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

AEROSPACE TESTING INTERNATIONAL

SEPTEMBER 2012

A class above

The latest test programs ensure bizjets meet demands for durability – as well as luxury

Turn up the heat

Thermography is having a huge impact on composite inspection

Sonic boom!

Sound advice from Gulfstream's Acoustic Test Facility and BAE Systems' Acoustic Fatigue Facility – plus an exclusive interview with the Benefield Anechoic Facility at Edwards Airforce Base

PILOT FATIGUE TRIALS • MAINTENANCE TEST FLYING • LEMV EXCLUSIVE •COMPUTER MODELS

www.AerospaceTestingInternational.com

Acoustic testing

Precious precision

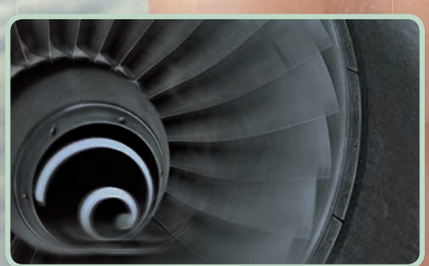
TRANSDUCERS – ACQUISITION – SOFTWARE – REPORTING

Centralised and distributed acquisition systems

Measurements conforming to international standards ICAO Annex 16 and FAR 36

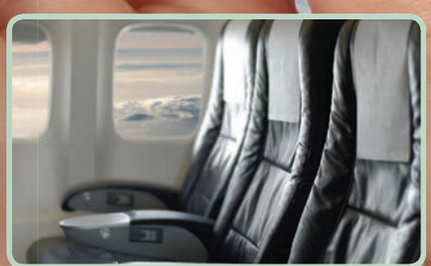
Exterior noise

- Ramp noise
- Flyover beamforming
- Aircraft certification
- Wind tunnel testing



Engine noise

- In-duct acoustic mode measurements
- Static engine noise
- Acoustic material testing
- Jet plume characterisation



Interior noise

- Cabin noise
- Flight testing
- Noise mapping
- Speech intelligibility
- Sound quality

www.bksv.com/aerospace

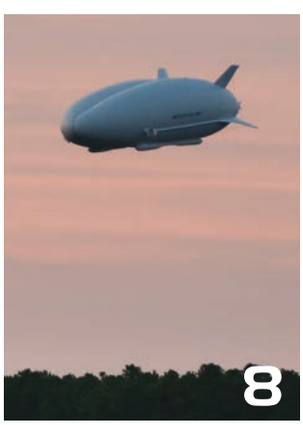
BN 1130–11

HEADQUARTERS: Brüel & Kjær Sound & Vibration Measurement A/S · DK-2850 Nærum · Denmark
Telephone: +45 7741 2000 · Fax: +45 4580 1405 · www.bksv.com · info@bksv.com

Local representatives and service organisations worldwide

Brüel & Kjær

creating sustainable value



Contents

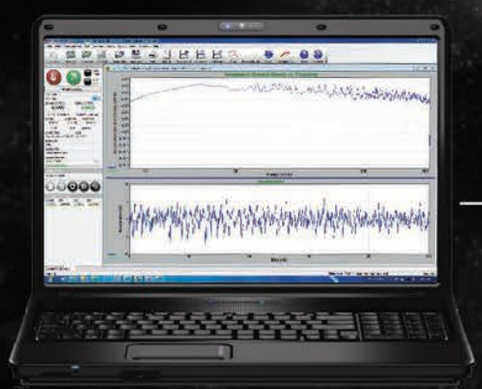
Vibration Research Corporation

Innovators in Vibration Control

Field To Report. Done!

The ObserVR 4 channel data recorder and analysis package smoothly integrates with the Vibration Research VR9500 Revolution control system to perform your test and issue detailed and robust reports, every time.

Acquire



Analyze

Test

Report

How Do I Get The Real World Peak G's Into My Test?

