

Head Office · Germany
HBM GmbH
Tel: +49 6151 8030 · Email: info@hbm.com

A step up

The AT-6 is a platform with multiple missions, resulting in initial pilot training, weapons training, operational NetCentric ISR and light attack capabilities for irregular warfare. The Beechcraft AT-6 is a multirole, multimission aircraft system designed to meet a variety of warfighter needs. It is:
- **A structurally strengthened spiral development of the proven USAF Beechcraft T-6A and USN T-6B;**
- **Designed to accommodate 95% of the aircrew population – the widest range in its class;**
- **Lockheed Martin plug-and-play mission system architecture adapted from A-10C;**
- **Flexible, reconfigurable hardpoints with seven external store stations;**
- **Long persistence with two aircrew and weapons that have up to 1,350 nautical mile self-deployment range;**
- **Extensive variety of integrated weapons including general purpose, laser-guided, and inertially aided munitions.**

and F-16. Finally, a missile alert and warning system is included that is based on the F-16's electronic warfare-management suite. Other AT-6 attributes include aircraft self-protection equipment, an ISR suite consisting of the L-3 Wescam MX-15Di, and a sophisticated communications suite. Finally, the AT-6, first certified for weapons employment for the Hellenic Air Force in 2002, has been upgraded with a state-of-the-art MIL-STD-1760-capable digital stores management set from the A-10C that will support a wide range of laser-guided and inertially aided precision munitions.

The exterior shape of the baseline AT-6 has not been modified a great deal. For this reason, when in the clean training configuration, the AT-6 maintains all of the superior, predictable training aircraft handling qualities of the safe, reliable and proven T-6A/B. Its light attack and armed reconnaissance role is designed to meet operational objectives when operating in permissive environments consistent with typical counterinsurgency scenarios. The AT-6 will enable partner nations to meet the sovereign training and combat needs necessary to successfully execute counterinsurgency operations in the same platform.

The AT-6 is a newer version of the Wichita-based company's US Air Force and US Navy T-6A/B trainer aircraft

AT-6 test processes

The AT-6 test program is a combination of Hawker Beechcraft and industry partner investment in capabilities and Air National Guard participation in a combined industry and government demonstration program. There are two AT-6 prototypes in the overall program (AT-1 and AT-2), each intended to integrate and demonstrate different AT-6 training and operational capabilities. AT-1 is the primary mission systems integration platform, demonstrating the MX-15Di sensor installation in concert with numerous communications systems.

AT-1 will also be used to integrate aircraft survivability equipment. AT-2 will be used primarily to integrate the more powerful 1600 SHP engine. Weapons integration testing will be accomplished on both aircraft. Effectively, there are synergistic integration and test programs for AT-1 and AT-2 that are being executed simultaneously.

The overall flight test program for the AT-6 supports four objectives. The first is to evaluate integration of the MX-15Di turret on the seventh hardpoint located on the centerline of AT-1. The second objective is to assess the A-10C functionality after integrating the AT-6's variant of the A-10C centralized interface control unit and AT-6 specific HOTAS. The third objective is to evaluate the performance enhancements enabled with the integration of the 1,600shp Pratt & Whitney PT6A 68/10 engine on AT-2. The final objective of the AT-6 test program will use AT-1 and AT-2 to qualify precision weapons not already tested during baseline qualification efforts. Again, these objectives are being accomplished in parallel, with elements of some being completed on both aircraft in order to quickly step through the flight test program.

AT-6 sustainment

The AT-6 is only one component of an integrated system for the training and light attack roles. The aircraft will leverage the world's premier pilot training system, the joint primary aircraft training system (JPATS) ground-based training system (GBTS), to train operators and maintainers on the AT-6 weapon system. The T-6 GBTS was developed by Hawker Beechcraft and its partners as part of the JPATS program and is the most sophisticated GBTS in existence. The system is built on a foundation of simplicity, using a high content of commercially available hardware and software, and consists of an array of courseware, simulation, and instructional management products. The AT-6 will benefit from this system's ability to adjust to configuration changes, visual system

> **"The main goal of the current AT-6 program is to rapidly integrate proven, fielded capabilities on a proven, fielded platform"**

upgrades, and courseware modifications. Hawker Beechcraft and its partners will adapt existing systems to reflect the AT-6 configuration and characteristics and will provide additional capability to meet combat air forces' training requirements.

Air Forces that operate the AT-6 will leverage the fleets of USAF/USN T-6A aircraft and USN T-6B aircraft already fielded to reduce cost and increase aircraft availability in the AT-6 fleet. To date, Hawker Beechcraft has fielded more than 560 T-6 derivatives and that number will grow to nearly 900 aircraft with current orders. In addition to the USAF and USN, T-6 derivatives are currently being operated by the NATO Flying Training of Canada, the Hellenic Air Force and the Israeli Air Force, with aircraft scheduled to enter service in Iraq and Morocco in 2010. Additionally, the fact that all future USAF pilots will begin their training in the T-6 gives the AT-6 an advantage that no other aircraft can match in either a US light attack role or a US advisory role for building partner capacity needs.

For more than 30 years, Hawker Beechcraft has teamed with L-3 Vertex for logistical support. The Hawker Beechcraft L-3 Vertex team has provided a variety of peacetime and wartime support options for utility, reconnaissance, trainer, and combat aircraft around the world.

The baseline T-6A was developed in an integrated product development atmosphere that provided L-3 Vertex logistics experts with equal authority to design accessibility and maintainability into each system and component. The result is one of the highest mission-capable rates of any aircraft in the government's inventory. Hawker Beechcraft and L-3 Vertex also provide an impressive menu of existing support products that range from full contractor logistics support and contractor-operated and maintained base supply to basic provisioning. The main goal of the current AT-6 program is to rapidly integrate proven, fielded capabilities on a proven, fielded platform at low technical and schedule risk. The AT-6 is a single platform that meets a wide spectrum of mission needs that range from initial pilot training and weapons training to operational NetCentric ISR and light attack capabilities for irregular warfare.

What sets the AT-6 apart is that it meets those mission needs at a fraction of the acquisition and sustainment costs of other platforms. As a derivative of the proven USAF T-6A, USN T-6A/B, and USAF A-10C, the AT-6 is designed to be sustainable in the long term for both logistics- and software-upgrade support. The AT-6's parallel integration and flight test programs are critical to fielding a robust training and irregular warfare airpower solution that transitions the USAF's theory of building partner capacity into practise. ∎

Derek Hess is director of AT-6 development programs based in Wichita, Kansas, USA

Look back

The T-6 is a development of the Pilatus PC-9, modified significantly by Beechcraft to enter the Joint Primary Aircraft Training System (JPATS) competition in the 1990s. A similar arrangement between Pilatus and British Aerospace had also been in place for a Royal Air Force competition in the 1980s, although this competition selected the Shorts Tucano. The aircraft was designated under the 1962 US Tri-Service aircraft designation system and named for the decades-earlier T-6 Texan. The Beechcraft brand has since been purchased from Raytheon by Onex Corporation as Hawker Beechcraft.

The aircraft will get the mission system from the upgraded A-10C, with satcom, datalinks, full-motion video downlink, missile warning, armor and fuel-tank protection

On the radar

AN EXCLUSIVE LOOK AT THE LATEST DEVELOPMENT OF THE HAWK T MK2 BRITISH MILITARY TRAINER: STAGE 2 OPERATIONAL CAPABILITY

The T2 is powered by Rolls-Royce/Turbomeca Adour Mk 951 turbofan engine with full authority digital engine control

BY CHRISTOPHER HOUNSFIELD

It was early this year that the MoD's UK Military Flying Training System (UKMFTS) Integrated Project Team accepted the first of the new generation of Advanced Jet Trainer (AJT) aircraft, Hawk T Mk2, which will be used to train Royal Air Force (RAF) and Royal Navy (RN) fast jet pilots of the future.

An initial six aircraft were accepted by the UK forces and these were used to undertake conversion exercise flying, to allow RAF qualified flying instructors to familiarize themselves with the new aircraft prior to the initiation of syllabus development flying. In parallel, some of the aircraft are being used as platforms for further development flying in support of the next incremental capability of the aircraft, Operational Capability 2 (OC2). OC2 will provide the aircraft with radar simulation that will allow the launch of synthetic, 'category 5' missiles against other Hawk T Mk2 aircraft as well as providing synthetic Surface-to-Air Missile (SAM) threats and a synthetic Electronic Warfare (EW) suite, enabling more advanced techniques and procedures to be taught.

One of the major advances of the T2 is the embedded 'weapons and sensor simulation' (for example radar, chaff and flare: RWR). It has a flexible mission system with an open architecture mission computer, which enables the use of embedded simulation to significantly enhance the student pilots' mission effectiveness.

Designated Hawk T Mk2, the aircraft is significantly more capable than the current fast jet training aircraft (Hawk T Mk1) and better represents the advanced cockpit environment of modern aircraft such as the Typhoon.

Talking to *Aerospace Testing International*, Phil Davidson, director Hawk UK, who is responsible for all Hawk programs and projects in the UK, explains the current state of development: "The test program involved a company demonstrator and the first two RAF production aircraft. These were initially produced as development assets. They were extensively used in the test program from 2004 onwards, and involved approximately 100 flights. The tests included a structured program with test points around all new developing systems, such as the inclusion of autopilot, TCAS (predictive ground proximity warning system (GPWS)) and the introduction of the FADEC controlled Adour 951 engine."

The Hawk first flew in 1974, and since then has won many – actually, the most – of the world's trainer competitions. Used by 22 countries, with more than 900 aircraft manufactured, it is a highly respected aircraft globally. The T2 takes it to a new level.

The first of the RAF's £450 million fleet of 28 Hawk T Mk2s arrived at RAF Valley in July 2009, after the provision of a Ground-Based Training Environment (GBTE) and supporting aircraft maintenance hangarage. This infrastructure is being delivered under the umbrella of the main UKMFTS contract.

Is the Hawk AJT T2 just an upgrade, or is it much more? "Changes in training are moving away from the standard aerodynamic aspects of aircraft handling, and taking us through a paradigm shift demanding the need for vastly

There was one time...

At the last round of software flight testing, we were ingressing at low level as a pair to a target with a high level of (simulated) ground-based threats (SAMs) while simultaneously being attacked by an enemy fighter (another Hawk simulating a Fulcrum on the datalink). At one point, the ingressing pair were reacting in formation to a (simulated) SA-8 threat while exchanging active missile shots with the aggressor aircraft.

All the while we were maintaining a 250ft minimum separation distance with the terrain. It highlighted, to all the team involved, just what a powerful training tool we are about to take into service.

Sqn Ldr Beard gives a tour of the T2 to Prince Charles

> "One of the early points involved shutting down the engine and gliding for more than a minute"

Into the Valley

BY CHRIS HOUNSFIELD & SQN LDR DAN BEARD

Squadron Leader Dan Beard is the officer commanding Hawk T Mk2 Development Flight, 19(F) Sqn, RAF Valley.

Beard has an impeccable CV, having previously flown the Jaguar, Hawk T Mk1 (as a qualified flying instructor (QFI)), and AMX (while on a three-year exchange with the Italian Air Force). Prior to this assignment, he worked for two years as a requirements manager on the Typhoon Integrated Project Team. Now he is responsible for the acceptance of the 28 Hawk T Mk2s to the MoD. He runs a flight of experienced QFIs who "shake down" all the airframes delivered from BAE Systems and work with Ascent (the training system partner within the UKMFTS) in developing the new syllabus for the T Mk2. On top of this there are additional responsibilities to act as subject matter experts (SMEs) to other program sub-contractors including Lockheed Martin for the ground-based synthetic environment, CAE for the full mission simulators, and EDS for the AMPA mission planning system. Moreover, he acts as the SME input for the 'Release to Service Authority' for all matters concerning airworthiness and to the MoD procurement agencies. What he doesn't know about the Hawk, doesn't matter.

Sqn Ldr Dan Beard says, "The Hawk T Mk1 first entered service with the RAF in 1976 and is still an aircraft of that generation. While the aircraft was a significant improvement over the previous advanced trainers it has, inevitably, fallen behind the immense technological advancements seen in frontline fast jet aircraft over the past 30 years.

The relative vice-free performance of the T Mk1 remains in the T Mk2. However, the avionics suite is now representative of modern fourth- and fifth-generation fighters. This will allow the instructors at the Tactical Weapons Unit (19(F) Sqn) to train future fast jet pilots in an environment that is closely representative of their future frontline aircraft. Moreover, the skill sets learned will be far more applicable to the modern tactical scenarios that we are currently facing in our operational theaters and may face in future conflicts.

The RAF unit

The primary role of 19(F) Sqn is that of training ab initio pilots for the fast jets. This is an unrelenting task that requires a steady flow of graduate pilots of the highest standards to be supplied to the RAF and RN fast jet frontline squadrons. The squadron motto is 'Possunt quia posse videntur' which translates as 'They can because they think they can'.

The T Mk2 Development Flight was established within 19(F) Sqn in August 2008. The six members of the The T Mk2 flight are tasked with the acceptance and shakedown of the 28 new aircraft being delivered to the MoD. In parallel with this activity, they are developing the new syllabus in close cooperation with the training system partner, Ascent. Once the syllabus development is complete, the team will be responsible for training the complement of approximately 45 instructors who will man the new course. Ascent is a joint venture between Lockheed Martin and VT Group and is working with the MoD to provide military flight training to the UK Armed Forces for the next 25 years. As the training system partner, Ascent will be responsible for the provision of the squadron infrastructure, the synthetic training environment (simulators), the syllabus design, and a small number of staff for the ground school and simulator support. The Phase 4 Fast Jet training will, ultimately, be aligned with Phase 3 A/B training on the Basic Trainer, which will replace the Tucano.

increased information and knowledge management. T2 is designed to meet this requirement, and provide a 'seamless' transition into the latest frontline aircraft," observes Davidson.

Nat Makepeace is the Hawk project pilot responsible for all marks of Hawk worldwide, as well aspects of the Typhoon and Tornado programs. He speaks plainly, "Compared to all previous Hawks, the Mk128, or T2 as it is known in the service, has a more advanced mission system and the most comprehensive set of avionics and systems ever fitted. Similarly, the 951 engine is the most sophisticated to date with full FADEC capability, surge recovery and automatic relight.

"The aircraft is more capable than ever for training in that the avionics are typical of a fourth/fifth-generation aircraft. However, the key is the use of sensor simulation, which will revolutionize training. Sensor simulation is the 'force multiplier' of training, allowing previously unachievable quality of training to be flown on a daily basis."

The heart of the whole program has been the OC2 software test. As Makepeace explains, "OC2 is the heart of the sensor simulation and is where the concept of this aircraft is realized. This is where for the first time we have full air-to-air and air-to-ground simulation, including SAM sites. These items bring a combat realism into a safe environment, they provide the training tools as well as immediate feedback.

"The new avionics have been evaluated through a series of parallel development loads using our own test pilots as well as RAF test pilots and flying instructors. That evaluation continues today and is due for completion in 2010. There were plenty of challenges when we first flew the simulated radar, although it worked well at range. When in close proximity to a target, the system would simply not lock to the target – a major limitation that prevented us achieving our test aims. However, the engineering team pulled out all the stops and fixed the problem so we were able to resume quickly without any impact on the program. This was just an example of many issues," Makepeace notes.

The new aircraft has an enhanced inertial navigation/Global Positioning System for enhanced navigation and weapon accuracy

Avionics system project

The T2 navigation system is an extremely advanced set of technologies, which replicates those of frontline fighters. The features include inertial navigation, GPS, moving map, and a data transfer system to allow for uploading of nav and comms data as required from the mission planning system. It follows standard BAE developments and integration processes with progressive software drops and software releases.

As Davidson states, "We are currently test flying the embedded simulation system, the test flying is about to start its third out of four phases. Flight testing is carried out jointly with the RAF, and is going very well." The company expects to issue its RTS for OC2 at the end of 2010.

Experimental test pilot Makepeace explains further, "The next major step in the OC2 program is to complete the final production software, ensuring it meets the required performance and maturity standards. This is being conducted over two phases, one this year and one next spring.

"One of the more interesting moments on T2 was during the engine testing phase on the Adour 951 program. One of the early test points involved shutting down the engine at 39,000ft and gliding for more than a minute before relighting the engine. Some new issues arose, such as the oxygen system requires the engine to be running to generate oxygen! However, multiple successful relights were conducted without modification."

In October 2009, the current station commander at RAF Valley, Group Captain Neil Connell, described the Hawk to a group of visitors as "the best training machine in the world". Perhaps it is true. ∎

This work will be concurrent with up to 22 other training pipelines that will eventually be developed across the UKMFTS. The T Mk2 Development Flight are closely involved in all aspects of this program.

Latest avionics

At the heart of the avionics lie two display and mission computers (DMCs) and the whole system is connected by a MIL-STD-155 databus. The open system architecture allows upgrades to be made to the aircraft systems relatively easily and cost-effectively.

The aircraft has an integrated inertial navigation and GPS (INGPS), which drives the digital moving map and attack symbology. It is the first military fast jet to be equipped with TCASII (Traffic Collision and Avoidance System 2). This detects any other aircraft within a 40 nautical mile radius and displays its position and height to the pilot. If a collision course is detected, the system can instruct the pilot how best to maneuver so as to avoid the threat. Moreover, the aircraft is fitted with a radar altimeter and a GPWS.

BAE Systems is currently testing the latest standard of avionics and software for the aircraft. Known as Operational Capability 2 (OC2), it introduces a datalink to the aircraft. The combination of the datalink and some very advanced software allows the aircraft to fully simulate a modern radar and radar warning receiver (RWR). The radar and HUD symbology very closely match that of Typhoon, allowing a seamless transition for student pilots who are destined for this RAF type.

A component part of the OC2 software is the ability to simulate ground-based radar targeted SAMs. A range of modern systems can be simulated and only the correct combination of aircraft maneuver and simulated chaff expenditure will allow the student pilot to survive the threat.

This all represents a massive leap in capability for the instructors at the Tactical Weapons Unit. There is no doubt in my mind that this capability will allow us to train our future fast jet pilots to a far higher standard in more relevant training scenarios.

By mid-2010 we will have completed our syllabus development and we will train the next batch of four Central Flying School (CFS) accredited instructors. With a full complement of CFS instructors, we will start the task of converting T Mk1 instructors to the aircraft in preparation for the arrival of the first student course in early 2012." ∎

Star of India

HINDUSTAN AERONAUTICS LIMITED'S CHIEF TEST PILOT AND EXECUTIVE DIRECTOR GIVES AN EXCLUSIVE AND DETAILED INSIGHT INTO THE DEVELOPMENT OF ITS NEW INTERMEDIATE JET TRAINER

BY SQN LDR BALDEV SINGH (RETD)

The Indian Air Force (IAF) follows a three-tier flying training system. Flight cadets commence their initial basic flying training on the HPT-32 aircraft, which is a side-by-side seating, piston engine propeller aircraft designed and built by Hindustan Aeronautics Ltd (HAL). After finishing their basic stage, the flight cadets commence their intermediate stage flying training on the Kiran aircraft, which is a side-by-side seating jet aircraft, again designed and developed by HAL. After the completion of their intermediate jet training the advanced phase of training is done on the Hawk aircraft, which is being manufactured under license at HAL.

The Kiran aircraft was developed in the mid-1960s and three versions of it were inducted into service. It has been a major training vehicle for the IAF and Indian Navy for the past four decades. The IAF and the Indian Navy also use the Kiran for their aerobatic display teams. A total of 251 Kiran aircraft were built and delivered to the IAF between 1967 and 1989, and to date the fleet has flown close to 0.85 million hours.

In the mid-1990s, it was apparent that the lead batch of Kiran aircraft would be completing their 'total technical life' and a replacement aircraft would be required by the middle of the first decade of the 21st Century. It was, therefore, necessary to find a replacement at the earliest point in time. HAL decided to launch a new project to design and develop a world-class jet trainer, which would bridge the flying training gap between the basic and advanced stages of training. The aircraft would provide easy transition training between these two areas.