With Vibration Research's patented Kurtosion® module the peakiness of the actual field data is introduced into your random test. This test simulates your real environment without altering the test profile.

How Long Should I Run My Test?

VibrationVIEW version 10 offers an optional Fatigue Analysis module which allows you to measure the fatigue seen in your recorded data and calculate the required test time to meet the fatigue your product will see during its useful life.

Vibration Research Corporation

2385 Wilshere Dr. Suite A, Jenison, MI. 49428 USA tel: +1 (616) 669-3028

www.vibrationresearch.com

First a tribute: it was July 21, 1969, when Neil Armstrong, who died in August aged 82, made his celebrated 'One small step for man, one giant leap for mankind' speech when he landed on the moon. He was an incredibly intuitive man, an amazing test pilot, and unbelievably courageous.

After flying combat missions in Korea, in 1955 Armstrong went to Cleveland, Ohio, as a civilian research pilot at the Lewis Research Center, which became NASA, and later that year he moved to Edwards Air Force Base in California, piloting and engineering many high-speed aircraft. He proved to be an astounding and resolute test pilot, and flew more than 200 models, including jets, rockets, helicopters, and gliders.

In 1962, he was chosen as an astronaut. On Gemini 8 for his first space venture, he brought his experience into play when the spacecraft continued spinning after completing a docking maneuver. The situation could have become life-threatening, but Armstrong averted disaster.

It was his serious attitude to the job that put him ahead of Buzz Aldrin to be the first to climb out of the lunar module. The authorities wanted someone with gravitas.

He lived a long life, but I was disappointed that the coverage of his accomplishments in the UK press was so meager. Every nation has its heroes, but Armstrong crossed that boundary to become a true legend. By setting foot on the moon, he became the first inhabitant of Earth to travel to the surface of another planet. He was everyone's reluctant hero, and for that I rate him as one of the greatest icons of all time.

I am an Englishman, and this has been the UK's year. First we had the Queen's Diamond Jubilee, and then London hosted the 2012 Olympics, which was praised worldwide as an amazing success. There has been a flurry of patriotism that is quite rare in this country, and there have even been celebrations of the UK's great aerospace past.

As the amazing aeronautical engineer, Sir Sydney Camm, said, "All modern aircraft have four dimensions: span, length, height, and politics." This applied to many UK projects and it is with this in mind that I point to the country's aerospace post-war rise; near-death through political procrastination, bad funding, and sell-offs to the USA; and then rise again.

The UK still has a massive aerospace industry, although over the past 50 years mergers have refined or neutered it. Through refinement and takeovers there exists one prime, standout company: BAE Systems. This issue's cover story (*Ministries of Sound*, p28) features the BAE Systems bespoke acoustic fatigue facility at its Warton site and a thermal acoustic facility at Brough specifically designed for fatigue testing of the F-35. The Warton site is one of only a handful of facilities worldwide where noise is converted to heat and mechanical vibration so the tests on the F-35 can focus on the effects of noise on the object rather than on the noise path.

As this publication goes to print, all F-35 developers have agreed on a multi-year campaign to demonstrate the single-engine stealth fighter's ability to dispatch weapons. BAE, with its acoustic tests, is at the forefront of these. For a start, the F-35 is expected to carry far more weapon types in its bays. Once the bays are open it has its own thermal and acoustic challenges and many weight issues. As well as acoustic tests, the aircraft is right now undergoing live weapons separation tests. BAE, is, without a doubt, an integral part of world aerospace development.

I'm not going to make a financial comment; that's not what *Aerospace Testing International* does. But it is incredibly important to mention the potential merger between BAE Systems and the colossal European civil company EADS. The UK is the second biggest aerospace nation in the world, with a proud history, but much of the sector is focused on manufacture of components rather than assembly of complete machines, with this arrangement being spread across international consortiums (think A380). Decision-making within a transeuropean defense and civil company may be hard. Consolidation is good for the UK market – maybe an amalgamation between BAE and Rolls-Royce would keep the UK's air heritage intact, give continuity to its aero past, and provide international competition. There is also a list of missile manufacturing companies, including MBDA, that may better suit this arrangement.

Christopher Hounsfield, editor

PRODUCTS & SERVICES

REGULARS

EDITOR Christopher Hounsfield (chris.hounsfield@ukipme.com)

ASSISTANT EDITOR Bunny Richards (bunny.richards@ukipme.com)
PRODUCTION EDITOR Alex Bradley
DEPUTY CHIEF SUB EDITOR Nick Shepherd
PROOFREADERS Aubrey Jacobs-Tyson, Frank Millard

ART DIRECTOR James Sutcliffe
ASSISTANT ART EDITOR Louise Adams
DESIGN CONTRIBUTORS Andy Bass, Anna Davie, Craig Marshall, Nicola Turner, Julie Welby, Ben White
HEAD OF PRODUCTION & LOGISTICS Ian Donovan
DEPUTY PRODUCTION MANAGER Lewis Hopkins
PRODUCTION TEAM Carole Doran, Cassie Inns, Robyn Skalsky

SALES MARKETING DIRECTOR Simon Hughes (simon.hughes@ukipme.com)
PUBLICATION MANAGERS Nick Barr (nick.barr@ukipme.com); Cheryl Standley (cheryl.standley@ukipme.com)
CEO Tony Robinson
MANAGING DIRECTOR Graham Johnson
EDITORIAL DIRECTOR Anthony James

 Aerospace Testing International USPS 020-657 is published quarterly, in March, July, September, and December by UKIP Media & Events Ltd, Abinger House, Church Street, Dorking, Surrey, RH4 1DF, UK; tel: +44 1306 743744; fax: +44 1306 742525; editorial fax: +44 1306 887546. Annual subscription price is £42/US$75. Airfreight and mailing in the USA by agent named Air Business Ltd, c/o Worldnet Shipping USA Inc, 155-11 146th Street, Jamaica, New York 11434. Periodicals postage paid at Jamaica, New York 11431. US Postmaster: send address changes to *Aerospace Testing International* c/o Air Business Ltd, c/o Worldnet Shipping USA Inc, 155-11 146th Street, Jamaica, New York 11434. Subscription records are maintained at UKIP Media & Events Ltd, Abinger House, Church Street, Dorking, Surrey, RH4 1DF, UK. Air Business is acting as our mailing agent.
Printed by William Gibbons & Sons Ltd, 26 Planetary Road, Willenhall, West Midlands, WV13 3XT, UK.
 ISSN 1478-2774 *Aerospace Testing International*
COVER IMAGE: JD MacFarlan, head of the F-35 program (Lockheed Martin)

Average net circulation per issue for the period 1 January 2011 to 31 December 2011 was 9,694

Published by UKIP MEDIA & EVENTS

Photo by Tim Ripley

Brimstone trialed against speedboats

The first trials of MBDA Brimstone missiles against a target designed to simulate Iranian speedboats have taken place at QinetiQ's Aberporth instrumented range, located in Wales.

In the tests, an RAF Panavia Tornado GR4 strike aircraft scored a direct hit on a remotely controlled speedboat using a £105,000 (US$169,000) Brimstone missile, which had previously only been used against land targets.

Details of the tests were revealed by the missile's manufacturer, the European guided weapon company MBDA, which also hopes to sell the weapon to Gulf states that are very concerned about countering the Iranian speedboat threat.

Military chiefs in the UK and USA fear that Tehran's Revolutionary Guards' fleet of hundreds of ultra-fast speedboats could launch 'swarm' attacks on tankers in the Straits of Hormuz and cripple the world's oil supplies in the wake of any Israeli strike on Iran's suspected nuclear weapons bases.

> **"A swarm of small comparatively fast speedboats presents challenging targets"**

Reports in late August that Iran has been accelerating its uranium refining capacity have added to the urgency to find a way to counter Tehran's military power.