The aircraft was required to be simple to handle in terms of flying and systems management, and yet provide the requisite training to handle modern advanced jet aircraft. It therefore needed to be superior to the Kiran aircraft in terms of performance, handling qualities, onboard systems, and fuel economy, and was also required to be able to take part in weapons training. In addition, modern training concepts such as inflight simulation, ground-based simulators, computer-based training systems, e-documentation, and e-maintenance were to be incorporated into the design of the total aircraft training system.

As the old saying in training goes, 'A good trainer is one that should be easy and simple to fly but yet presents a sufficient degree of challenge to separate the men from the boys. Stick and rudder flying ability must strike an appropriate balance with cockpit systems management'. The design of the intermediate


WESTMORELAND MECHANICAL TESTING & RESEARCH
INTERNATIONAL
Youngstown, PA USA
Banbury, U.K.
BOEING
AIRBUS A380
WESTMORELAND MECHANICAL TESTING & RESEARCH LTD.
www.WMTR.com
www.WMTR.co.uk

Performance and technical features

Clean training mass:	4,000kg
Length:	10.965m
Wing span:	10m
Height:	4.392m
Wing area:	18m^2
Dihedral:	+2°
Wing sweep:	5.56°
Maximum speed:	750km/h
Maximum Mach number:	0.75IMN
Maximum load factors:	+7 to -2.5*g*
Maximum range with two drop tanks:	1,500km
Maximum endurance with internal fuel (900kg):	2 hours
Maximum weapon load (on four wing stations):	1,000kg

The cockpit uses a conventional tandem two-seat configuration (above)

The IJT aircraft is built from light alloy and composites, using a conventional low wing design with a sweptback wing (right)

jet trainer (IJT) has been driven to a large extent by this philosophy.

Early days and systems

Preliminary studies were carried out in consultation with the launch customer, the IAF. Formal sanction and the air staff requirement (ASR) for the IJT were received in July 1999. The IJT was conceived as a tandem-seating trainer with a single French Larzac low-bypass jet engine of 1,400kg thrust. Both prototypes were fitted with the Larzac engine, and until May 2009 flight testing was done with this engine. At this point, the first prototype was re-equipped and flown with the Russian AL-55I engine, which has a higher thrust of 1,700kg. All production aircraft will be fitted with this engine because a higher-thrust engine became necessary to meet the performance targets laid down in the ASR.

The IJT has manual flying controls with three-axis electrical trim capability. The hydraulic system operates the undercarriage, airbrake, and the wheel brakes, which are fitted with an anti-skid system. The three-position flap is electrically operated.

Both prototypes are fitted with the zero-zero Russian Zvezda K36LT ejection seats, but are being replaced with the Martin Baker zero-zero 16S ejection seats for the production aircraft. The electrical system is a 9kW 9kVA-DC starter generator along with two 40A Ni-Cd batteries. The avionics suite of the aircraft comprises a HUD, air-data computer, mission computer, AHRS, VOR/DME/ILS, GPS, IFF, and two VHF/UHF communication sets.

> “The aircraft has the capability to carry out a large amount of inflight failure simulation”

An innovative feature on the aircraft is the capability to carry out a large amount of inflight failure simulation. This was an express requirement of the IAF in the ASR. Even though emergencies and system failures can be practised on a ground simulator, it was felt that the provision of inflight failure simulation would be an added benefit that would equip pupil pilots to handle emergency situations with a higher degree of confidence. The inflight failure simulation capability on the aircraft enables the instructor from the rear cockpit to deprive the pupil pilot in the front cockpit of his flight, navigation, and system information. In a real world environment, the instructor can then assess the pupil pilot’s handling of the aircraft in a degraded flying condition/emergency situation.

To cater for this requirement the cockpit is equipped with 3in and 4in ATI, Active Matrix Liquid Crystal Displays (AMLCDs) for the display of flight, navigation, and system information. The ASI, Altimeter, and the VSI are 3in-ATIs and the HSI and ADI are 4in-ATIs. The display formats on these instruments are conventional displays as depicted on a mechanical instrument. A novel feature is that all five display formats of these flight instruments are loaded and available for display on every instrument. This has the additional advantage of being able to swap displays onto the other instruments in the event of a hardware failure of a particular instrument. It also leads to a reduction in the number of spare instruments that need to be held in inventory, thereby reducing overall lifecycle costs. Engine, fuel, hydraulic systems, trim positions, brake pressures, and cabin differential pressure is provided on two 4in x 5in glass displays. Information between both these displays can also be swapped. In the event of an ADC failure, flight information is available on a 3in display with integrated standby information.

The cockpit display information has been designed in such a manner that pupil pilots would start their initial flying on the aircraft using only head down instruments. It is felt that once the pilot is comfortable with the flying of the aircraft, the HUD and its associated mission computer (MC) functions can be introduced to the pupil in a phased manner to handle head-up flying and the associated system management of the MC.

Weapons suite

This consists of 12.7mm pod guns, 70mm rocket pods, free-fall bombs of up to 250kg, and CBLS for 25 lb and 3kg bombs, which can have the appropriate drag plates to simulate a retarder bomb or free-fall bomb. Appropriate weapon symbology has been provided on the HUD to introduce the pupil pilot from a basic fixed sight display, followed by a gyro gun sight display and then advanced displays such as the CCIP and CCIL, as found on combat aircraft. The IJT therefore provides a low-cost weapon training platform for easy transition to weapon training on an advanced jet trainer/frontline combat aircraft.

"HAL has already started work to develop a new trainer, which has been named as the Hindustan Turbo Trainer (HTT-40)"

Indian Government project sanction was accorded in July 1999. The aircraft configuration was frozen in March 2000. Aircraft layouts and inboards freeze and drawing release took place in April 2001, metal cutting for the first prototype commenced in June 2002, and the first engine ground run was carried out in February 2003. The first flight of the first prototype took place on March 7, 2003, and the second prototype first flew in March 2004.

Flight and AL 55-1 test

The flight test program has covered the entire flight envelope of the aircraft, including the low speed regime. System testing of the aircraft is almost over, and spin testing is scheduled to start in December 2009 followed by weapon testing in the first quarter of 2010. Final operational clearance is scheduled for June 2010. The flight test program has been delayed due to a mishap with the first prototype just after take-off in February 2007. It suffered extensive damage and it took almost 18 months to get it back to a flight-worthy condition. The delay in supply of the first AL 55-I engine by over a year further contributed to program delay.

The AL-55-I is a two-shaft low-bypass turbo jet. The engine has a three-stage low-pressure axial compressor and a five-stage axial high-pressure compressor, which has variable inlet guide vanes. The turbine is a two-stage axial turbine consisting of a single-stage high-pressure and low-pressure turbine, and the exhaust unit is a fixed area convergent jet nozzle. The engine produces 1,700kg of thrust at ISA sea-level conditions. The engine is equipped with a FADEC and provides an auto-relight capability.

Engine testing of the AL 55-I is currently in progress. The engine has been tested to the corner points of the aircraft flight envelope, and 10 engine inflight shut downs have now been completed. In the next 20-30 flights it is planned to establish the relight envelope, carry out performance testing, and also assess engine operation in the back-up mode (FADEC failure conditions). Once this testing is over, spin testing will be undertaken. In the fight testing carried out so far the engine has been found to be very responsive with very good acceleration timings and a low specific fuel consumption (SFC).

Aircraft production program

The IAF has already placed a firm order for 12 limited series production (LSP) aircraft. These 12 LSP aircraft are being built at HAL Bangalore. The first LSP aircraft will fly in November 2009, with all 12 aircraft being delivered to the IAF by March 2011. A series production order of 73 aircraft is in process. It is envisaged that this will be followed up with a further order for a similar number. The final number of aircraft that will be built for the IAF could be close to 200. The series production aircraft would be built at HAL Kanpur.

The HPT-32 aircraft is also due for replacement in about three years. HAL has already started work to develop a new trainer, which has been named as the Hindustan Turbo Trainer (HTT-40). A majority of the systems already developed for the IJT will be used for the HTT-40, cutting development time and cost. The requirement for this class of aircraft is also close to 200 aircraft.

HAL has been designing and developing trainer aircraft for the IAF and the Indian Navy since the 1950s. The IJT is another fine trainer from this lineage. ∎

Sqn Ldr Baldev Singh is executive director and chief test pilot with Hindustan Aeronautics Limited, Bangalore India.

On February 4, 2009 PT-2 landed on its belly after an aerobatic sortie. The aircraft was piloted by article author Sqn Ldr Baldev Singh. There was structural damage to the undercarriage and belly, the doors and one of the wing tips

Making the upgrade

SWEDISH AIR FORCE PILOTS TRAIN IN JETS FROM THE WORD GO. AS AN INTERIM SOLUTION UNTIL A LONG-TERM PLAN KICKS IN, THE UPGRADE CONTRACT FOR THE SK60 JET TRAINER WAS AWARDED TO ITS DEVELOPER, SAAB

BY CHRISTOPHER HOUNSFIELD

National emergency

From the late 1960s, a number of SK60s were developed for light-attack operations. The Light-Attack SK60 was intended to operate in the most northern parts of Sweden. In the event of war, the four squadrons of SK60s would have three main tasks: to prevent border crossings, to fight helicopters and other slow aircraft, and to carry out joint operations with the army.

The SK60B and SK60C versions were developed for these roles. The SK60C differs in that it has a reconnaissance camera in the nose so the nose is longer and more angular than on other versions.

In late September 2009, the Swedish defense and security company Saab received an order valued at SEK130 million (US$20 million) from the Swedish defense material administration, FMV, for the development and upgrade of the armed forces SK60 training aircraft.

"This is an important order for Saab that will secure additional jobs, both in terms of workshop and engineering resources," says Saab Aerotech business unit manager, Lars-Erik Wige. "The upgrade involves the modernization of the SK60 aircraft, making them more competitive for many more years to come."

The order includes the installation of a new GPS, audible altitude and primary warning signals for the pilot, plus the replacement of specific flight instruments. The result is a new aircraft cabin layout in which, for example, the altitude and speed go from being displayed in meters and kilometers to providing the pilot with information in feet and knots.

The SK60 (Saab 105) was developed in the early 1960s for the Swedish Air Force. It entered service to replace the De Havilland Vampire in 1967. Originally, it featured two Turbomeca Aubisque low-bypass turbofan engines, manufactured under license by Volvo Flygmotor, as the RM 9. In 1993 an updated version was equipped with the Williams International FJ44, designated the RM 15. A total of 150 aircraft were bought by the Swedish Air Force, and another 40 were exported to Austria, designated Saab 105.

The existing fleet of SK60 aircraft is used mainly for basic flying training, as well as basic tactical training (lead-in training). The upgrade will be completed by the end of 2011. The Saab 105 is also the aircraft used by the Swedish Air Force display team (Team 60).

Modernization program

This follows the Swedish armed forces' plans to modernize the SK60 training platform to secure its use until 2017. In December 2008, Saab and FMV signed a contract that made Saab, as the main supplier, responsible for handling the

In addition to its primary role as a trainer, the SK60 is used as a target aircraft, and for liaison and weather flying

operation, maintenance, and readiness of all SK60 aircraft. Saab now ensures that the system is airworthy and available for the Swedish Air Force as needed.

Explaining the SK60's role to *Aerospace Testing International*, Torsten Öhman, Saab Aerotech head of customer alliance solutions, says, "Since 1986 the SAF has had no primary flying training on propeller aircraft and the students fly jet aircraft from the very beginning. After this basic flying and basic training, the students continue with the conversion training on the SAF combat aircraft JAS39 Gripen, followed by operational flying training. The upgrade is based on the SAF requirement of a modern platform as an interim solution until a long-term solution becomes operational around 2018-2020."

Will it be capable of training pilots for the next generation of fighters? "Yes, absolutely, the new avionics should make it easier for the pilot to perform the conversion and operational flying training in JAS39 Gripen NG [next generation]," confirms Öhman.

Saab's contract is valued at approximately SEK900 million (US$132 million) and means that, as the main supplier, Saab is responsible for operating, supporting, and maintaining all SK60 aircraft. The company will ensure that the aircraft system is airworthy and is available, as needed, by the Swedish armed forces.

"The new avionics should make it easier for the pilot to perform the conversion and operational flying training in JAS39 Gripen NG"

"This lays the foundation for a long and close partnership with the Swedish armed forces for pilot training, and our, already good, relationship will strengthen and develop further through this agreement," says Saab CEO, Åke Svensson. "Increased public-private partnerships are good for both parties and lead to greater efficiency and flexibility for the armed forces, as well as for Saab."

The basic agreement runs through to mid-2017 and contains a number of options, including an extended commitment to additional flying hours. Saab, however, is not dressing this up as a new aircraft, for this is just an upgrade – albeit a very ground-breaking one. It is, in the best possible way, plugging a gap.

But there has been some serious work going on, mostly on the cockpit as Leif Johansson, project manager at Saab customer alliance solutions, explains: "The most notable change will be a new cabin layout. The pilot now has information in feet and knots just as in today's Gripen system. The upgrades will also include a new electronic horizontal situation indicator (HSI), GPS navigation system, attitude heading reference system (AHRS), transponder mode-S diversity, audio panel, a system for warning of overload, and an onboard registration system for flight evaluation.

The testing

The test program starts with just three weeks of ground testing, followed by approximately 25 test flights over a period of two months.

"The biggest challenge has been to develop a new audio system within the given timeframe and to deliver the aircraft by the third quarter of 2011," Johansson explains.

"The audio system is one fairly normal example of how we handle our integration projects. We plan to meet this challenge by working closely with the system supplier throughout the design process and integrating their activities into our own overall development plan. Of course, our own engineers will be closely involved and will monitor the progress of the supplier team as well."

Currently, the test aircraft has been identified and preparation has already begun for the coming modification, verification, and kit proofing. After the kit proofing is finished, ground and flight testing will commence. The aircraft will be removed from service around 2017. What then?

"One possible solution could be a brand-new trainer, possibly owned and operated by industry in a PPP [public-private partnership] agreement," suggests Johansson. "Another solution could be that the Swedish armed forces will be part of a European joint solution – the Advanced European Jet Pilot Training Program [AEJPT] concept.

"Of course, this is speculation and only the customer knows for sure at this point. As for the 105 aircraft, if there is customer interest and/or a market opportunity, we see a potential for extended service, even beyond 2017." ∎

Team 60 was formed in 1974 as a group of four SK 60 from the Air Force Central Flying School at Ljungbyhed AFB in southern Sweden

The latest order includes the installation of a new GPS, audible altitude and primary warning signals

Craft of a 1,000 flights

THE TIME WHEN THE M-346 WAS CONSIDERED A PROTOTYPE HAS ALL BUT ENDED. HAVING JUST COMPLETED ITS 1,000TH FLIGHT, IT IS NOW ON THE VERGE OF PRODUCTION

BY BARBARA BUZIO

The Alenia Aermacchi M-346 Master is the latest-generation advanced fighter trainer specifically designed to bridge the technological gap with the new generation fighters. The M-346 'Master' has now reached the symbolic 1,000 flight milestone

The M-346 flying qualities are born out from a number of state-of-the-art design characteristics embedded in the aircraft. The M-346 platform blends full authority fly-by-wire flight control system with advanced aerodynamics, high thrust-to-weight ratio, and systems that provide the aircraft with high performance in terms of energy maneuverability, acceleration, and the capability to fly at extreme angles-of-attack (over 35°) comparable to the latest-generation fighters.

The M-346 avionics and comprehensive embedded simulation systems takes advantages from the unique expertise gained by Alenia Aermacchi with the MB-339CD and allows the pilot to be trained in modern weapons system and mission management tasks in a high-performance environment.

The end result is that, at the lower end of the training spectrum, the M-346's flight characteristics and performance ensure an easy transition for student pilot progressing from the basic trainer.

At the upper end of the training spectrum the M-346 is capable of downloading training modules from the OCU Phase flown on much more expensive fighters. The structural design includes nine hard-points, accounting for 3,000kg of external stores. The M-346 is characterized also by provisions for the installation and integration of helmet mounted display, radar sensors, electronic warfare system and tactical data link.

The speed of the M-346, its ability to climb quickly and the extreme maneuverability make it a highly-survivable aircraft when compared to traditional turboprop light attack aircraft. The low-maintenance man-hours per flight hour and efficiencies offered by a trainer bases aircraft design also make it a very cost-effective option.

The 1,000th flight was made by the third prototype, representative of the pre-series M-346 standard. The flights were all performed by

The avionics architecture is based on a dual-redundant MIL-STD-1553B digital databus, which has capacity for additional systems

just the three M-346 prototypes and have covered a broad range of missions, from aircraft testing and development to display flights for the many interested air forces and ferry flights for international demonstration tours for important aviation events.

In December 2008, the first M-346 achieved the speed of Mach 1.17, becoming the fastest Italian-designed airplane of all time. The long ferry flights, the completion of air-to-air refuelling tests, and angles of attack of over 30 degrees indicate the significance of the results achieved so far and the overall development of the program, which is now close to its complete maturity.

In addition to Alenia Aermacchi test pilots, the three M-346 have already been flown by over 40 Italian military pilots and by more than 70 from other countries worldwide, including those of the United Arab Emirates, whose air force selected 48 M-346s in February 2009, and those of Singapore, where the M-346 is participating in the competition for 48 aircraft and a complete integrated training system.

The M-346 Master is a military transonic trainer aircraft. It is based on work done by Yakovlev and Aermacchi while working on the Yak-130 as a joint venture.

The M-346 Master programs

The development phase of the M-346 program is now virtually completed. The opening of the flight envelope is also in its final stages. The speed of Mach 1.17 has already been reached, to be followed by further flight envelope expansion up to the design speed of Mach 1.2 and the high angles-of-attack will shortly be achievable (about 40º).

In January 2008 the second M-346 prototype carried out the flight tests in collaboration with the Experimental Test Unit (RSV) of the Italian Air Force, providing also qualification for inflight refuelling using a Tornado equipped with a buddy pod.

With the first pre-series aircraft, which took to the air in July 2008, the M-346 moved into the production phase. The industrialization process is now underway. Production has already been launched on some aircraft parts. The company is also preparing the areas for production and final assembly.

The M-346 production line will be state-of-the-art and has been designed on the basis of a digital manufacturing process. The production flows have been optimized through a simulation based on the DELMIA software that is already widely used in the commercial aerostructures business. An initial rate of 18 aircraft per year is predicted, with the possibility of reaching up to 24 to 48 aircraft per year depending on customer request.

The Italian Air Force should soon sign the contract covering its first batch of the M-346 to fulfil its advanced, lead-in fighter training needs. In February 2009, the M-346 was selected by the United Arab Emirates (UAE) for their new training air fleet. Furthermore, it has been shortlisted (two competitors) in Singapore within the local Fighter Wings Course (FWC).