"There has been a growing recognition of the potential threat posed by fast inshore attack craft [FIAC] over the past few years," Douglas Barrie, senior fellow for military aerospace at the London-based think-tank the International Institute for Strategic Studies, told Aerospace Testing International.

"A swarm of small comparatively fast speedboats presents challenging targets – the intent is to overwhelm defences through numbers. Some vessels in this class are also being equipped with short-range anti-ship missiles. The use of FIACs in the Straits of Hormuz is one of a number of potential threats the USA and its allies are taking into account."

MBDA executive Paul Stanley said the tests proved to be a resounding success, saying the missile successfully engaged and sunk the target.

"This latest firing was a great success for the team," said Stanley. "This demonstrates Brimstone's low collateral yet lethal effects against moving and maneuvering fast inshore attack craft." He described the Brimstone as "an extremely effective, anti-swarming FIAC capability". Brimstone uses a built-in radar to find and track targets, which makes it more effective against ships than other smart weapons.

"This makes Brimstone the only currently available weapon capable of providing a fully effective solution against small, fast moving and maneuvering maritime targets," said Stanley.

US defense expert James Dunnigan said the fast-moving small armed boat destroyed during the test was similar to the type favoured by the Iranians. "The Brimstone used its own radar to keep track of the target," he said. "This 'fire and forget' capability makes jets, operating outside the range of any weapons on these small boats, capable of quickly and safely destroying many of these fast attack boats. This is not surprising as Brimstone was the most outstanding air-to-ground weapon used during the Libya campaign last year, and for many of the same reasons."

SWARM ATTACKS

The speedboats are similar to those used in ocean racing and are heavily armed with machine guns, missiles and mines. During naval exercises in the Gulf, Revolutionary Guard naval units regularly practice so-called swarm attacks, which aim to overwhelm naval defences by making mass hit-and-run raids from underground harbors build into islands along the Straits of Hormuz.

For regular news updates:
www.AerospaceTestingInternational.com

COVERING ALL DIMENSIONS OF VIBRATION TESTING

SignalCalc
Dynamic Signal Analyzers

SignalStar
Vibration Control Systems

SignalSound
High Intensity & Underwater Acoustics

SignalForce
Shakers & Amplifiers

TEST & MEASUREMENT SOLUTIONS FOR NOISE & VIBRATION APPLICATIONS

Learn more at
www.dataphysics.com

Data Physics Corporation

Record race gathers pace

Eurocopter president and chief executive Lutz Bertling has cocked the starting gun in an effort to beat the unofficial 250kts rotorcraft speed record set two years ago by Sikorsky's X2 technology demonstrator helicopter.

Speaking at the Farnborough airshow back in July 2012, Bertling said the company's X3 hybrid rotorcraft would "significantly" extend its 232kts speed when it returned from a promotional tour of the USA in September. He said the X3 had only used 80% of its engine power to achieve its last top speed in level flight and the performance of the experimental aircraft had proved better than expected during its two years of testing since it first flew in 2010.

The X3 demonstrator is based on a Eurocopter EC155 helicopter with the addition of short-span wings, which are each fitted with a tractor

For regular news updates:
www.AerospaceTestingInternational.com

Euro-UCAV takes off

Development of the next generation of European unmanned combat air vehicles (UCAVs) was given a boost in July when the UK and French defence ministers signed off the first stage of the project.

The memorandum of understanding involves a commitment to spend €12 million (£9.3 million, US$14.5 million) on the first phase of the Future Combat Air System (FCAS) demonstration project, split between teams led by the UK's BAE Systems and France's Dassault. It is envisaged that the two companies will eventually join forces to build a UCAV to meet the needs of the UK and French air forces.

During a visit to BAE Systems' Warton site in Lancashire in June, the company showed *Aerospace Testing International* the progress on its Taranis UCAV demonstrator ahead of its projected first flight next year. Taranis is being built in conditions of great secrecy at Warton and visitors can only view it from a distance and from the front, while any photography and sketching of the UCAV is banned.

Taranis is funded by the UK Ministry of Defence (MoD) as well as private sector players led by BAE Systems. By developing its own technology and expertise, the UK side hopes to have a leading role in developing the FCAS and benefiting from its production.

From the brief view available of the Taranis, it is apparent that it is now painted in grey radar-reflective paint, compared with its previously seen black surfaces.

Tom Fillingham, director of future combat air systems at BAE Systems' Military Air & Information business unit, said the results of recent radar cross-section (RCS) tests had been "very promising", although the results were still being analyzed by the UK MoD.

TRIAL LOCATION
Fillingham declined to comment on where Taranis would make its first flight, but it seems unlikely that this would take place in the UK because of airspace restrictions and the inability to keep any flight away from prying eyes. This makes it highly likely that this first flight will take place at the Woomera range in southern Australia, where the company's Mantis unmanned aerial vehicle was tested in November 2009.

For regular news updates:
www.AerospaceTestingInternational.com

propeller. The tractor propellers are gear driven from the two main turboshaft engines that also drive the five-bladed main rotor. The helicopter is designed to prove the concept of a high-speed helicopter that depends on the slowing down of the rotor speed to avoid drag from the advancing blade tip, and to avoid retreating blade stall by unloading the rotor. A small wing is intended to provide up to 80% lift instead.

Potential customers in the USA got a view of the X3 earlier this summer after Eurocopter took it stateside on a tour. The X3 made its debut at the Grand Prairie, Texas, headquarters of Eurocopter's US subsidiary American Eurocopter, which was attended by employees, elected officials, customers and industry partners. Several commercial customers from various market segments flew the X3 when it demonstrated its flight characteristics, which include a cruise speed of 200kts, high rates of climb and executing high-speed maneuvers that are not routine for conventional rotary-wing aircraft.

Several guest pilots flew aboard the X3 during its stops at Huntsville's Redstone Army Arsenal Airfield, Fort Bragg's Simmons Army Airfield and at Fort Belvoir's Davison Army Airfield in July. The X3 concluded its US tour at the Pentagon in Washington DC.

According to Fillingham, flight tests have been pushed back from late 2012 into 2013 by the need to conduct further testing. "The [Taranis] program is in good shape for that [flight testing] activity," Fillingham stated.

Once further RCS testing – also referred to by the company as 'pole testing' because of the 6m- (19.7ft-) high, cone-shaped poles the Taranis is mounted on for the RCS tests – has been carried out, the company will enter the extended development phase of the Taranis program, including structural and mission systems testing.

From the limited available views of Taranis it is unclear if it has a weapons bay and BAE Systems executives were non-committal about whether its future tests would include live weapon drops. This next step might have to wait until the FCAS takes to the skies toward the end of this decade.

FASTCRAFT ADVANTAGE

Eurocopter's X3 technology demonstrator is a very radical design that is causing a stir in the helicopter world and offers a major breakthrough in rotorcraft technology. It performed its first demo flight in September 2010, and then in May 2011 exceeded its original speed target of 220kts by attaining an incredible 232kts in level, stable flight. By investing its own money in the X3 project, Eurocopter hopes to show that the concept can offer the high-speed cruise efficiency of a turboprop at a more affordable cost – that means a 50% increase in performance with only a 25% increase in cost. This offers to give the company a major competitive advantage in both the civil and military helicopter markets. Bertling said the company is "well positioned to bring this type of helicopter to market in the next 10 years".

AEROSPACE TESTING INTERNATIONAL NEWS EXCLUSIVE

US army airship takes to the skies

Lakehurst naval air station has witnessed some of the most dramatic events in the history of airships, so it was perhaps fitting that the New Jersey airfield should host the first flight of the US Army's newest airship.