Current market analysis tells us that there are in service some 2,900 advanced trainers, about 30% of which are already obsolete. We forecast that within the next 25 years the world – excluding Russia and China – will require about 2,000 advanced training aircraft in the M-346 class. Alenia Aermacchi could win over 30% of this market. ∎

Barbara Buzio is head of external relations with Alenia Aermacchi SpA in Italy

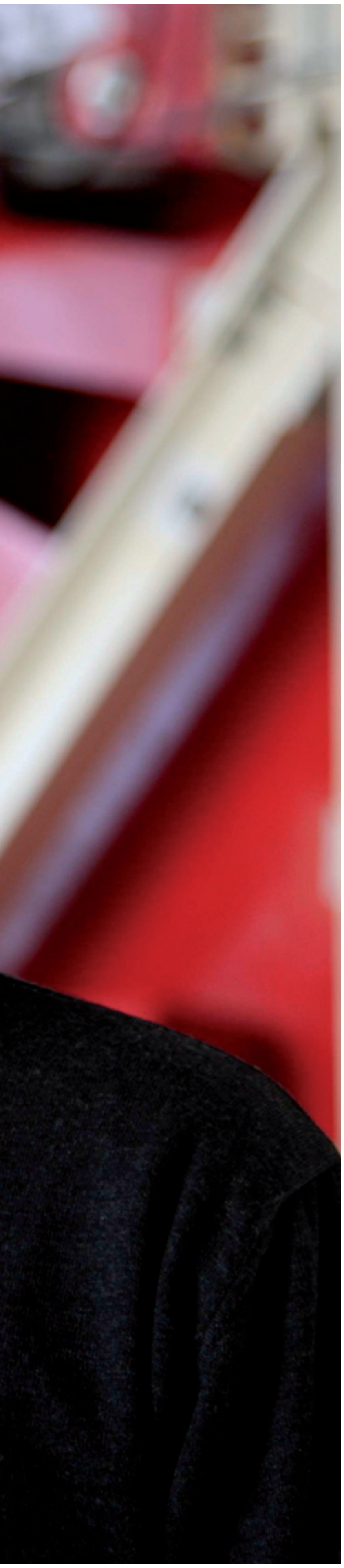
Middle Eastern assembly

The United Arab Emirates government announced at IDEX 2009 (International Defence Exhibition and Conference) in Abu Dhabi that it had begun negotiations for the acquisition of 48 M-346 advanced lead-in fighter trainer aircraft in April 2009.

The agreement, which also includes the creation of a joint venture in the UAE between Alenia Aermacchi and the Mubadala Development Company (Mubadala) to establish a final assembly line for the M-346, is the result of close collaboration between the Italian government and the UAE defense industry.

Man with the XWB-factor

THE DEVELOPMENT OF THE A350 XWB IS MOVING APACE. THOMAS NIELSEN IS AT THE ENGINEERING FRONTLINE AS HEAD OF STRUCTURAL TESTING AND SAYS THAT THE PROGRAM IS ENTERING A CRUCIAL NEXT PHASE



Sparring partner

GKN Aerospace is preparing a dedicated factory to build Airbus A350 composite wing spars and trailing edges in a former warehouse building 8km from the Filton, UK, manufacturing plant it bought from Airbus in January.

Development hardware will be installed in March or April 2010, and the plant will ultimately house five of the world's biggest automated CFRP machines to be capable of turning out 90 of the 20m-long wing spars a month for shipment to Airbus's plant in Broughton, Wales, for assembly.

Senior vice president of business development Frank Bamford says GKN is investing in extra capacity as part of its long-term strategy to win work from customers other than Airbus.

GKN's A350 program investment to date totals £190 million (US$318 million), including £60 million (US$100 million) in repayable launch aid from the UK government.

BY CHRISTOPHER HOUNSFIELD

Times are tough for the big two civil manufacturers. Both have major airliner programs underway, and both are at various faltering points of development. The prime business models upon which orders for many wide-body jets were planned during the boom time a few years ago have all but dried up, despite a predicted increase in air traffic.

To add further strain to this, particularly for Airbus, it still has to spend billions developing the A350 XWB. Boeing has been hit already, and if the 787 flies within the next few months it is still a long way from aircraft certification, a very long way from delivery, and beyond imagination before the company may see a return.

There is a still a big gap in funding for the A350 XWB, challenged only by the rework costs of the A380 as well as compensation due on the A400M.

On top of this there are also accusations of unfair European funding for Airbus, and issues of cross-subsidies. In November 2009, the Spanish government pledged more than €500 million (US$750 million) for the Spanish arm of Airbus, including €278 million (US$417 million) in launch aid specifically for the mid-sized A350, between 2009 and 2015. None of this helps the engineers on the front line of the latest development aircraft in the Airbus stable, despite the optimism of the executives. Executive vice president Tom Williams said recently that Airbus could deliver 'close to 500 aircraft' this year.

In a presentation, Williams confirmed that Airbus has set a production schedule for the A350 XWB jets of 10 aircraft a month. In late 2008, the A350-900 achieved the key 'maturity gate (MG) 5' milestone on schedule.

The company says it is now planning for the A350 to make its first flight in the first quarter of 2012, with entry into service with customer airlines in 2013 (Qantas). Otherwise, Airbus has booked orders for 493 A350s from 31 customers.

Thomas Nielsen, is the senior manager for structural tests for the A350 XWB, and he refuses to be drawn on the issue of cross-funding and downturns, or the preliminary report by the World Trade Organization (WTO) that has found that Airbus received illegal subsidies for the A380 and several 'other' airplanes: "The A350 XWB program funding [including any 'reimbursable launch investment' (RLI)] does not have anything to do with the WTO case. In short, it has had no effect on the project and its progress," he says.

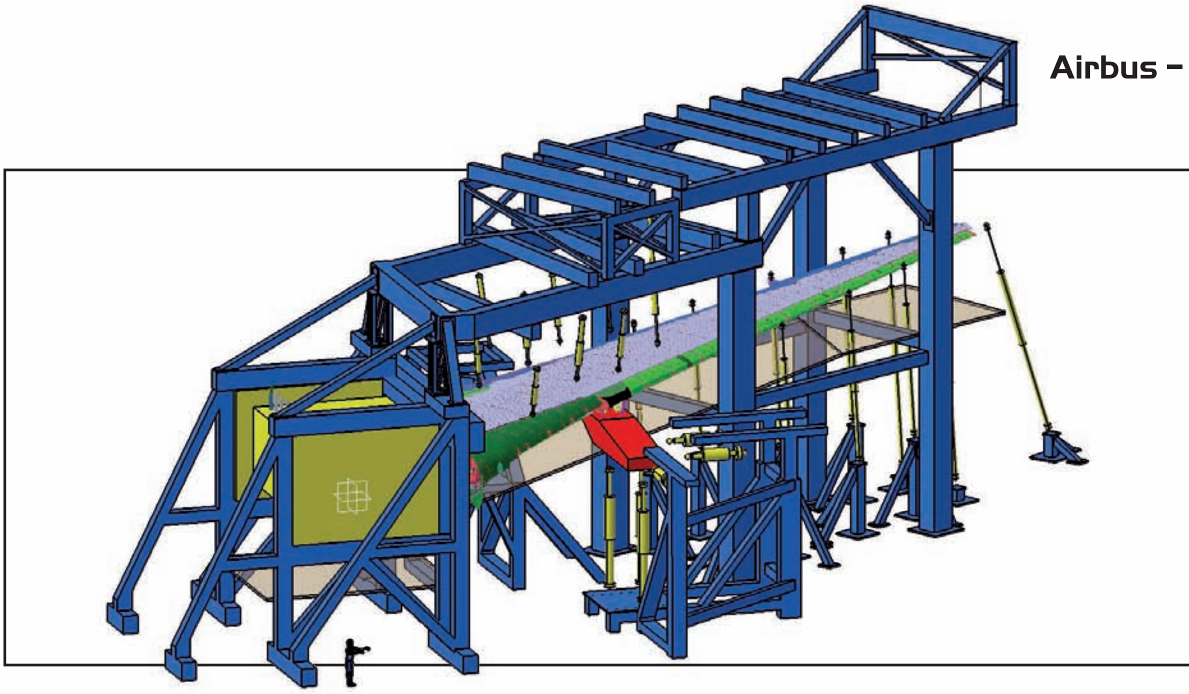
Nielsen started working for Airbus in 1985 as a structural engineer in the fatigue and damage tolerance department, where he coordinated all Airbus fatigue tests for the A320 (center, aft fuselage, and wing) and A330/A340, and then become project leader for the corresponding A340-600 test. Since then he has become something of a legend in his own circles. After the A340-600 project he led the A380 static and fatigue test bench and is now the project leader for the major static and fatigue tests for A350 XWB. "I am responsible for delivering the full airframe static test, multiple section fatigue tests covering the whole airframe, and the single wing hybrid static and fatigue test covering specific areas."

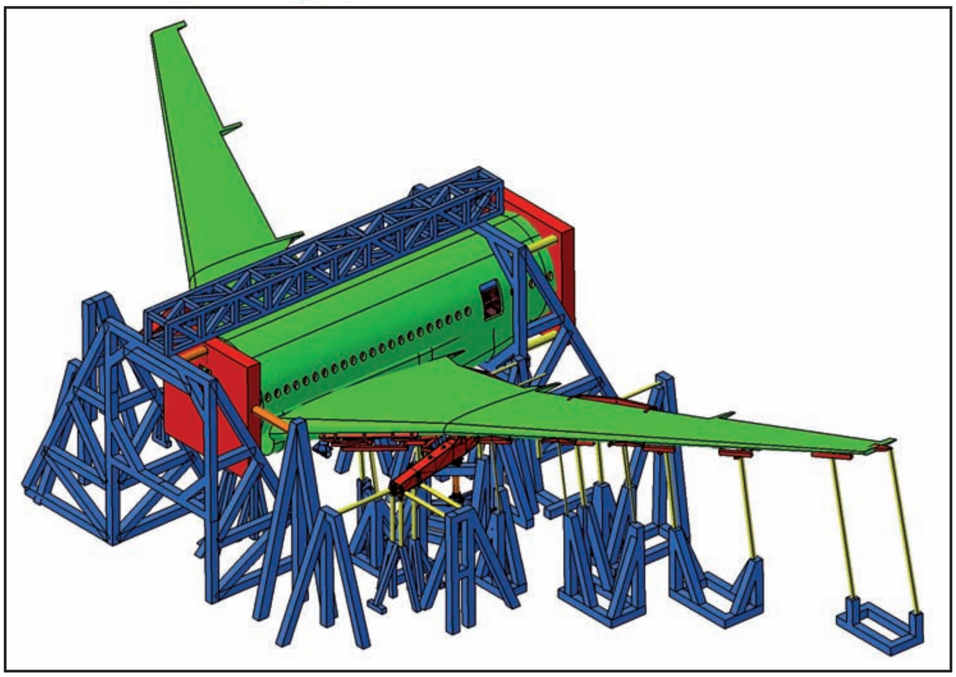
Bearing in mind the current state of the project, how does he view the development from an engineering point-of-view? "All tests are properly specified and defined to enter into test preparation phase – i.e. to start test setup and test means design. These activities will be coordinated with test labs, otherwise known as suppliers.

"In short, the A350 XWB is becoming real. Structure demonstrator programs are progressing well, and by the end of July 2009, Airbus had completed its second A350 XWB test barrel [all carbon fiber reinforced plastics (CFRP)]. The first stone of the new final assembly line in Toulouse was laid on January 14, 2009, factories around the world are taking shape, and production of MSN 1 [the first composite layup] will start soon."

In fact, in August Premium AEROTEC delivered the 27m-long, 8m-diameter autoclave for production of the forward fuselage sections for the A350 XWB. Once fully installed in the A350 hall currently under construction, the autoclave's first cure cycle is planned for the beginning of 2010. It is expected to be fully available for production from the spring of 2010. The barrel's three sections closely reflect the final design of the

The A350XWB second barrel test for the fuselage 1b currently being performed in Hamburg





EW – essai wing – LH wing box (combined static and fatigue test)

EF2 – essai fatigue 2 – Center fuselage plus wing boxes LH and RH (fatigue test)

> **“Supplier selection represents the entry point into the test preparation phase”**

fuselage and were used to develop and validate the complete process chain from the manufacture of individual panels, frames, and clips to shell assembly, section assembly, and the production of circumferential joints.

The main objective of Barrel 1B is to support the validation of design principles and sizing methods. The tests performed on the barrel will mainly focus on the fatigue and damage tolerance of the composite structures, as the barrel will be part of the certification of the aircraft.

The 74,000m^2 factory will house the first stages of final assembly for the A350: the joining up of the fuselage and wings. Aircraft testing and cabin equipping will then be completed in the nearby A330/340 facility.

Smooth planning

It was originally thought that the facility in Toulouse, France, would provide work for more than 1,000 people when fully operational. However, the facility, which has been described as Airbus’s most eco-efficient final assembly hall, is now expected to house a much larger workforce. “With all key players selected today there are more than 5,000 people working on the program, and this figure is expected to increase to 13,000 engineers, including production workers, once production is underway,” reveals Nielsen. Problems have been few, and were, he says, easily dealt with: “On the A350 we have a smaller number of Tier 1 risk-sharing partners who manage the onward supply chain. This program benefited from earlier supplier selection, which was arranged a year earlier than for our previous aircraft programs, and a joint development phase with suppliers.

“Today Airbus is working with our suppliers on a ‘central plateau’. Moreover, our composite test demonstrators are validating our CFRP manufacturing and assembly techniques. Working all together as one – Airbus and our ‘extended enterprise’ – we’re using the same processes, methods, and tools. We have also invested more time, skills, and resources up front to ensure a much more mature design and aircraft, to ensure mature aircraft at first flight, and to allow for faster ‘ramp-up’.”

The whole program has just undergone the next critical phase of supplier selection, but Nielsen is unable to discuss in detail for obvious reasons: “Supplier selection, i.e. test house selection, is a great milestone for such projects. It represents the entry point into the test preparation phase with a design and production of the test setup and test means. It also proves the maturity of the test specification, planning, and resources assessment.”

Although Airbus originally planned to make the A350s from aluminum-lithium, the A350 XWB will feature large CFRP panels for the main fuselage skin. After facing criticism for maintenance costs, Airbus confirmed in September 2007 the adoption of composite fuselage frames for the aircraft structure. The composite frames will feature aluminum strips to ensure the electrical continuity of the fuselage, but the fuselage crossbeams will still be metal.

Test pieces for the A350 are now being built, and Airbus has already produced a prototype wing test piece measuring 18m x 7m to validate its component manufacture and assembly concepts. The A350’s wings will be assembled inside a dedicated 46,000m^2 building at the company’s site in North Wales, UK, construction of which is due for completion by the end of 2010.

According to Nielsen, it is the integration of metallic frames and CFRP panels that has been the most challenging element of the project to date, particularly regarding the wing test. "In general, structural testing for A350 XWB design selected has extensively changed, i.e. a hybrid of traditional metallic structure plus the innovative CFRP structural elements. As a result, the effort on structural tests was increased to establish new databases for this kind of advanced aircraft design. In terms of major structural tests one additional test is required – the single wing test – to justify the wing structure combined with new design elements."

"Techniques need to be developed to react on shorter aircraft development lead times and faster recurrence of similar tests"

The bigger picture

On a broader scale, Nielsen thinks efficiency needs to be high on the agenda for the latest technological developments in structural testing. "When looking at airframe structural testing, as in this project, a focus needs to be on the efficiency of test setups to combine testing and loading of metallic and CFRP structures without overloading the adjacent elements for a common approach toward justification and means of compliance – in other words, an early definition of the overall test pyramid from full scale to component testing with mature test requirements for planning purposes is needed. The future challenge will be for a more virtual testing approach.

"Technical issues can always be seen as challenges as well. In this context aerospace structural testing needs to find answers to the testing of new materials to validate their properties and to provide testing solutions for hybrid designs in the transition from traditional metallic structure to full CFRP airframe structures."

With decades of experience under his belt, Nielsen has a clear and passionate vision for the future of prime test processes. "Aerospace testing needs to develop solutions for test setup, test means, load introduction, and improved control and monitoring systems on a toolkit basis. Techniques need to be developed to react on shorter aircraft development lead times and faster recurrence of similar tests – even full scale and reuse of previous equipment – for a quick and economical test performance.

"The industry also needs to spend an enormous effort on developing more innovative, clean, and efficient products that are light in weight, comfortable for passengers, and economical for successful air traffic with the objective of a less polluted environment and also the satisfaction of people's flexibility and mobility," he says. He is adamant that the prime focus should be the environment: "The aerospace industry, very specifically, needs to take care of the overall environmental resources available on this planet for a clear contribution to all efforts to reduce pollution and limit environmental impacts."

Essential project milestones that must be completed over the next 18 months or so include the completion of the detailed design as well as the finalizing of the baseline specification for the smaller and larger versions of the XWB family, the -800 and -1000. ∎

Airbus's 18m long A350 XWB demonstrator fuselage helped validate the production process for this widebody jetliner's composite airframe

Long-haul, low-cost carrier AirAsia X has signed a firm contract for 10 A350 XWB aircraft, to be used on a network linking its Asian hub in Kuala Lumpur with destinations worldwide

FOR YOUR MOST COMPLEX AEROSPACE TESTS, MOOG MAKES SUCCESS SIMPLE.

Validate new designs faster, manage increased regulatory pressures and optimize test run rates through rapid, repeatable and accurate tests, while protecting your valuable test specimen. When the pressure is on you to perform demanding aerospace tests, Moog's leading-edge solutions deliver flexibility, efficiency and high performance.

Our unsurpassed technical expertise, proven industry experience and close customer collaboration make us the ideal partner for structural, static and fatigue testing for aero structures, components and flight control systems.

Contact us at test@moog.com for more information.
Or learn more about our test solutions for commercial and military aircraft at www.moog.com/aerotest.

WHAT MOVES YOUR WORLD

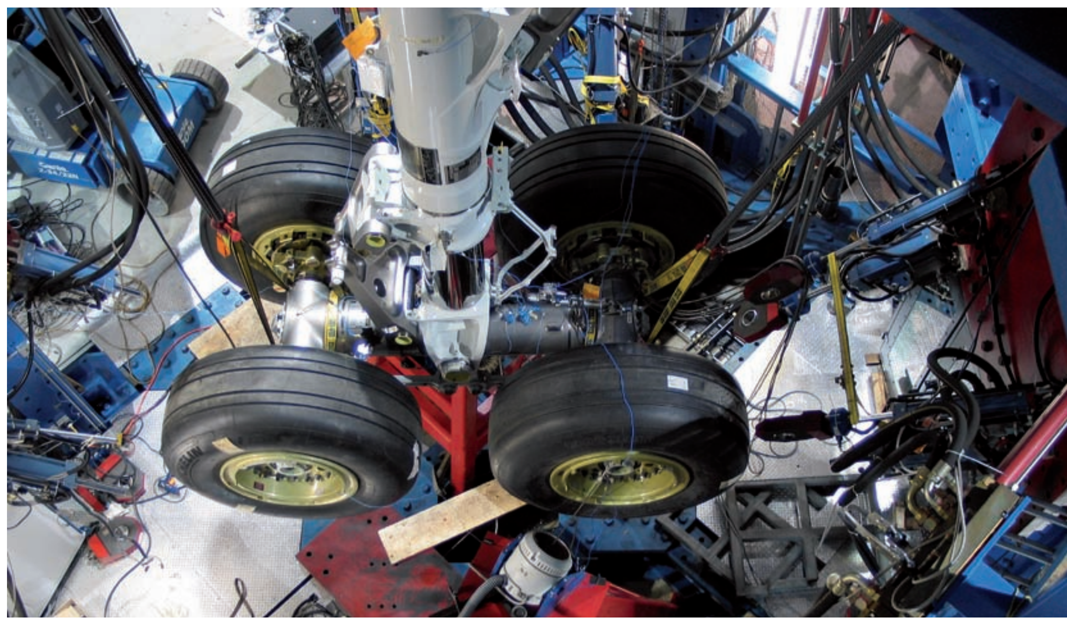
MOOG


WESTMORELAND MECHANICAL TESTING & RESEARCH
INTERNATIONAL
Youngstown, PA USA
Banbury, U.K.
BOEING
AIRBUS A380
WESTMORELAND MECHANICAL TESTING & RESEARCH LTD.
www.WMTR.com
www.WMTR.co.uk

The wheels on the (big) bus

THE HUGE AIRBUS A380 LANDING GEAR TAKES A FORCE OF 1,300,000 LB. PERFORMING EXPERIMENTAL MODAL ANALYSIS DEMANDS VERY SPECIAL EQUIPMENT

"When testing at highest force levels, the resulting bending and torsion modes became truly visible"



BY JERRY FIREMAN

In the Super Rig at Goodrich Corporation's facility in Oakville, Ontario, consultants subjected a body landing gear prototype assembly for the Airbus A380 to experimental modal analysis (EMA). The six-wheel landing gear system weighs approximately 12,000 lb, and its size exceeds 25ft when fully extended. After suspending it 12ft above concrete, burst-random and stepped-sine excitation was applied up to 1,000N force levels. The major landing gear mode shapes extracted from the test data, both in static and fully extended stroke, supported structural studies at Airbus and helped engineers verify finite element (FE) models generated by Goodrich's Landing Gear division.