The demise of the famous German airship, the Hindenburg, in 1937 is still honoured by a memorial at Lakehurst, but the August 7 flight by Northrop Grumman's Long Endurance Multi-intelligence Vehicle (LEMV) went without a hitch, according to the company's lead on the project, Alan Metzger. "This is a success story," Metzger told *Aerospace Testing International*. "We had a successful first mission." The successful 25-month effort to get from contract signature in 2010 to first flight in August 2012, according to Metzger, was down to the "vision" of senior US Army leaders, who gave the Northrop Grumman-led team the flexibility to do whatever needed to be done. Eventually, three LEMVs will provide US Army units deployed in Afghanistan with low-cost persistent intelligence, surveillance and reconnaissance (ISR) support in the place of traditional aircraft and fixed aerostats. It is intended that unmanned LEMVs will be able to stay on station for several days or weeks supporting combat troops. He said the US Army wanted "persistent surveillance available to war fighters at affordable cost, with fewer people, less fuel and fewer gaps in coverage than at the moment".

The groundbreaking LEMV draws on the airship designs of the UK-based Hybrid Air Vehicles Ltd and incorporates four diesel engines and aerodynamic mini wings to provide additional lift and power. Prime contractor Northrop Grumman has brought together a team of 18 US and international companies, including Warwick Mills for fabric development, ILC Dover for hull fabrication and seaming, AAI Corporation for air vehicle control through its Universal Ground Control Station, and SAIC for full-motion video exploitation.

The 90-minute first flight was intended to demonstrate take-off, flight maneuver up to 3,000ft, and landing. "We did all three," Metzger said.

The first flight was the start of a test program that will progressively demonstrate the capabilities of the airship and its

> **"We will expand the envelope and mature the capability. We will start with short flights and then move to do multiday missions"**

HYBRID DESIGN

In November 2011 the Congressional Budget Office published a report called *Recent Development Efforts for Military Airships*, in which they stated that: "LEMV … will provide substantially greater payload-duration than do the three Predator class unmanned aircraft in use today: the Air Force's Predator and Reaper and the Army's Grey Eagle. For example, at a 500-nautical mile combat radius, the Army's LEMV would have a payload-duration about 80 times that of the Grey Eagle."

The hybrid air vehicle provides an ultra-long endurance platform with exceptional stability. It has been called a "game-changer" by the US Army, exceeding the capability of all other platforms in terms of low operating costs, duration and payload. With unmanned surveillance of up to 21 days at up to 20,000ft (6,096m), and up to five days manned at 16,000ft, it offers true "persistence" in surveillance and can operate in partnership with other land, sea and air-based assets to offer a complete security solution.

onboard sensor package, he said. A period of inspection and the installation of mission systems will follow the first flight and then flight testing will resume. "We will expand the envelope and mature the capability. We will start with short flights and then move to do multiday missions."

The "methodical" test program has many similarities to those conducted on traditional aircraft, but Metzger said there were some differences in the technology being used. "We are working with fabrics, not aluminum," he said. "It is different – it is an inflatable, not a hard structure."

Although it is ultimately envisaged that the LEMV will be an unmanned system when it is deployed operationally, during the first flight and many subsequent test flights it will be manned. "We had people on the vehicle during the tests – our pilots," he said.

The 150ft long structure under the air vehicle provides a level of comfort needed for the test personnel to operate during extended flights. Metzger described the cockpit environment as similar to that experienced in a commercial airliner. "It more resembles a 767 cockpit than that of a fighter aircraft," he said.

The first flight took place in military airspace within the confines of Joint Base McGuire-Dix-Lakehurst, but Metzger said later ISR trials would eventually take place in Florida to "mature the payload".

The success of the LEMV first flight shows the potential of the airship to replace or augment the ISR systems currently in use with the US Army in Afghanistan, particularly fixed or tethered aerostats that provide a significant element of the service's persistent ISR capability.