"In landing gear system development, it is our task to meet the required modal stability and structural safety in reaction to all loads and circumstances it will encounter throughout its service life," says Alvin Fong, manager of landing gear performance at Goodrich's Oakville landing gear facility.

To support the structural testing campaign to be performed on the right-hand body landing gear system, Goodrich contracted the US-based team of LMS Engineering Services. The LMS assignment involved EMA on a landing gear system, which enabled Goodrich to validate FE models of this complex mechanical assembly.

The central feature of the Oakville facility is the Super Rig, an extremely large steel structure that encompasses nine test bays, each capable of handling an A380 body or wing gear. The entire Super Rig structure sits in a 3ft-deep pit approximately the size of two football fields.

The test setup required the fabrication of two solid stands, each filled with 5,000 lb of concrete. To avoid free-play in landing gear joints as much as possible, the body landing gear unit was preloaded with static forces, applied vertically through soft bungee straps.

Multiple shakers were installed to ensure sufficient energy provision while performing modal tests on a specimen of this size and weight. Two electrodynamic shakers, capable of generating 1,000N peak forces, were conditioned to provide either burst-random or stepped-sine system excitation. Initial modal tests showed that the test rig itself exhibits dominant fore-aft motion around 8Hz. As these dominant frequencies fall within 0-10Hz frequency, and are of interest for landing gear modal testing, dynamic coupling between ear modes and test rig modes was observed. To keep a close eye on this rig-gear interference throughout the test campaign, LMS engineers added a number of rig measurement points to the modal test geometry of the landing gear unit.

To verify the quality of the modal test setup, LMS consultants evaluated autopower spectra, as well as frequency response function (FRF), coherence, and reciprocity. These checks indicate whether all input energy is present at the output side, and whether excitation and measurement points are located favorably. Autopower spectra, related to front and rear shaker excitation, showed that both shakers' inputs were of the same force level and excited all frequencies equally across the frequency range of interest.

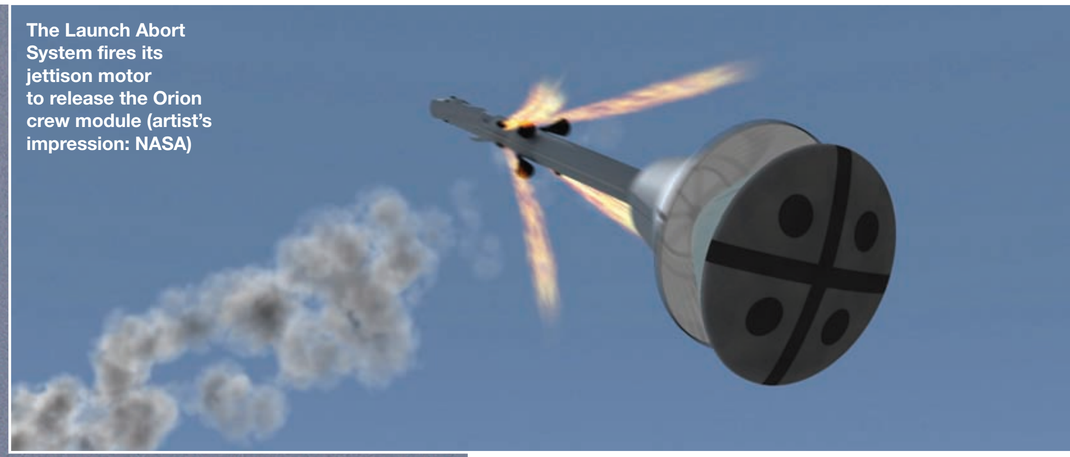
"When evaluating structural FRF coherence and reciprocity, the two burst-random shaker inputs created only limited non-linear landing gear behavior in static stroke and extended positions, at specified force levels of 5-15N," explains Paul Weal, LMS Engineering's business development manager. "However, when increasing force levels firmly using stepped-sine excitation, 200-1,000N, we identified stronger non-linear behavior, mainly as a result of a slight backlash that was present in the huge landing gear-joint connections," continues Weal. "When testing at highest force levels, the resulting bending and torsion modes became truly visible, as we witnessed displacements of about 1in."

The high level of correlation between measured and synthesized FRFs showed that the modal analysis was successful in accurately reproducing the measured FRFs.

"The most relevant modes retrieved for the landing gear static-stroke configuration were fore-aft, lateral, and torsion resonance below 15H," adds Fong. "For extended stroke, the identified fore-aft, lateral, and torsion modes were lower than the static stroke. In general, the measured mode frequencies turned out to be lower that their predicted counterparts.

"The project confirms the modal characteristics of the right-hand body landing gear system developed by Goodrich for the new Airbus A380 airliner. The major mode shapes extracted from the test data were used to verify FE landing gear models here at Goodrich, and supported structural investigations at Airbus." ∎

Jerry Fireman is the president of Structured Information, based in Lexington, , Massachusetts, USA



The Launch Abort System fires its jettison motor to release the Orion crew module (artist's impression: NASA)

Escape plan

AS CONCERN ABOUT ASTRONAUT SAFETY GROWS, NASA HAS INCLUDED A LAUNCH ABORT SYSTEM (LAS) IN ITS CONSTELLATION PROGRAM. THE FIRST FULLY INTEGRATED TEST IS SCHEDULED FOR EARLY NEXT YEAR

The Max Launch Abort System successfully launches at NASA's Wallops Flight Facility in Virginia (NASA/Sean Smith)

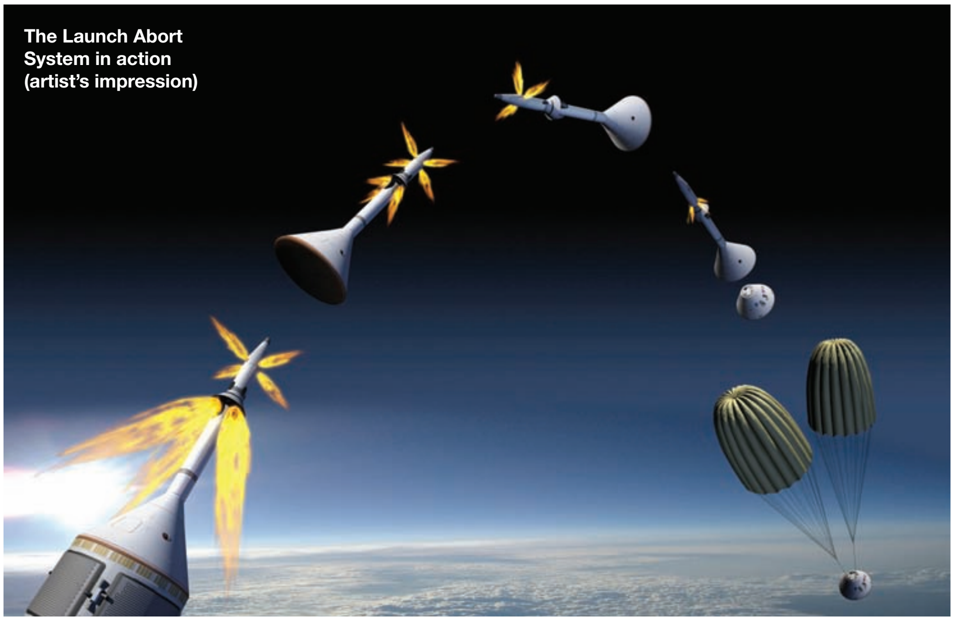
BY LIZ ELLIOTT

NASA's manned spaceflight program is soon to reach a critical stage. With the Space Shuttle due to retire in 2010, a new launch vehicle will be needed to carry the astronauts of tomorrow to orbit and beyond. Constellation is NASA's answer. The new launch system will have cutting-edge technology, and the capability to one day reach other planets in the solar system, such as Mars.

The Constellation spacecraft for manned missions consists of an Ares I Launcher (a two-stage rocket), the Orion crew module, and the Launch Abort System (LAS), which sits on top of the Ares I launcher and is attached to the Orion module. The LAS is one considerable difference between this new manned launch vehicle and the Space Shuttle, which had no such system. However, it is not the first time such a system has been implemented – the Apollo program rockets of the 1960s and 1970s also had a Launch Escape System (LES) that sat atop the crew module.

The LAS is an improvement on the LES design, enabling the crew to escape over a wider timeframe. If a malfunction occurs on the launch pad, during launch, or during the early stages of flight, the LAS fires its abort motors and attitude control motors to separate from the Ares I launcher, carrying the Orion crew module with it. At this point, astronauts inside the capsule would be subjected to an acceleration of around 12g (the maximum acceleration experienced by the crew in a Space Shuttle launch is around 3g). The LAS then uses its attitude control motors to reorient the crew module before releasing it. The Orion crew module can then make a safe parachute landing. If the LAS is not used before 30 seconds after the ignition of the second rocket stage, it is jettisoned using its jettison motors. The Ares launcher second stage then continues its ascent while the LAS falls to the ocean below. So as not to be a navigation hazard for ships, it is designed to sink and is not recoverable.

In March 2010, the LAS will be put to the test in Pad Abort 1 (PA-1), which will simulate an emergency abort on the launch pad. This will take place at White Sands Missile Range in New Mexico, where the LAS is currently being integrated in preparation for the test. A mock-up of the Orion Crew module will be used to enable testing of the full abort cycle, including separation of the module from the LAS and the parachute landing of the module. This integrated test


The Launch Abort System in action (artist's impression)

The testing of rocket motors during the development of the Launch Abort System's jettison motor at the Aerojet facility in California (Photo: Aerojet)

> "The control motor represents quite a jump in the technology for controllable solids"


David McGowan, chief engineer of the Orion LAS project

is the first of a series that will be used to assess the performance of the LAS in a variety of scenarios, including various critical stages of ascent of the launch vehicle.

Getting ready to motor

David McGowan is the chief engineer of the Orion LAS project, based at NASA's Langley Research Center, Hampton, Virginia. He has been working closely with the engineers of the LAS team to bring the LAS to a state of readiness for the integrated tests. Currently the LAS structures, jettison motor, and abort motor have been successfully integrated; however it is the attitude control motor that is proving to be the most challenging aspect of the LAS design.

The attitude control motor is a solid propellant motor consisting of 18 directional nozzles that has the important function of reorienting the Launch Abort Vehicle (or LAV – this is the name for the combination of the LAS attached to the Orion crew module) before the crew module is released. Without this essential part of the abort sequence, it would not be possible for the crew module to safely deploy parachutes.

"The attitude control motor represents quite a jump in the technology for controllable solids," says McGowan. "It is an extremely complex motor that is really pushing the state-of-the-art." The eight-valve controllable solid rocket motor went through a series of valve-level tests early in the development cycle, where failures occurred.

"These failures were eventually attributed to failures in the composite carbon-carbon/silicon carbide material used for key components inside the valve," McGowan explains. "What we found was that we had lower than desired material properties and through additional refinement of our analysis of the valve, we felt that the loading environment was more severe than originally predicted.

"We are addressing these issues through material processing improvements in the composite materials and through additional tests to better characterize the internal environments and to help correlate our analytical predictions. We did have a successful hot fire test of a valve earlier this year which was able to improve our confidence in these parts as we move to PA-1."


Test fire of a sub-scale Launch Abort System attitude control motor thruster for the High Thrust 8 test (Picture: ATK)

The multidisciplinary nature of the LAS project has meant that engineers from one or more NASA centers have to work together. This provides further challenges – the attitude control motor being a case in point. The team is able to work together in a virtual manner.

"We have relied heavily on the combined knowledge of the LAS team members at both Langley Research Center and Marshall Spaceflight Center," says McGowan. "This team has been critical in working on the challenges of this motor with the contractor team and helping the LAS leadership team stay informed of the rapidly changing environment.

"Although we can do a lot of things virtually, more frequent travel has been required because of the added benefit of face-to-face interactions – especially when you are new to the team."

After Pad-Abort 1, the next test will be Ascent-Abort 1 (AA-1) in 2011. A retired Peacekeeper missile stage will be used to launch the LAS and mock-up crew module to a key phase of flight, where an abort will be initiated. As the velocity of the launch vehicle is increasing while the atmospheric pressure is decreasing with altitude, there will be a point of maximum dynamic pressure (also known as max Q), where the aerodynamic loads are the worst.

What the NASA team wants to know is whether the LAS can successfully complete the abort sequence under the extreme conditions of that point in the flight. Similarly in Ascent-Abort 2, scheduled for June 2012, the LAS abort sequence will be tested at the point where the launch vehicle breaks through the sound barrier (called the transonic flow regime). During this phase, the drag forces on the craft will be

The mock-up Orion crew module that will be used for the Launch Abort System Pad Abort 1 test is prepared for transport to the White Sands Missile Range in New Mexico

The mock-up Orion crew module that will be used for the Launch Abort System Pad Abort 1 test prior to transport to the White Sands Missile Range in New Mexico (Pictures courtesy: NASA)

Max Launch Abort System

An alternative escape system, called the Max Launch Abort System (MLAS), has been developed by another NASA team, led by the NASA Engineering and Safety Center (NESC). The MLAS utilizes a slightly different technological design to the LAS, with four solid rocket boosters inside a bullet-shaped faring that is attached to the crew module. Like the LAS, it carries the crew module clear of the launch vehicle in the event of an emergency.

On July 8, 2009, the MLAS test launch took place at NASA's Wallops Flight Facility in Virginia. The test simulated an abort on the launch pad, with the MLAS boosters firing for around seven seconds, lifting the MLAS and a full-scale crew module mock-up to an altitude of around one mile. The crew module then separated successfully and made a parachute landing into the Atlantic Ocean.

Despite a successful demonstration of the MLAS, there are no current plans to use it for the Orion spacecraft. Although a promising concept, the limited analysis and testing it has so far undergone means that it has a long way to go before it can be given serious consideration for Orion.

the worst due to the turbulent nature of the transonic airflow.

The results of Pad-Abort 1 will be used to improve the LAS in time for Pad-Abort 2 in May 2013. The final test will be Ascent-Abort 3 in October 2013, which will assess the performance of the LAS in the event that control of the launch vehicle is lost. The flight data collected in all these tests will monitor and thereafter be used to improve the response and controllability of the LAS. Thermal, pressure, acoustic and strain data will provide the LAS team with an accurate picture of how the LAS and its components withstand the extreme conditions of launch, ascent, and an abort.

On completion of the tests, the LAS will be ready for the first manned flights of the new Orion/Ares I spacecraft to the ISS, planned for around 2015. The resultant LAS that will be attached to the real Orion crew module, the 'production' vehicle, will be ready to respond to a number of possible triggers, which can be manual or automatic.

ADL and computer simulation

For the latter, abort decision logic (ADL) software is used to decide if an abort is required. This software monitors critical systems on the Orion and Ares vehicles via a set of abort triggers, as well as monitoring that the launch vehicle is on course. As an extra fail-safe, it will also be possible for the crew or ground personnel to initiate, delay, or modify an abort if needed. All the abort triggers will be tested, using pre-planned flight conditions and test-specific avionics.

The LAS may not have flown yet in the real world, but in the virtual world of computer simulation, it has flown many times, in many different scenarios. Predicting the characteristics of the aerodynamic, aerothermal, acoustic, and structural loading that the LAS will undergo during ascents and aborts is also an important task that computer simulation can be used to perform. "Computer simulation plays a large part throughout the development and testing of the LAS," says McGowan. "Computer models are used to analyze the various elements of the LAS as it is being designed and tested. Various levels of assembly are analyzed as part of this process."

Although computer simulation is invaluable for the first stages of the design and testing process, it does not completely replace the need for real-world hardware tests – at least not yet. McGowan recalls the first time that he was on site for a test of one of the valves for the Attitude Control Motor, "I was pretty new to the project and there already been several other tests. It was a great experience to see the hard work of so many people come together."

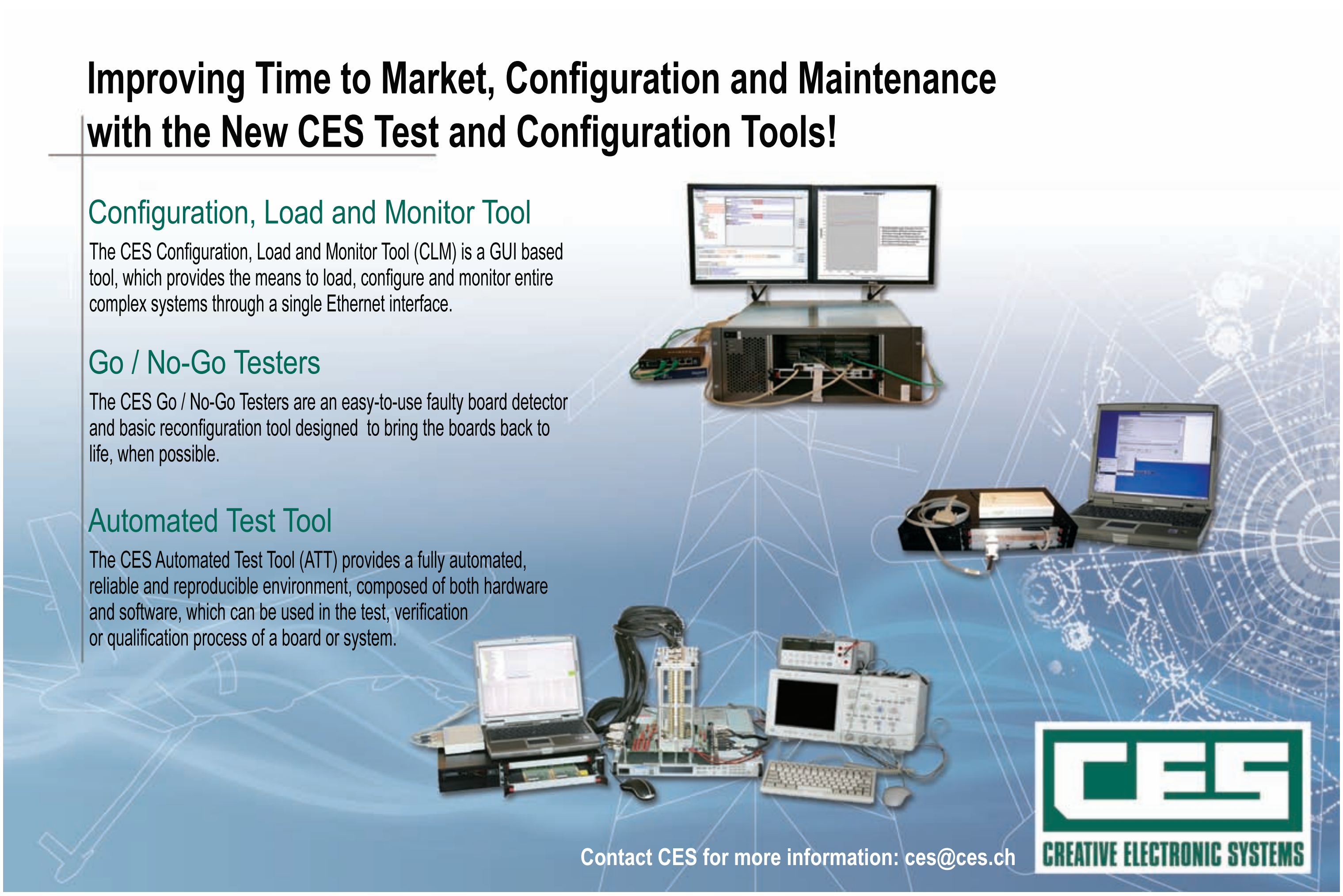
The LAS team is currently working hard to deliver the Attitude Control Motor in time for the first integrated test in March. When the Launch Abort System is completed, it will be the one part of the spacecraft that should never have to be used in a real-life launch. It is possible that it never will be. Has it been worth all the effort? McGowan thinks so.

"The LAS will substantially improve crew safety," he says.

In the future, loss of a spacecraft during launch will no longer also mean the loss of its crew, and that can only be a good thing. ∎

The Launch Abort System's abort motor is connected to the adapter cone assembly at the White Sands Missile Range in New MexicoPhoto credit: US Army White Sands Missile Range


Avionics Development, Test & Integration Tools
Proud to be Part of the A350 Development Team
Avionics Test System Family ADS2
Avionics Databus Products (MIL-STD-1553, ARINC 429, AFDX, ARINC 825)
Data Loading Products (ARINC 615-3, 615A)
Mobile Simulation Systems and Software (AFDX, CMS380, CMS350, etc)
AFDX Lab Switch for Test & Integration
ADS2 Realtime System Integration Bench
Laptop-based AFDX Solution
NEW
NEW
MIL-STD-1553 MIDS Compliant
AFDX Switch
TechSAT Technical Systems for Avionics and Test • www.techsat.com
TechSAT GmbH
Gruber Strasse 46c • 85586 Poing • Germany
Tel +49 (8121) 703-0
Fax +49 (8121) 703-177
ts-info@techsat.com
TechSAT Hamburg GmbH
Hein-Saß-Weg 36 • 21129 Hamburg • Germany
Tel +49 (40) 333-979-45
Fax +49 (40) 333-979-54
hamburg@techsat.com
TechSAT North America
Lake Washington Air Harbor • Hangar Three
3849 N.E. 98th Street • Seattle WA 98115 • USA
Tel +1 (206) 910-3908
north.america@techsat.com
techSAT
mastering realtime complexity


Improving Time to Market, Configuration and Maintenance with the New CES Test and Configuration Tools!
Configuration, Load and Monitor Tool
The CES Configuration, Load and Monitor Tool (CLM) is a GUI based tool, which provides the means to load, configure and monitor entire complex systems through a single Ethernet interface.
Go / No-Go Testers
The CES Go / No-Go Testers are an easy-to-use faulty board detector and basic reconfiguration tool designed to bring the boards back to life, when possible.
Automated Test Tool
The CES Automated Test Tool (ATT) provides a fully automated, reliable and reproducible environment, composed of both hardware and software, which can be used in the test, verification or qualification process of a board or system.
Contact CES for more information: ces@ces.ch
CES
CREATIVE ELECTRONIC SYSTEMS

Flying off the fat of the land

UP TO 600,000 GALLONS OF BIOFUEL WILL BE PRODUCED FOR THE US NAVY AND US AIR FORCE OVER THE NEXT COUPLE OF YEARS

Jennifer Holmgren is general manager of renewable energy & chemicals for UOP LLC

BY CHRISTOPHER HOUNSFIELD

Almost 600,000 gallons of biofuel will be produced via a renewable jet fuel process technology for the US Navy and Air Force as part of a joint program run by the Defense Energy Support Center (DESC). Up to 190,000 gallons of biofuel will go to the Navy and 400,000 to the Air Force for alternative fuels testing and certification for US military aircraft. This started in October 2009 and will continue throughout 2010.

DESC awarded the contract to UOP, a Honeywell company, for fuel made from tallow, or animal fat, provided by Cargill. Sustainable Oils was awarded the contract for camelina as the feedstock and Solazyme was awarded a contract for use of algae as the feedstock.

All are sustainable non-food feedstocks that do not interfere with valuable food, land, or water resources. Jennifer Holmgren is the general manager of renewable energy & chemicals for UOP. She spoke to *Aerospace Testing* about the detail of this unprecedented project.

How does the process tie in with the US government program on biofuels?

We are pleased to see that the US military is taking this important step toward the use of bio-derived jet fuel on its platforms. We have proved that our technology produces a viable fuel in commercial flight applications and are pleased to have the opportunity to work with our partners to support the needs of the US military.

What will be done with these initial deliveries of biofuel?

The fuel that UOP will produce will be used for testing by the US Navy and Air Force. Ultimately the data gathered from these activities will be used to pursue certification of biofuels for military platforms. The Navy has said they are hoping to begin test flights on the F/A-18 by this summer.

UOP laboratory fuel samples and production plant

Please could you describe the test and development program?

The testing will be completed by the Navy and Air Force. The fuel will be produced using the UOP renewable jet fuel process technology that was developed in 2007 under a contract from DARPA.

The actual production will take place at a third party fuel facility, modified to run our process. Some fuel has already been delivered. We will continue production and deliveries this year and into 2010.

How was UOP chosen?

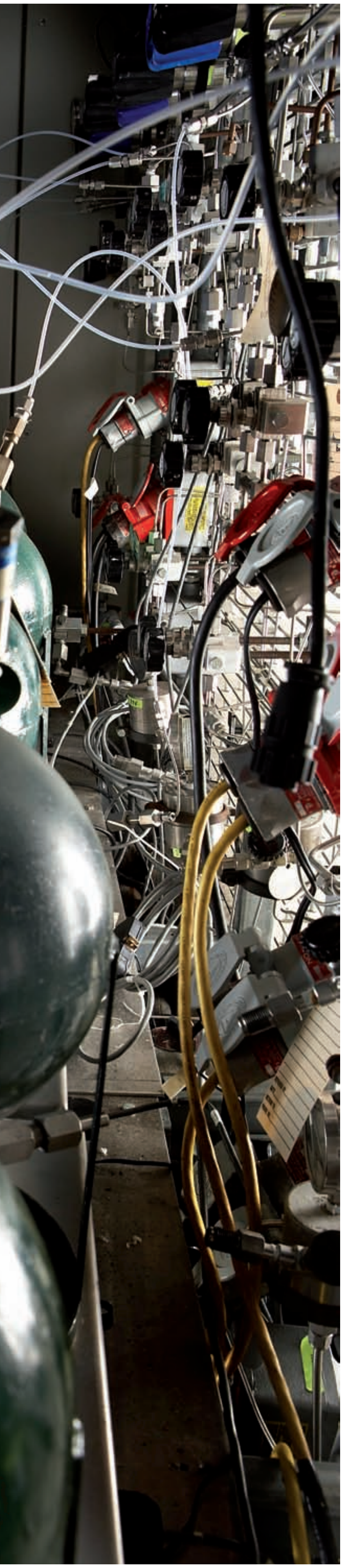
I would say that our renewable jet fuel technology has been proved already in other flight applications and we were able to prove to DESC that we could meet the specs they required using second-generation feedstocks.

What techniques are used to extract the fuel from algae (and other substances)?

The UOP proprietary process is based on the hydroprocessing technology that has been used in refiners for almost 50 years. Hydrogen is used to remove oxygen from the natural oil and then the product is further isomerized to get to the product properties needed.

What is the long-term aim?

We believe that commercial production and use of biofuels in aviation could happen within the next five years, but there are a few hurdles to overcome. First, we must continue to develop the technology and processes for harvesting and processing feedstocks to get to the natural oils used in our process.



Fuel from saltwater

Boeing, Honeywell's UOP, and the Masdar Institute of Science & Technology announced in October 2009 that they will commission a study on the sustainability of a leading family of saltwater-based plant candidates for renewable jet fuel.

The study was commissioned as part of the Sustainable Aviation Fuel Users Group consortium. The Masdar Institute of Science & Technology in Abu Dhabi will lead the study, which will examine the overall potential for sustainable, large-scale production of biofuels made from salicornia bigelovii and saltwater mangroves – plants known as halophytes. Yale University's School of Forestry & Environmental Studies will also participate in the analysis, which will include an assessment of the total carbon lifecycle of biofuels.

Halophytes can be highly productive sources of biomass energy, thrive in arid land, and can be irrigated with seawater, making them suitable for biofuel development and confirming that Abu Dhabi is a viable location for conducting a lifecycle-analysis study. With improved plant science and agronomy, early testing results indicate that halophytes have the potential to deliver very high yields per unit of land.

> **"We believe that commercial production and use of biofuels in aviation could happen within the next five years"**

Japan Airlines (JAL) was the first airline to conduct a demonstration flight using a sustainable biofuel refined from the energy crop, camelina (below)

We have proved that our technology can convert oils from second-generation feedstocks to fuel, but we need to make sure that there are enough feedstocks to support large-scale production. Camelina and jatropha are two sources that we believe will achieve this within the next three years or so. Algae is probably further away, but it has great potential. These oils are being produced today, but in smaller quantities that will need to increase to support commercial use.

The other large hurdle is certification, which is why this program is such an important milestone. The data collected will help with that process.

The final hurdle to commercial use is the construction of a refinery to produce the fuel. We are seeing interest from the refining community and hope to announce technology licensors in the near future.

How will the 600,000 gallons be integrated into the fuel system?

The fuel does not require any changes to the aircraft. The Navy/Air Force will blend the bio-based fuel with petroleum-based fuel and execute lab, ground, and flight tests.

The 600,000 gallons is coming from multiple feedstocks and will be delivered to the Navy and Air Force at separate times. The complete amount will not all be used in the same place. The awards were given based on the feedstock that is being used to create the fuel.

For the Navy, Sustainable Oils will provide up to 190,000 gallons of fuel from camelina; Solazyme will provide up to 1,500 gallons of fuel from algae. For the Air Force: Sustainable Oils will provide up to 200,000 gallons of fuel from camelina, and UOP will provide up to 200,000 gallons of fuel made from animal fats provided by Cargill.

What aircraft and how? What alterations need to be incorporated into aircraft engines to adapt to the new fuels?

The Navy and Air Force are looking at several platforms. The Navy's first objective is the F/A-18. No changes are required to the aircraft with this fuel. That is a key property of the fuel that our technology produces. It is virtually indistinguishable from petroleum-based fuel, enabling it to leverage the existing infrastructure from the refinery to storage, transportation, and the fleet technology.

How did UOP get involved in the scheme?

Our efforts started back in 2007 when we received a DARPA contract to develop technology for the conversion of biofeedstocks to renewable JP-8 fuel for the military. Once the project was complete and we had a viable technology, we continued to look for further opportunities with military and commercial applications.

Earlier this year, we worked with Boeing and several commercial airlines (Air New Zealand, Continental, and Japan Airlines) to conduct biofuel-demonstration flights on Boeing commercial aircraft. ∎

The fast and the curious

MOOG HAS INTRODUCED SYSTEM-OF-COMMUNICATION INTERFACES BASED ON REAL-TIME ETHERNET THAT INCREASES THE FUNCTIONALITY OF SERVO CONTROLLERS, RAPIDLY BOOSTING TEST TIME

BY MARIE LAURE GELIN

Commercial and military aircraft manufacturers place great emphasis on the accuracy and repeatability of the test loads applied to their structures, with test-specimen safety being of paramount importance. Performing static and fatigue tests on high-value aero-structures and components requires specialist skills and experience in a wide range of engineering disciplines.

Moog's advances in real-time Ethernet interfacing, data acquisition, and control for advanced test control systems enable a growing range of test tasks to be carried out more easily, reducing setup time and optimizing test running rates. This places accuracy and test specimen safety at the heart of their system architecture.

In an industry that continuously pushes technology to its absolute limits, employing the most advanced test-and-simulation solutions is crucial. Testing, whether military or commercial, is designed to validate the design and structural integrity of aircraft, and manufacturers must conduct rigorous and stringent test programs to ensure they meet a wide range of mission-specific performance, regulatory, and commercial requirements.

Moog, the designer, manufacturer, and integrator of test and simulation systems and precision-control components, develops high-performance test solutions for aircraft manufacturers and test laboratories around the globe that focus on testing flexibility, improved productivity, and increased accuracy, all the while ensuring the test specimen is completely safe.

Faster, for accuracy

Test systems must be operational for long periods of time, anywhere from two to six years, to be able to run comprehensive and conclusive tests to verify aerodynamics and fatigue factors under a variety of conditions and loads.

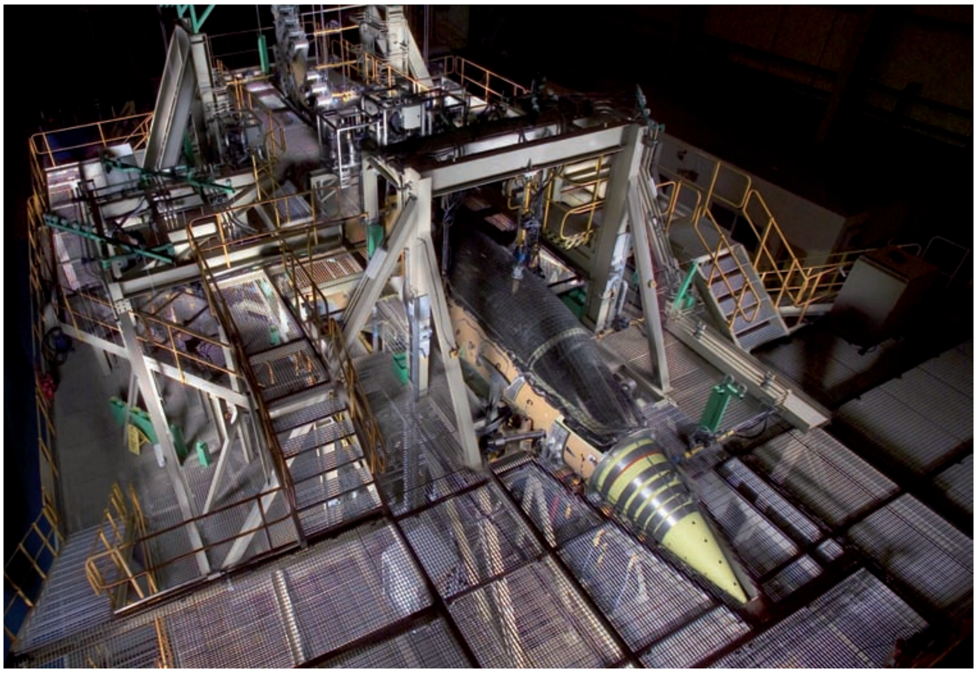
Moog has recently introduced a combination of communication interfaces based on real-time Ethernet that increases the functionality of servo controllers and boosts the performance of aerospace testing – providing faster graphics, accurate synchronization of up to 500 control channels, reduced latency time, and complete management of specific safety procedures to eliminate any risk on the test specimen.

"The real-time Ethernet interface provides the test system with a high bandwidth and an unprecedented level of safety, and is particularly suited for high-performance aircraft, helicopter, and spacecraft testing," says Karel van Gelder, product line manager at Moog.

"The test specimen can be protected against single-point failures as well as dormant failures of any part of the control system," adds van Gelder. "No component should fail without being detected. Other systems using legacy technologies can't provide the same level of safety, based on a system architecture uniquely supported by real-time Ethernet."

The new hardware architecture uses two types of Ethernet interfaces. One Ethernet interface enables real-time data transfer between the command generator (real-time front end) and the localized control loops managed by the Moog test controller. It uses specific and dedicated protocol software for data transfer, which contributes to reduced latency while running tests. For example, the Quad Core IPC processor technology, combined with the new Ethernet interface, enables reliable control of 500 control channels with up to 500Hz set-point command rate and a latency of less than 5ms, even with large iron bird test systems with up to 640 look-up tables and calculation channels.

A second type of Ethernet interface is used for the transfer of time-stamped force and position variables, and spec-



The Typhoon Eurofighter undergoing major fatigue testing (picture courtesy BAE Systems)

The Moog 160-channel test controller system for Northrop Grumman (above)

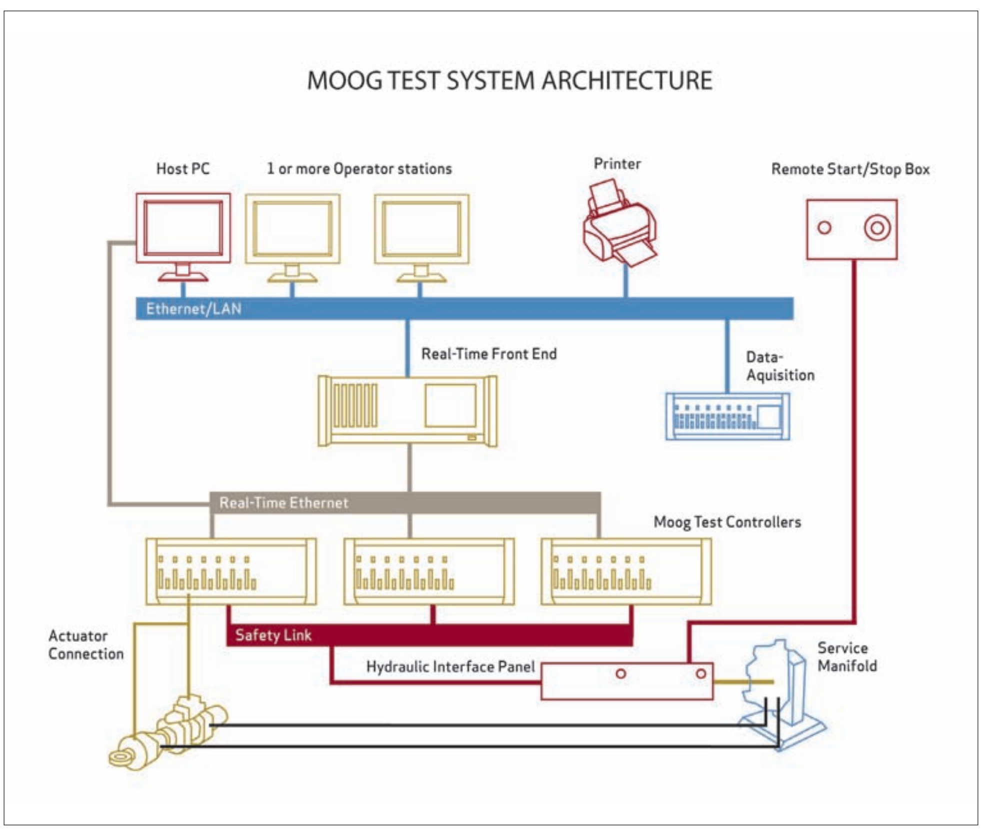
trum data from the load-control system to the data acquisition system. The Ethernet interface can also be activated to produce snapshots, archives or analysis from the servo controller, based on data from the data acquisition system. "This is all about fast- and easy-to-setup test systems that can be integrated with the users' existing test and laboratory infrastructure," explains van Gelder.

Moog's test controllers incorporate an innovative control loop technology that can handle complex multichannel tests of up to 500 servo channels. Their flexibility and high-performance handling of complex testing formulas using proprietary software are particularly suited for advanced aerospace testing. Moog provides servo controllers that run static and dynamic structural tests, ranging from complete aircraft and subassemblies to components.

Aerodynamic loads at control surfaces

Iron-bird solutions can be used to study and test flight controls, landing gears, and hydraulics of an aircraft system. The correct functioning of different aircraft systems and endurance testing can both be supported. A hydraulically powered computer-controlled loading system is used to reproduce inflight aerodynamic loads.

During the test, the user can define virtually any real-time relationship between any input and output, including modifying mathematical functions, using measured values, and applying values of any channel or pseudo channels, such as real-time-updated calculations as parameters. This enables programming of different load versus angle curves for each flight phase to be automatically sequenced during the iron-bird test.



Seamless integration with existing infrastructure

A recent test system installation involved a fully integrated multiple channel system that combines Moog software and test controllers and includes real-time Ethernet interfaces. The test system features a higher communications bandwidth that enables large scale multichannel tests to be run more quickly with improved safety.

Specific features include a load control system where one cabinet can operate multiple independent tests from a number of workstations. The system can perform one full-scale test or a variety of individual tests in any combination of control stations depending on the specific application.