"LEMV is mobile," he said. "That is the main difference. Aerostats provide persistent stare on a single location, they stay over one location and feed information to ground and take power through one cable. LEMV removes the tether."

Addressing perceptions that airships are vulnerable to enemy fire, Metzger agreed that they are large, but said when flying at 15,000 or 20,000ft they do not appear large to observers on the ground. They are also quieter than traditional aircraft. "Things we found about airships in the commercial world is that people shot at them all over the world," he said. It is relatively straightforward to patch them up and get them back in use.

Metzger said the company was aware the US Army is likely to want to use the LEMV in places apart from Afghanistan. "We have built it with modular open architecture. We know requirements will change and customers will need to rapidly adapt for new missions."

He said the product could have applications outside the US Army and be of interest to other customers. "We try to build it so it can satisfy multiple roles and missions," he said. "LEMV is a military product and has special sensors." Media organizations such as the BBC, for example, could change the sensors on the airship and use it as a traffic pattern analysis platform.

Fly By Wire . . . Or With Wiring Faults?

Your systems depend on wired interconnections for top performance. Is your wiring up to the task? Make sure with automatic wire harness testing from DIT-MCO International. Find out why for over 50 years the aerospace industry has relied on DIT-MCO's test solutions.

- From simple wire harness to entire aircraft testing
- Open and short fault detection
- High voltage HIPOT tests
- Component verification
- Relay activation
- Data archiving and statistical analysis

DIT-MCO International

Call 800-821-3487 or visit www.ditmco.com for more information.

---

safety in test > safety in flight TEST-FUCHS

Test Equipment for Aerospace

Mobile and fixed test systems for all kinds of civil and military aircraft components.

Everything from one source - from concept to comissioning and lifelong after sales support.