The load control system can be set up to communicate seamlessly with different external data acquisition systems, such as HBM, providing greater flexibility to manage a range of tests. Because the two systems are connected via Ethernet, the system enables direct cross-checking of data from the load control system and data acquisition system through time stamps. This enables all data to be stored and archived more quickly and efficiently on a hard disk for post-test analyses. ∎

Marie Laure Gelin is the marketing manager with Territory

Defusing the time bomb

WHEN AIRCRAFT OUTLIVE THEIR TEST EQUIPMENT, NEXT-GENERATION INTERFACE SOLUTIONS FROM MBS WILL MAKE UPGRADING EASIER

BY JOHN COLE

Computer-hosted testing solutions often hold a hidden cost for aerospace testing and maintenance organizations. Although their aircraft often remain in service for 30 years or more, the computer databases used in their test systems typically become obsolete within 10 years. Consequently, maintaining an operational test system when computers or databases fail can require the expense of replacing interface cards, developing new software, and re-qualifying the test system.

Fortunately, a new class of avionics bus testing solutions is emerging that offers longer life spans for test equipment. Employing standard Ethernet and IP protocol, they show promise for ending this vicious cycle.

For almost 30 years, test-system manufacturers have consistently made use of the latest PC consumer interface technologies. From PC-XT in the early 1980s, to PC-AT, to PCI and PCI-X – each new generation has brought greater performance and ease of use at low cost.

“There’s a problem, however,” says Charles Nicholls, technical director of MBS Electronic Systems. “These buses are lasting no longer than 10 years before being phased out – but the pieces of aircraft equipment they test have lifetimes of two to three times longer. As test systems get old, it becomes more and more difficult to replace parts when failures occur. This is creating serious problems.”

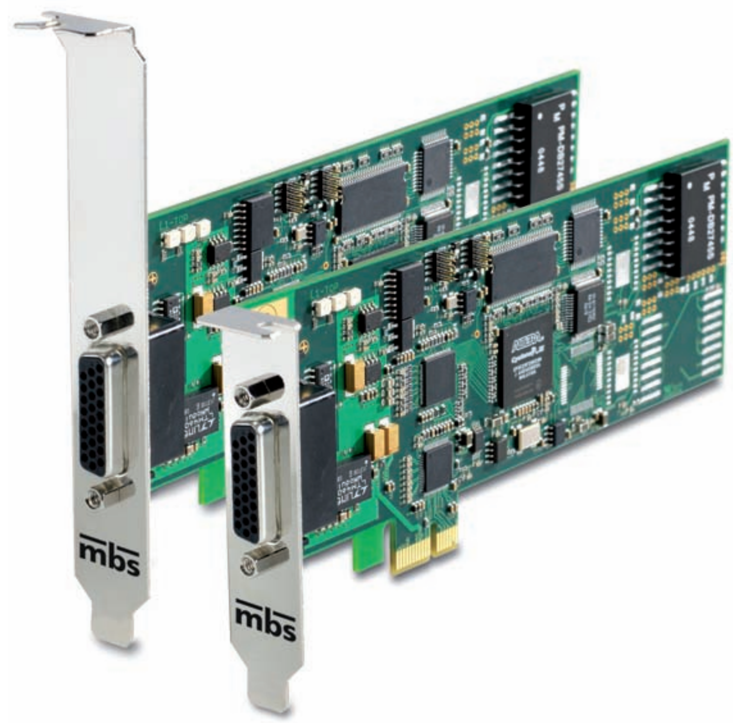
MBS encounters this regularly. In a recent telephone conversation, a maintenance manager complained he could not find a new interface card that would work with his test system. He was still using PC-AT computers because all his test software had been written for that standard. And now he was afraid if it broke down, he would be unable to maintain and test his products.

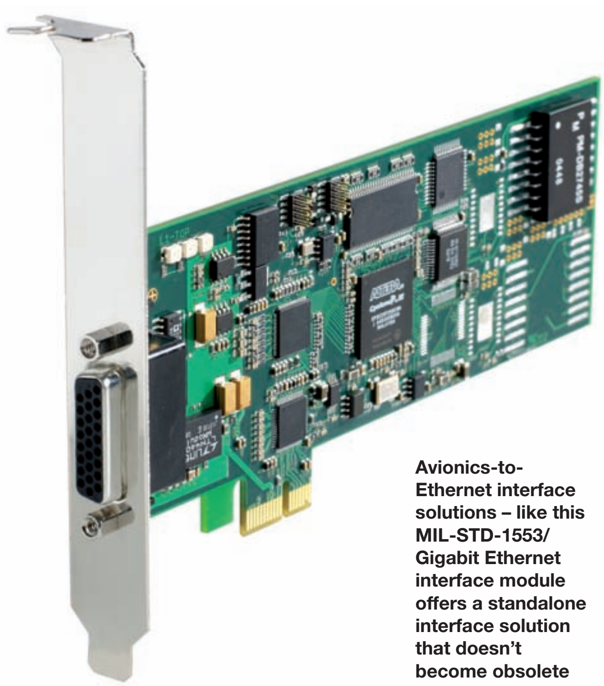
The PCI time bomb

This cycle is getting ready to repeat itself for a new generation of testers. The world is moving away from PCI and even PCI-X and rapidly toward high-speed serial buses such as PCI Express (PCIe). Already, we find fewer and fewer PCI slots in our PCs.

This trend is not confined to the PC world. Similar things are happening in industrial computing. VITA is also moving to high-speed serial buses. In particular, with VITA 42, we see the rise of XMC with PCIe, RapidIO, and HyperTransport.

What happens when PCI hits the dust? Is the testing world responding to these changes? Or is it burying its head in the sand and hoping that computers with the old, parallel PCI buses will live forever? Test equipment designers should take this rapid obsolescence of computer buses into account and adopt solutions with a predictably long lifespan. They need to ‘think outside the box’ – in this case, outside the PC.

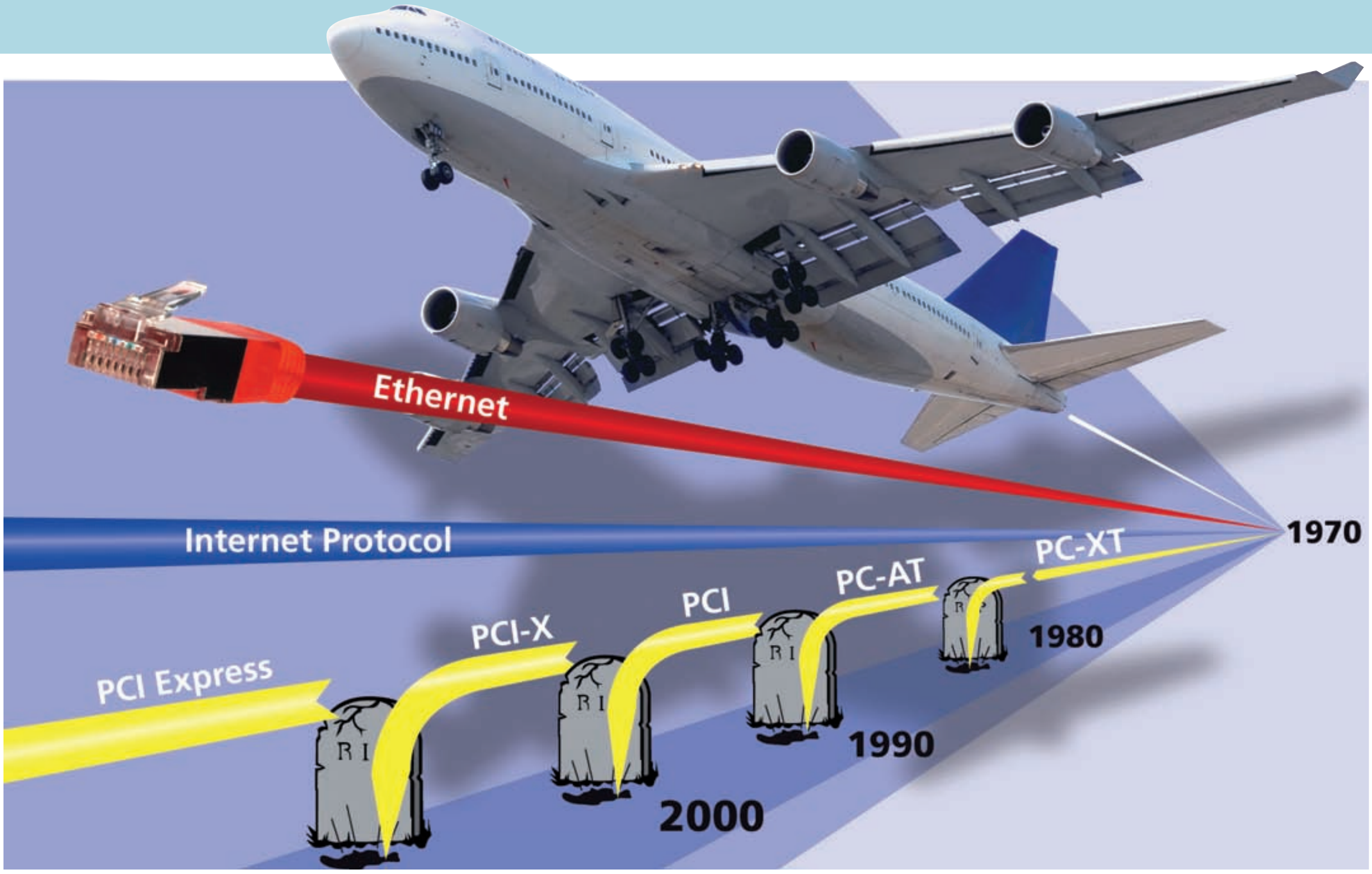




Avionics-to-Ethernet interface solutions – like this MIL-STD-1553/Gigabit Ethernet interface module offers a standalone interface solution that doesn’t become obsolete

One solution to this dilemma has already emerged: avionics-bus-to-Ethernet interface modules. Ideally, these are standalone units, independent of any host computer. They employ a standard Ethernet interface in full duplex mode, and communicate using standard UDP/IP protocol.

A major benefit of this solution is its promise of longevity. Ethernet began 30 years ago and all evidence seems to indicate that it will be around for another 30 years. Indeed, the standard has been upgraded several times, constantly increasing its speed while remaining backward-compatible. These modules offer other benefits as well. As they aren’t installed in computers, no device drivers are required. And as every operating system supports Ethernet and IP protocol, any computer can access them. Users can upgrade computers, software, and other parts of their test system without replacing or even disturbing the avionics interface.



Computer buses come and go while Ethernet and internet protocol lives on

Unlike many interconnect options, cable length is not an issue with Ethernet, which is very useful for potentially hazardous situations such as engine testing.

And Ethernet and IP are very well supported. Low-cost infrastructure is readily available, making it inexpensive to set up a LAN and replace components. Wireless networking is an option for some applications where cables would interfere.

There seems to be no real alternative to Ethernet for a computer-independent interface solution. The so-called 'Industrial Ethernet' standards EtherCAT and ProfiNET employ new protocols that are not standard to operating systems. In fact, the only open standard interface that would meet this criterion seems to be USB 3.0

Why not use USB? USB also goes some way in this direction, and the criticism that it is too slow is gradually being overcome as USB 3.0 finds its way onto the market. But USB 3.0 also has its limitations. Computers and operating systems do not yet support it to the same extent the Ethernet-UDP/IP pair enjoys. What's more, it lacks many of the features that make the Ethernet-UDP/IP combination so attractive. It cannot be networked, it cannot be simultaneously accessed by multiple applications, and it has problems relating to cable length – possibly no longer than 3m for USB 3.0.

Next-generation interfaces

MBS Electronic Systems was the first to come to market with an avionics-to-Ethernet solution when it introduced its ÆSyBus line three years ago. Other suppliers are now following suit. It has taken some time to get the word around, but now others are coming out with their own Ethernet interface products.

MBS currently offers ÆSyBus data-bus-to-Gigabit-Ethernet interface modules for MIL-STD-1553, ARINC 429, ARINC-717, AFDX, RS-485, and CANbus. And it continues to expand the range.

In addition to the benefits listed above, ÆSyBus offers a number of other advantages over conventional interface cards. ÆSyBus modules provide multi-user access for up to 10 applications simultaneously. And there are no processing bottlenecks, because there are no processors or controller software to slow things down. All functions are performed in hardware, and the Gigabit Ethernet transfers data 1,000 times faster than MIL-STD-1553 and 10,000 times faster than ARINC 429.

What about engineers who just need a short-term solution? There will always be those who need a system in a box. Their system doesn't need the benefits of networking and they don't want an interface 'on a string'. They want their interface in a slot. These engineers need to be considered.

For those engineers, MBS recommends interface cards built on PCI Express or XMC standards. If they opt for a PCI card, they should be aware that it may be a very temporary solution.

MBS has recently begun developing a new range of PCI Express cards. ARINC 429, MIL-STD-1553, and CANbus are already available. A similar range of XMC cards will soon follow these products. ∎

John Cole is a freelance writer and avionic systems engineer with more than 20 years of aerospace industry experience. He is the founder of Aerospace Marketing Ink, headquartered in Turin, Italy

Bright spark idea

MANY OLDER-GENERATION AIRLINERS HAVE BEEN PREMATURELY RETIRED. HOWEVER, SOME COULD BE RESCUED BY ANOTHER PROBLEM: GLOBAL HEATING, WHICH HAS SPARKED A GREATER RISK OF WILDFIRES

BY DAVID OLIVER

One of the biggest losers in the current global economic downturn is the airline industry, which has resulted in hundreds of older-generation airliners being prematurely retired. However, some may be rescued from the scrap heap by another worldwide problem: an ever-increasing risk of wildfires.

There is now a massive demand for more modern and capable firefighting aircraft to replace aging ex-military aircraft that have been converted to airtankers, many of which are piston-engined and at the end of their useful lives. In North America there are currently well over 150 aircraft of 16 different types operating in this demanding role including the C-130, DC-4, DC-6 and the PV-2 Neptune.

As a result, trials have recently been carried out by the US Federal Aviation Administration (FAA) to evaluate the safety and utility of the DC-10 and Boeing B747 commercial jet aircraft in the Aerial Retardant Delivery role. Specific objectives associated with this effort were to verify the airworthiness of the DC-10/B747 aircraft with the Aerial Retardant Delivery mission environment and flight profiles, determine the mission compatibility of these aircraft with the Aerial

Retardant Delivery mission environment and flight profiles, and develop recommended operational usage regimes, policies, and procedures for incorporation by the US Forest Service (USFS) and the Department of the Interior.

All of these objectives were accomplished. Data provided by the customer, vendors, and other sources was used to analyze the performance, handling qualities, systems, and structural suitability of the DC-10 and B747 as potential Very Large Aerial Tanker (VLAT) aircraft. Simulated and inflight evaluations of the aircraft during mission-representative tasks were performed.

Evergreen International Aviation's B747 Supertanker won certification for operation after receiving its interim approval from the Interagency Air Tanker Board. The aircraft also received its Supplemental Type Certificate from the FAA in November 2008 and the aircraft was available to assist world firefighting agencies during the 2009 season and beyond.

"Evergreen International Aviation's B747 Supertanker won certification for operation"

The multi-role Supertanker, the largest tanker aircraft available today, showed impressive results during the USFS-administered grid tests. With a payload of more than 20,000 US gallons and a response time of 600mph, it has more than eight times the drop capability and twice the speed of any other federal air tanker currently fighting fires. Its patented pressurized system has the capability to disperse product at high pressure for an overwhelming response, or disperse at the speed of falling rain in a single or several segmented drops. This system also allows for drops at higher altitudes, creating a significant safety buffer and enabling the Supertanker to fight fires during the day and at night, when they are most vulnerable.

Evergreen International Aviation, which has more than 70 years of firefighting experience, has invested five years and US$50 million of its own funding to develop this next generation of firefighting aircraft. On the firefighting front, the Supertanker will be available to provide service to international governments, as well as private industry.

The DC-10 aircraft, highly regarded for its durability as a passenger and cargo airliner, is now capable of being modified and operated as highly effective aerial firefighting tankers by 10 Tanker Air Carrier of Victorville, California, USA.

After four years of development, testing, and certification by US federal and state regulatory agencies, 10 Tanker demonstrated the modified DC-10's capabilities and effectiveness on 26 fire missions in 2006 throughout Southern California and the state of Washington.

Capable of carrying 12,000 gallons of retardant or water in its cavernous external tank system, the 10 Super Tanker has proven to be extremely effective in building fire-breaking lines and contributing significantly to wildfire containment. Firefighting experts have stated that this innovative tool for aerial firefighting

The BAE 146 airtanker dropping retardant (right)

10 Tanker's DC-10 dropping water (below)

Evergreen's Supertanker dropping water (far right)

is a real 'game changer' in terms of the volume of liquid carried, the continuous length of effective retardant line built in a single mission, and its jet speed to the fire.

All or partial loads can be dropped in a matter of seconds, providing excellent ground coverage, and permitting ground crews rapid access to firefighting positions. Typically, the drops are made from 200-500ft over the target, at a speed of 140-150kts.

While more VLAT aircraft will be put into operation in the future, there is a larger market for a medium-size jet airtanker and this is being addressed by BAE Systems. Back in 2003, the idea of using the BAe 146, a 100-seat medium-range airliner, in this role originally came from several US airtanker operators.

Minden Air Corporation of Nevada purchased an early model BAe 146-100 and carried out a successful set of trials in September 2004. The BAe 146 flew a total of nine sorties using an instrumented and ballasted aircraft. The aircraft was flown on typical firefighting flight profiles to demonstrate the performance and handling in this environment and to gather the resulting loads data. These flight trials were conducted in the presence of members of the firefighting operator community in the western USA and showed that the aircraft type was capable of flying typical mission profiles.

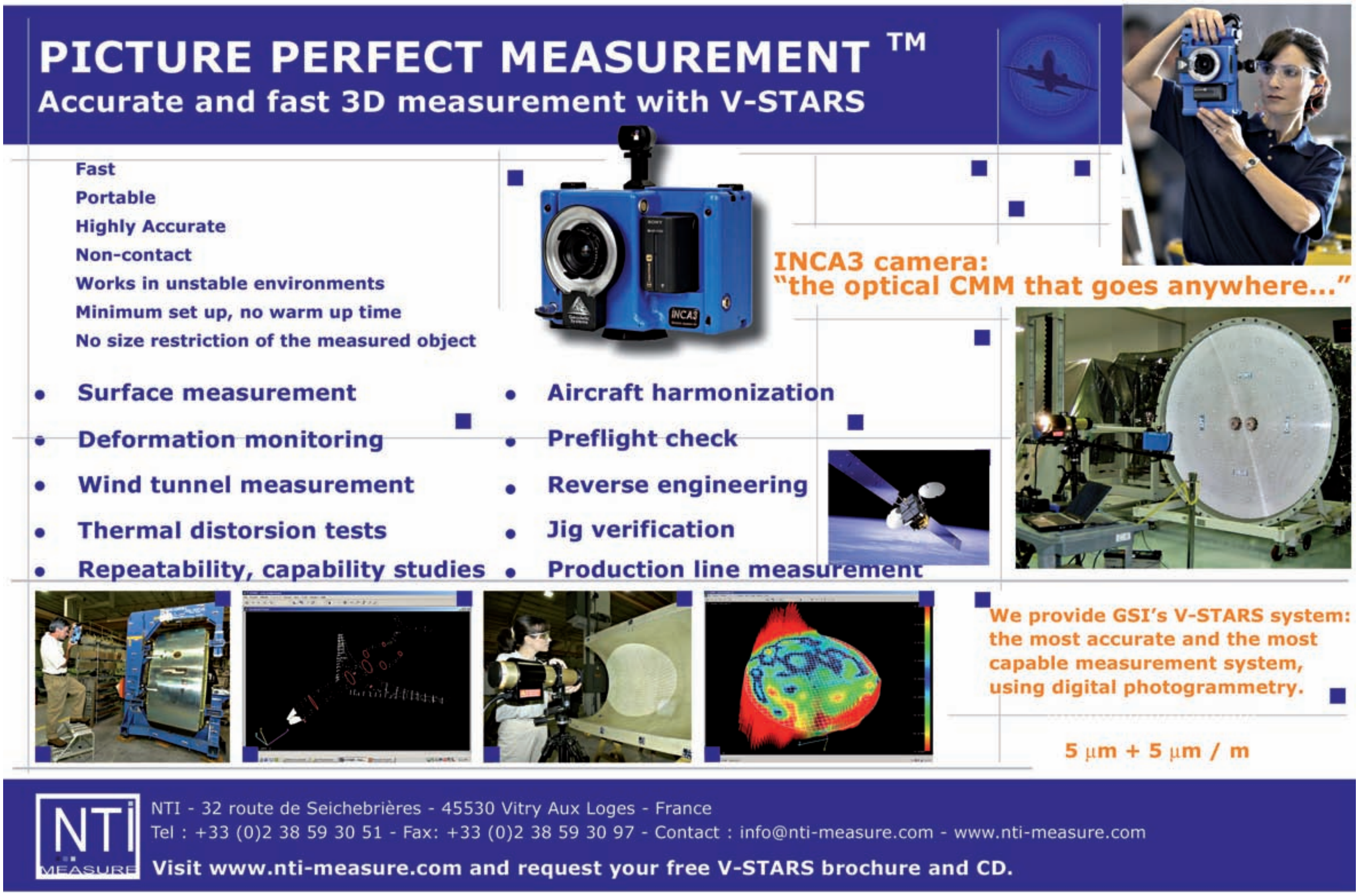
"All or partial loads can be dropped in a matter of seconds, providing excellent ground coverage"

Minden Air then decided to purchase a younger BAe 146-200 from BAE Systems for the conversion. BAE Systems Regional Aircraft contacted operators and the USFS who agreed to consider the BAe 146 for this role. The conversion by Minden Air would be under a Supplemental Type certificate so it will be their technical responsibility while BAE Systems will stand by any design/technical contribution it is asked to make.

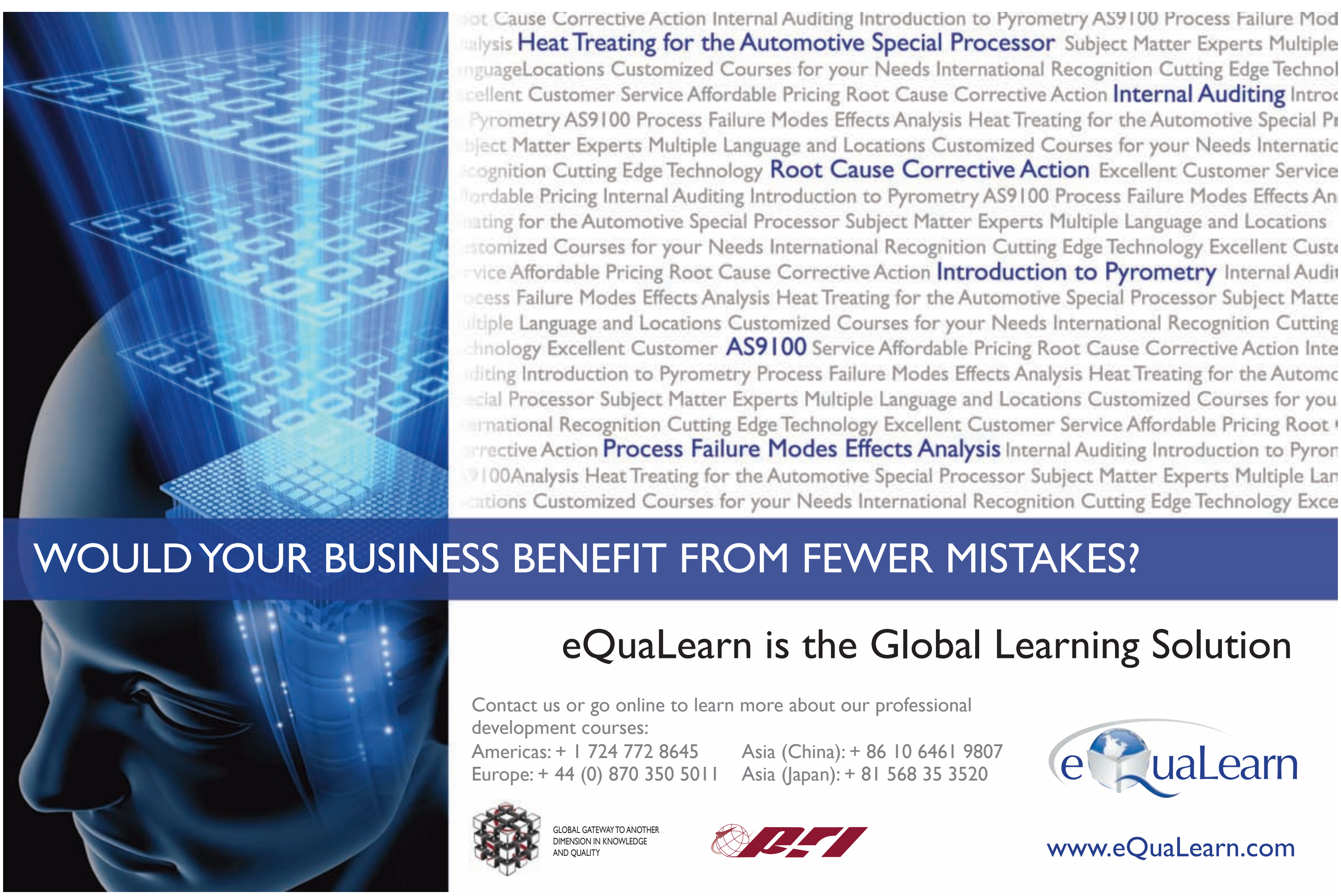
Minden Air has been converting the aircraft in readiness for the 2010 fire season before which it has to receive two sets of approval, first from the FAA and then the USFS. Proving the aircraft can do the mission will be much more complicated as it involves spreading patterns of retardant and various volumes of retardant in a range of profiles.

On the plus side, the BAe 146's advantages over current airtankers include a 3,000-US gallon tank capacity making it a US Class 1 tanker, quick turnarounds on the ground, a higher transit speed to destination, and a better climb rate out of the danger area. It also has four engine reliability, outstanding field performance, and low speed maneuverability,

The BAe 146 airtanker will inevitably be cheaper than a new aircraft solution such as those offered by Bombardier or Beriev. In addition to Minden Air, BAE Regional Aircraft sees the potential opportunity to work with other airtanker converter/operators, and it is possible that individual companies will be developing their own designs for the conversion of the BAe 146. ∎



PICTURE PERFECT MEASUREMENT ™
Accurate and fast 3D measurement with V-STARS
Fast
Portable
Highly Accurate
Non-contact
Works in unstable environments
Minimum set up, no warm up time
No size restriction of the measured object
INCA3 camera:
"the optical CMM that goes anywhere..."
• Surface measurement
• Deformation monitoring
• Wind tunnel measurement
• Thermal distortion tests
• Repeatability, capability studies
• Aircraft harmonization
• Preflight check
• Reverse engineering
• Jig verification
• Production line measurement
We provide GSI's V-STARS system: the most accurate and the most capable measurement system, using digital photogrammetry.
5 µm + 5 µm / m
NTI MEASURE
NTI - 32 route de Seichebrières - 45530 Vitry Aux Loges - France
Tel : +33 (0)2 38 59 30 51 - Fax: +33 (0)2 38 59 30 97 - Contact : info@nti-measure.com - www.nti-measure.com
Visit www.nti-measure.com and request your free V-STARS brochure and CD.



Heat Treating for the Automotive Special Processor
Internal Auditing
Root Cause Corrective Action
Introduction to Pyrometry
AS9100
Process Failure Modes Effects Analysis
WOULD YOUR BUSINESS BENEFIT FROM FEWER MISTAKES?
eQuaLearn is the Global Learning Solution
Contact us or go online to learn more about our professional development courses:
Americas: + 1 724 772 8645
Europe: + 44 (0) 870 350 5011
Asia (China): + 86 10 6461 9807
Asia (Japan): + 81 568 35 3520
GLOBAL GATEWAY TO ANOTHER DIMENSION IN KNOWLEDGE AND QUALITY
PRI
eQuaLearn
www.eQuaLearn.com

Mechanical processes for composites

The massively increased use of composite materials requires broad campaigns of structural mechanical testing to ensure airworthiness and to get the material certified from an aircraft manufacturer's point of view.

The mechanical behavior of these structures is different from what was found in the past with aluminum or any metallic material. To perform good matching between finite element method (FEM) calculations and experimental results, whole field measurement techniques are required. A technique called stereo digital image correlation makes it possible. The specimen is video recorded with a stereo bench (two cameras looking at the structure) while the test is running. Dedicated software analyzes the recorded images and calculates the displacement fields of the structure surface. The stress offices are then able to compare directly calculated and experimental values and have an overall vision of the specimen's deformation.

NDT Expert has been providing the measurement capability, supporting the Airbus Operation SAS mechanical testing lab for more than two years. The technology used is a VIC-3D system from Correlated Solutions Inc. Tests such as tensile tests, impacts tests, and fatigue tests on monolithic and sandwich panels, frames, stringers are all performed.

High-speed camera recordings are also delivered to better understand the mechanism of fracture or rupture during mechanical tests, impacts, and harpoon tests.

NDT turnkey solutions

A company that wishes to use adapted technologies to control composite materials means taking on board a whole setup of completely new NDI activities from subcontractors or supplier facilities. A lot of composite structure manufacturers, newly chosen by the main contractors for their knowledge, have to fulfill the regulation requirements from the aerospace industry, particularly with regard to NDI. The background in this field is often very limited and specialized competencies are needed to achieve the work. NDT Expert provides a global support to these companies, from the writing of basic specifications to the training of operators, going through the writing of NDT procedure, with NADCAP preparation and level three services.

NDI UT cartography analysis

In the last year, a partnership has started with the company Duqueine Composites, one of the two suppliers chosen by Airbus for the manufacturing of the A350 composite frames. After supporting the UT control activity with a phased-array technology of the prototype parts, the definition of a complete automatic system based on UT immersion technique using phased-array is now running.

The goal is to control around 1,000 frames a month at the full production stage. Five NDI aerospace UT level two operators will be trained and certified for this program. The NDI control of large composite panels and structures requires a great deal of analysis of the inspection results, as well as the control in itself. Numerous ultrasonic systems are used by the main and subcontractors and all the resulting data needs to be compared. The analysis capabilities of the systems are not always relevant and compatibility is often difficult. Therefore a need for harmonizing the ultrasonic data arose a few years ago.

EADS Innovation Works developed a dedicated software able to insure the compatibility to various data file formats (2D ultrasonic and A/C scans). This software also provides ultrasonic data-processing capabilities, automatic defect detection and sizing, automatic C-scans matching or merging, and C-scan/CAD fittings. It has been selected by Airbus as the official diagnosis software for the A350 program.

NDT Expert has been using this software for a number of its projects and is now in charge of the training of operators inside the Airbus and EADS plants in Europe. In terms of its development worldwide, the company is also in charge of the deployment and training of this software outside the EADS group: subcontractors and suppliers, at any place where composite material UT inspection is required. This product extends the set of dedicated tools already proposed: the MoireView for impact analysis, the ScratchView for scratch analysis, and the LineView for gap/flush and big scratch measurement.

CONTACTS

Sandrine Badia
NDT Expert
Email: contact@ndt-expert.fr
Tel: +33 534 361 203

Go to online reader enquiry number 101


TESTFUCHS
safety in test - safety in flight
SAVING COSTS
SAVING TIME
Pump and motor testing (Skydrol)
Non-rotating and servo-valve testing (Skydrol)
NEW HYDRAULIC
MODULAR CONCEPT
for
shop maintenance
of civil aircraft
- Pump testing
- Motor testing
- Non-rotating testing
- Servo-valve testing
TEST-FUCHS GmbH
Test-Fuchs Strasse 1-5
A-3812 Gross-Sieghart
www.test-fuchs.com
Tel: +43 (0) 2847 9001-0
Fax: + 43 (0) 2847 9001-299
mail: office@test-fuchs.com


maximize the moment
pco.dimax
High Speed and High Resolution
Highlights
• 1279 fps @ 2016 x 2016 pixel
(4502 fps @ 1008 x 1000 pixel)
• 12 bit dynamic
• image memory up to 36 GB
• various trigger options
pco.
dimax
pco.
imaging
www.pco.de
in America:
www.cookecorp.com

Life in the FAST lane

TechSAT has developed a new test system architecture, called FAST (future architecture system testing), which simplifies test installations for safety-critical applications found in modern aerospace and avionics industry.

FAST is an I/O subsystem that can be integrated in any test system via Fast Ethernet. The concept comprises a family of self-contained modules designed for processing standard and avionics-specific signals as well as for simulation, monitoring, and routing between UUT, original equipment, and test system.

Rigorous admission regulations for safety-critical systems demand clear and precise specifications of system requirements, modes of behavior, failure rates, and reliability values. To this end, manufacturers must prove the fulfillment of these requirements, demonstrate the correct implementation of the functionality by prototypes, and finally validate their implementation through incremental test stages including board test, system integration, and functional integration.

Current simulation environments and test systems keep adding more and more complexity, thereby inflating the 'cost of test'.

With FAST, TechSAT has developed a concept that, based on a compact architecture, both increases the reliability of test systems and, at the same time, reduces their costs significantly. To reach this goal, TechSAT loosened the strict separation of hardware functions and, instead, integrated the essential functions into the FAST modules in a signal-specific way. As an example, for Hardware-in-the-Loop (HiL) testing, FAST provides an interface to the original equipment (OE) for typical signal processing applications, such as reading, writing, analysis, and fault stimulation, including stress and limit tests.

A FAST module can be used in simulation mode and, alternatively, as a monitor between the OE and up to two units or systems under test (UUT/SUT). The model behavior can be directly compared to the tested equipment, permitting quick diagnostics of potential faults. A FAST system can consist of individual modules, a subsystem crate with 21 module slots, or a logical subsystem combining several modules or crates.

This flexibility is achieved through the following core features: standardized interfaces for signal transmission, programmable signal conditioning and stimulation/error injection, hardware and logical scalability, API for integrating test applications, and full integration into TechSAT's Avionics Development System ADS2.

With an uncomplicated connection via Ethernet, the configuration of modules and subsystems is very adaptable and inexpensive. Moreover, errors in the system configuration can be analyzed and fixed quickly and easily. Since a considerable amount of test system wiring can be saved, the FAST concept also decreases the overall development costs of the entire test system.

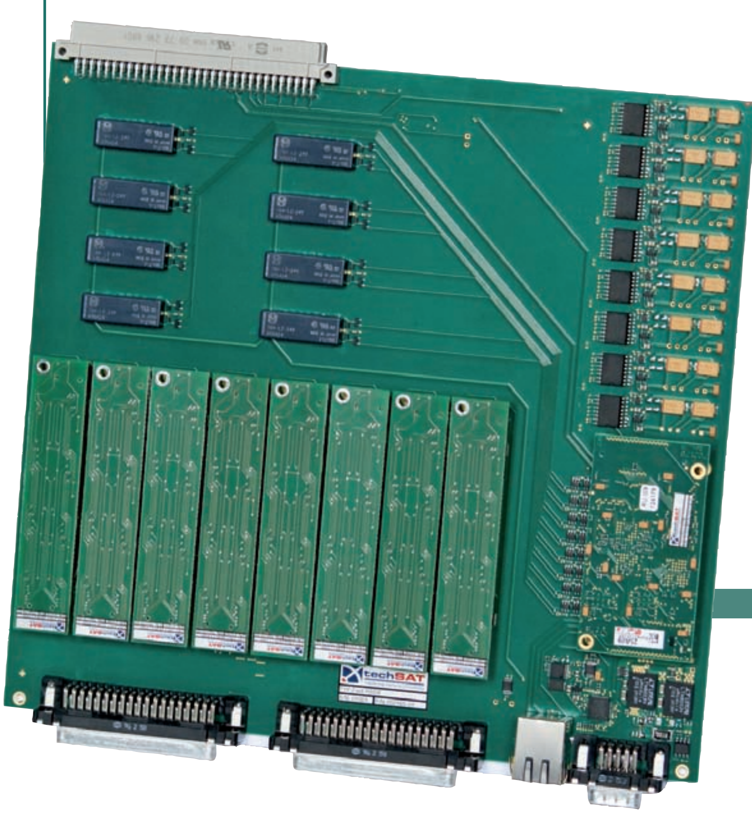
Each FAST family member has a local CPU running an embedded Linux OS. The CPU is released from time-critical I/O tasks by either an FPGA or DSP core computing the I/O without interaction of the main CPU. Time-stamping of all activities allows for distinct analysis of cause and action within complex, multidomain test systems.

The FAST subsystem can be operated in either of two modes, frame-based or event-driven. Events can be generated through predefined conditions, such as signal limits or signal filters, or through programs executing locally on the FAST module. Due to the open source Linux OS, extensive development support is provided to write these programs.

Synchronization of all FAST modules within a subsystem is accomplished by a time sync bus, such as IRIG-B, GPS, or NTP.

With the avionics industry in mind, FAST supports customized test scenarios with various I/Os, such as analog, digital, and proprietary serial interfaces as well as resistive sensor simulation and current loads. The integration into the test system is achieved through a uniform software API interface.

A FAST module incorporates the following functions: host communication via standardized LAN, built-in microcontroller for gathering the signals of the entire system and translating internal control commands, signal processing through integrated FPGA or DSP, signal conditioning, digital I/O, analog I/O, programmable simulation of pressure and temperature sensors, stimulation and injection of programmable failures directly on the FAST module, internal switching between original equipment and simulated components, and time synchronization via optional Timemaster (NTP, IRIG-B, etc).



Synchronization of all FAST modules within a subsystem is accomplished by a time sync bus, such as IRIG-B, GPS, or NTP

CONTACT
TechSAT GmbH
Tel: +49 8121 703 221
Fax: +49 8121 703 177
www.techsat.com
Go to online reader enquiry number 102

Fatigue failure detection

Testing of composite materials can present complex problems, so specialist testing services have been developed and a range of UKAS-accredited tests have been added to the existing portfolio. These are prEN, ASTM, and BS EN standards covering tensile, compression, in-plane shear, residual strength, and fatigue. All these are steadily becoming the main requirements of composite research and qualification projects.

Due to the nature of composite testing a new set of skills and techniques are required, including solutions for gripping and strain monitoring practicalities that have been developed for a variety of aerospace customer-led applications. Full conditioning of samples to a saturation point is typically required with testing necessary at subambient plus hot or wet conditions. Temperature-based tests are conducted using purpose-built environmental chambers with the ability to control from -100˚C to +300˚C, and they have the additional benefit of humidity control where necessary.

On occasions strain gauges alone may not be suitable for the required strain measurement. Some materials, typically research-focused materials, need a fresh approach that can include strain measurement over the complete free section. Westmoreland Mechanical Testing and Research Ltd has acquired new equipment to provide optical non-contact measurement for monitoring the relationship of multiple strain points, even enabling post-test playback and data analysis. This is in the process of being fully evaluated under 'round robin' conditions before being used on projects, but is expected to be available in 2010.

Dynamic strain gauge measurement and acquisition is also performed using Vishay 5000 and 7000 systems, which generate data in suitable file formats for post-test analysis or for use in finite element analysis (FEA). Load and position data output from the test frame control tower can be fed into these strain measurement systems to produce synchronized strain-load data.

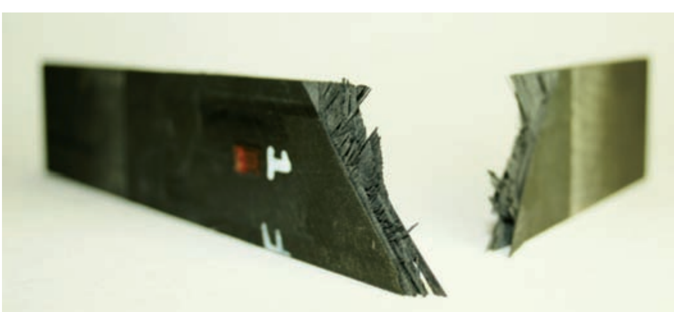
The majority of metallic fatigue testing has two well-defined, easy-to-establish failure criteria. Part separation and rupture are typically used in high-cycle fatigue (HCF), and a load drop-off or crack initiation can apply to low-cycle fatigue (LCF) testing. When composite materials are fatigue tested, these failure definitions may not be always be applicable. A dramatic change in material properties such as stiffness may occur well before rupture, and depending on material lay-up, a drop-off in load can go undetected.

During an HCF program, samples tested at stress levels that should have provided failures after approximately 100,000 cycles continued to run, almost indefinitely. However, it was clear that the specimen had changed in the way stress was distributed along the gauge section and therefore the material properties had exhibited change.

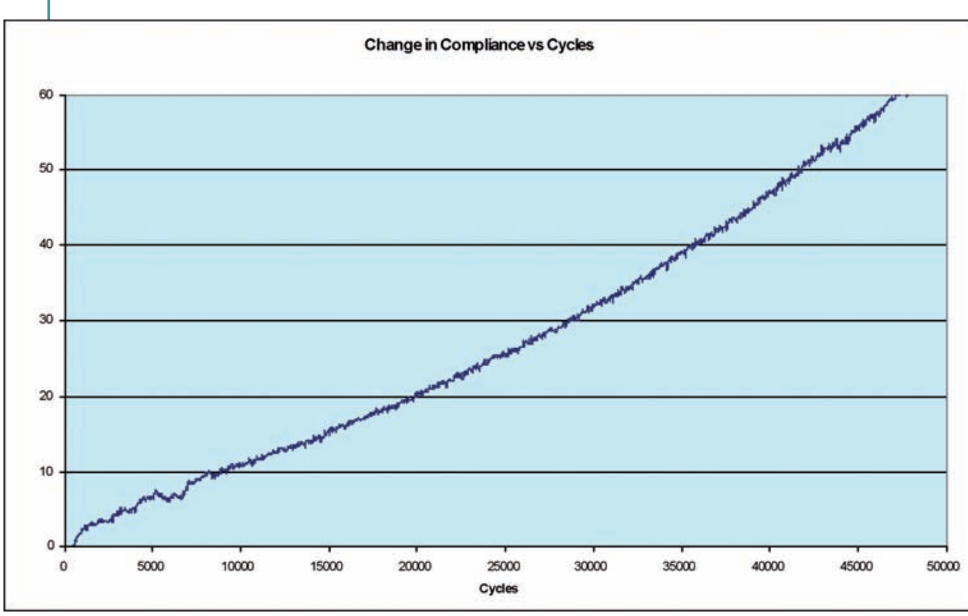
It became apparent that other end-of-test criteria were needed, taking into account the change in the 'notable' specimen properties. Monitoring the specimen compliance dynamically during the testing was decided as a suitable method; however, this required a new approach to strain measurement.

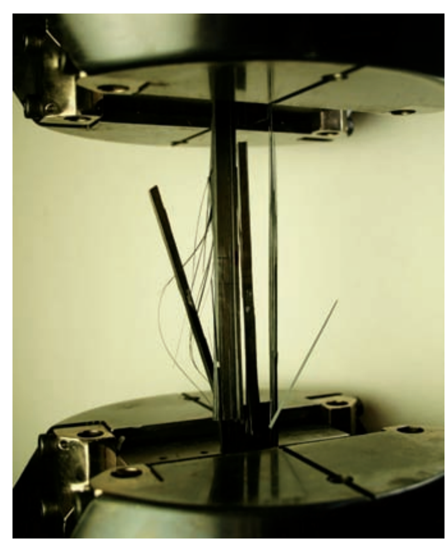
The standard method of using strain gauges or an extensometer for modulus data was found to be unsuitable for two reasons: one based on the material, and the other due to practicalities. The material in question incorporated a reinforcement weave that, during fatigue, caused the surface of the specimen to deform locally, which in turn interfered with the strain gauges or point of contact for the extensometers with a detrimental effect on the data produced. It was also found when testing specimens without the reinforcement weave that extensometers were not suitable because changes in the specimen that occurred outside of the extensometers measurement were not detected. A new method had to be devised that could monitor the entire length of the specimen from one end to the other.

A technique was developed using high-accuracy displacement transducers that were mounted in such a way that any measurement of the test frame compliance was avoided completely. Therefore, it was possible to continuously monitor the specimen and its subsequent behavior during fatigue up to failure. Repeatable data analysis showed that the stiffness of the sample changed progressively as cycles were applied.



The graph below indicates the variation in 'compliance versus cycles'





CONTACT

Westmoreland Mechanical Testing and Research Ltd

Email: npoyner@wmtr.co.uk

www.wmtr.co.uk

Go to online reader enquiry number 103

Images of radiography

Radiography is a non-destructive testing technology (NDT) that has found broad application across the aerospace sector. Radiography has been predominantly used in the production environment to inspect castings, components, and structures with stringent inspection standards guidelines. Historically these inspections have been carried out using wet film technology, but increasingly inspectors are converting to digital techniques for a variety of reasons.

For example, film needs to be developed, and normally this takes place on site in dedicated darkrooms, which can take up valuable space. In addition there are accompanying operational costs, such as the cost of consumables and the costs of disposal of development chemicals. Film storage is space-intensive, retrieval of archived film is time-consuming, and results-sharing is only possible by copying film or reshooting. For many years equipment manufacturers have endeavored to develop radiographic systems that incorporate all the benefits of wet film systems with none of the disadvantages in order to increase the functionality of radiography and realize the benefits of digitization in data processing, analysis, and storage. This has seen the birth of a new generation of radiography: digital radiography.

Digital radiography in the aerospace sector can be described by three distinct technologies: computed radiography (CR); direct digital radiography (DDR); and computed tomography (CT) or 3D radiography.

Computed radiography uses a phosphor imaging plate instead of film, and when an exposed plate is scanned in a suitable scanner, a digital image is created that can then be viewed on a proprietary local monitor, a remote monitor, or shared among a number of monitors. Images can then be filed and archived for future reference and traceability, and as they are digital, they can be enhanced to focus on particular areas of interest.

The latest CR scanner from GE offers great flexibility as it can be used either with hard cassettes, in which the phosphor imaging plate never leaves the cassette, or it can scan any size of phosphor screen up to 14 x 17in. Any shape can be accommodated, such as circles, triangles, rectangles, and pie shapes. These individual imaging plates can be exposed using a soft, flexible cassette (with or without lead), before scanning.

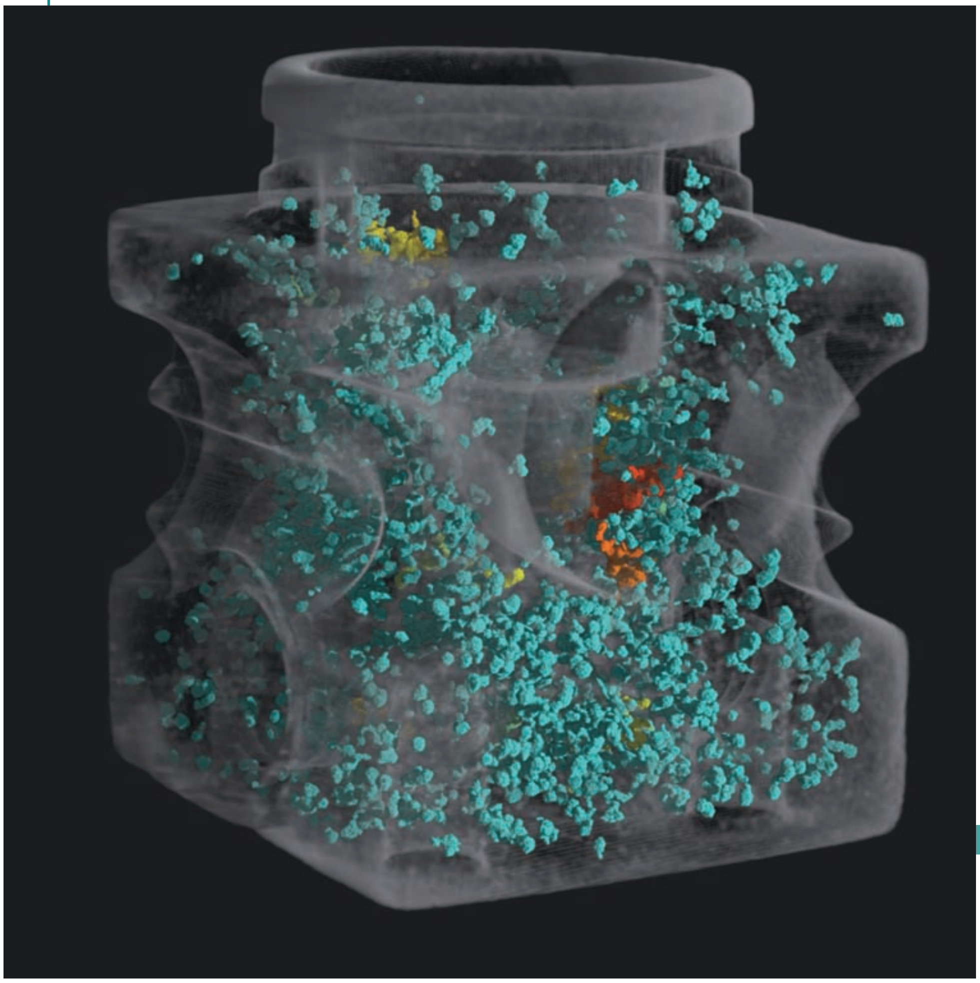
The x-ray detectors used in direct digital radiography provide instant radiography, where images are viewed in real time. In the past, DDR has been confined to the production environment – unlike CR, which can be used both on the shop floor and in service. However, with the introduction of portable detectors, such as GE's Portable 16 x 16 Prime, the technology can now be extended to tasks such as on-wing inspection.

Over the past few years, industrial computed tomography (CT) has made great advances with regard to increasingly high resolutions and greater reconstruction speeds of 3D volume data. It is now possible to carry out 3D analyses of materials with submicrometer resolution and gain an insight into internal structures, which had previously been inaccessible.

In today's quality market, because of inherent limitations, many of the inspection requirements can no longer be satisfied with conventional x-ray inspection methods. High-resolution CT presents an effective method of mapping the internal structure of components in three dimensions.

With this technique, any internal difference that corresponds to a contrast in material, density or porosity can be visualized and measured. These properties allow the use of CT as an NDT tool, permitting examination of samples for internal porosity, cracks, delamination, inclusions, and mechanical fit. CT techniques are also used to measure internal distances or the internal wall thickness of complex castings.

Radiography will continue to be one of the major inspection tools in the aerospace sector, in production and in service. However, the technology will continue to evolve in terms of resolution, accuracy, reportability, and repeatability to meet the increasingly stringent industry quality requirements.



A CT scan of a casting taken for pore analysis as part of a rigorous quality control regime

CONTACTS

GE Sensing & Inspection Technologies

Tel: +44 1925 604095

Web: www.gesensinginspection.com

Go to online reader enquiry number 104


i1
One Solution
Infinite Connections
Rugged Connector
10,000 Cycles
Rugged engagement mechanism engineered for 10,000 cycles
Removable backshell and engaging mechanism offers easy access to wiring
Horizontal and vertical stackability
Simple half-turn engaging mechanism
Variety of I/O options available
Spring Locks
Easy Access
VPC Virginia Panel Corporation
To learn more visit vpc.com/AT14
Mass InterConnect Solutions ...creating order out of wiring chaos


DISPLACEMENT SENSORS FOR EXTREME ENVIRONMENTS
IN CRYOGENIC FLUIDS
HIGH PRESSURES
HIGH TEMPERATURES
HIGH ELECTRICAL FIELDS
HIGH MAGNETIC FIELDS
INSIDE MECHANISMS
IN VACUUM
CUSTOM PROBES
A Complete Line of
Vacuum Passthru Hardware for
Measurements in Vacuum
CRYOGENIC TURBOPUMP SHAFT DISPLACEMENTS • SATELLITE PROPULSION THRUST TESTING • SPACE TELESCOPE LENS FOCUS • MICRO-TURBINE SPEED • TURBINE BLADE PASS
WWW.PHILTEC.COM
PHILTEC
FIBEROPTIC SENSORS
DISTANCE | DISPLACEMENT | VIBRATION

Modular hydraulic test benches

An increase in the number of aircraft means an increased requirement for maintenance, repair and overhaul (MRO) activities, which itself leads to an increased requirement for the production of test benches. The pressure on price and the necessity of reducing time-to-market no longer allows unique customer solutions to be made, with their one-off development costs, longer lead time and risks borne by one customer.

The goal of developing modular hydraulic test benches is to test various aircraft hydraulic components more cheaply, rapidly and in an environmentally friendly manner. An affordable price can only be achieved by off-the-shelf designs and installed components.

The modular design of the Test-Fuchs test bench enables testing of a combination of components. For example, a single modular holding fixture with a 350 bar system pressure for A380 and B787 components ensures an easy, quick and safe change of the aircraft components tested.

By using dynamic test stations for modern actuators with complex control systems, both hydraulic actuators with their high loading and electric actuators with their higher dynamics can be tested using a single modular holding fixture.

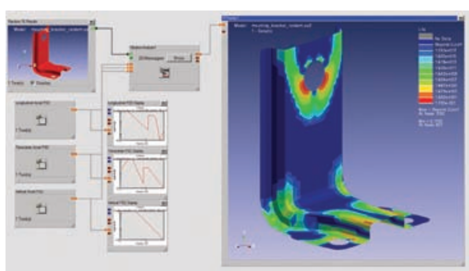
By accomplishing the company aim of testing rationalization, Test-Fuchs has achieved an important technological and financial advance in the development of hydraulic test benches.

For further information contact
Test-Fuchs GmbH
Test-Fuchs Strasse 1-5
A-3812 Gross Siegharts
Austria
or go to online enquiry card 105

Virtual electrodynamic shaker

Vibrating components are highly susceptible to fatigue failure. Most aerospace components must fulfill some form of durability certification test, often using electrodynamic shakers, prior to production or deployment. But there can be challenges in defining an appropriate test that is both realistic and time-efficient. There are also increasing needs to simulate these tests prior to actually breaking a prototype.

nCode software from HBM enables the sign-off test to be accelerated using reduction factors applied on the PSDs to optimize costs and development duration. Additionally, the software enables this to be simulated using finite element models as a 'virtual shaker test'. The numerical simulation helps by verifying the loading is realistic and representative and by showing a contour plot of the component damage calculated using the material fatigue data. A white paper describing this mixed Test/CAE approach and its application in a case study is available at www.ncode.com/resourcelistgridveiw.aspx.



For further information contact
HBM-nCode
USA tel: +1 248 350 8300
UK tel: +44 845 620 6060
Email: ncode@hbm.com
Web: www.hbm.com/nCode
or go to online enquiry card 106

Innovation with test and measurement

Q-Star is one of the leading suppliers of innovative cost reduction, quality improvement, electronic health management and prognostic (predictive diagnosis) solutions, design-for-test (DFT) and test-related services, and electronic and PCB engineering services supporting prototype development and small-series production. Its activities span design to testing and combine both products and services.

The company's solutions improve engineering, production and failure analysis (FA) productivity; reduce test time; enable efficient deployment of current-based test strategies for electronic circuits, irrespective of technology; offer improved defect detection, test cost and test escape risk reduction, health observation capabilities, and improved defect localization and identification.

Q-Star's consulting and training services address themes such as DFT, DFT implementation, and test optimization; implementation and application of current-based testing; achieving 0ppm and 0bpm quality requirements; hardware and software design with a focus on DFT, verification, and test; and prognostics implementation and application.

The engineering services focus on hardware, software, and combined hardware/software development; electronic circuit and system design, prototyping, validation, and test; developing dedicated test and measurement hardware; and test program development and optimization.

The electronic prognostic solutions consist of IP blocks, concepts, measurement modules, and supporting software tools, enabling the continuous monitoring of electronic health and the ability to make reliable (remaining) lifetime predictions.

For further information contact
Q-Star Test nv
Lieven Bauwensstraat 20
B-8200 Brugge
Belgium
Tel: +32 50 319273
Fax: +32 50 312350
Email: info@qstar.be
Web: www.qstar.be
or go to online enquiry card 107

> "The motor and drive systems are able to deliver 1.3MW of shaft power"

Craig Delves

Director, sales & marketing, Torquemeters Limited

For over 50 years, UK-based Torquemeters Limited has specialized in the design and manufacture of high-performance torque measurement systems for the turbo machinery market. Director of sales & marketing, Craig Delves, says 80% of the company's business is export, across five continents. His prime responsibility is to understand customer requirements and increase the visibility of company products and services across the global market.

Can you describe what Torquemeters does within the industry?

Our custom design and standard Torquetronic product range has played a key role in the development of performance and efficiency of gas turbines and high-performance rotating machinery in the oil, gas, petrochemical, and aerospace industries, as well as F1 and leading research and development institutes.

The accuracy and reliability of Torquetronic products has resulted in the major turboshaft engine manufacturers (GE, PW, RR, Honeywell, Turbomeca), and their customers, both military and civil, using the line almost exclusively for the development, production, and overhaul testing of engines on fixed test stands, such as the T700, Makila, RTM322, PT6, and GE 38.

What does Torquemeters see as the prime developments in aerospace testing?

Over recent years, Torquemeters has witnessed the increasing use of e-motor technology in aero systems that were previously driven hydraulically or by power take-off from the engine. Aero systems suppliers required new test systems capable of loading motors and actuators so that their characteristics could be defined and optimized. The challenge for a test system supplier is to configure and produce dynamometer equipment with an operating range as wide as possible. This reduces capital cost, test cell space, and demand on facility services. Additionally, the test machine may need to reproduce or complement the dynamic characteristics of the unit under test in its installed condition.

Examples of Torquemeters' involvement in supplying test systems include those used for the development testing of electrohydraulic systems for the A380 (now in service) and the Iron Bird test facilities at Lockheed Martin in Texas.

Can you give an example of one of Torquemeters' latest projects?

We are currently designing a 330kW, 32,000rpm direct-drive dynamometer test stand for Wright-Patterson AFB in Dayton, Ohio. We had to design our permanent magnet motor to deliver the high-dynamic, backlash-free, low inertia drive to the test article, to enable the customer to accurately model the test article simulating its installed condition. Our TorDAC data acquisition and control system enables the customer to run remote control algorithms generated in MATlab.

The four-quadrant regenerative drive stand can also be axial-coupled to a second system, which delivers a 660kW dynamometer. The motor and drive systems have twice the overload capability and are therefore able to deliver 1.3MW of shaft power.

Is the Torquetronic system making an impact? What makes it different?

Torquetronic's phase-shift technology makes it ideal for the high speed levels found in many aerospace testing applications. This is because phase-shift senses shaft twist rather than shaft strain, with which many people are perhaps more familiar. The advantage of this is that there are no rotating electronics (strain gauges, rotary transformers, etc.), and so issues such as rotating mass, dynamic balance, and long-term integrity are much easier to address.

What test systems are you developing for the future?

We embarked a couple of years ago on a project with a leading UK university to design and develop scalable technology for high-speed permanent magnet motors. The ultimate goal is to offer the aerospace industry cost-effective solutions that can be used in test systems for the development of new aero engine ancillaries – alternators, starters, fuel pumps, etc.

What message would you like to give to the industry

Torquemeters does more than torque measurement. Ten years ago, we detected a small but growing change as the major players in the aero industry – airframe, engine, and systems manufacturers – reduced their in-house test rig capability and increasingly out-sourced test equipment. Our customers stopped buying components and started buying systems, so we had to adapt. Now, we can offer bespoke engineered, fully integrated test systems from concept design to installation, commissioning and ongoing support.

Index to advertisers