Lube Oil Test Stand

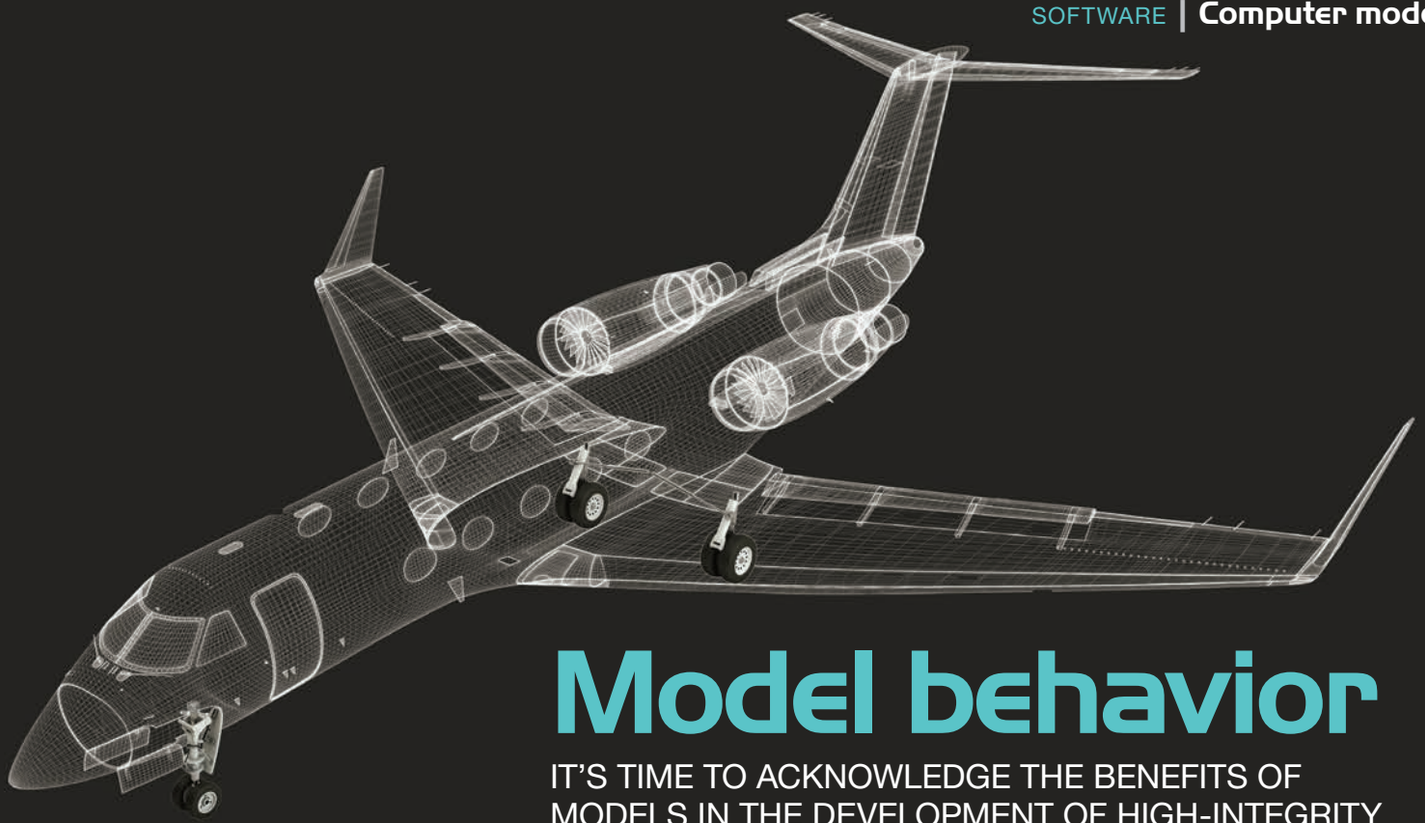
Modular Hydraulic Test Bench

Hydraulic Ground Power Unit

Bonding and Loop Resistance Tester

TEST-FUCHS GmbH / Test-Fuchs Strasse 1-5 / A-3812 Gross-Siegharts
T +43(0)2847 9001-0 / F +43(0)2847 9001-299 / office@test-fuchs.com

WWW.TEST-FUCHS.COM



Model behavior

IT'S TIME TO ACKNOWLEDGE THE BENEFITS OF MODELS IN THE DEVELOPMENT OF HIGH-INTEGRITY AEROSPACE SYSTEMS

Mark Walker is the principal engineer at MathWorks, based in the UK

BY MARK WALKER

As software requirements for modern commercial aircraft become increasingly complex, the number of documents needed to fully specify a design and show it has been developed correctly scales disproportionately with the complexity.

As ever, commercial pressures are forcing engineering teams to do more with less wherever possible. The complexity of many modern systems containing software has reached a point where it is difficult for development processes based on text documents and handwritten source code to compete with projects using model-based design.

Advances in software tools are enabling engineers to tackle the development of high-integrity systems with greater efficiency. The latest revision of the DO-178 standard, which defines the development process for airborne software, was published by the FAA and EASA in January 2012 as revision C. It clarifies how modern software techniques can be used in the development process.

For the first time the standard includes a supplement, DO-331, providing specific guidance on how to use models in the design and verification process, formally acknowledging the valuable role they play. Rather than writing specification documents and then developing code, executable models can be used directly to define the behavior. This approach, 'model-based design', enables engineers to design and develop complex multi-domain systems through a simulation-based approach.

Working directly with models can improve efficiency in many areas. When models are used to communicate requirements between teams or companies, such as the airframe manufacturer and the equipment supplier, both parties can work to a well-defined behavior for that part of the system. By contrast, a written specification document is open to different interpretation by different teams.

The more subtle differences in understanding or expectation may only be identified late in the acceptance testing process, leading to expensive rework. Just as with a paper document, the model can be reviewed by looking at it. Importantly, a review of a specification model can be supplemented by other forms of analysis, such as simulation. This enables a deeper understanding of the possible behaviors and is especially beneficial as system complexity goes up.

Engineers can use these models to develop designs from the highest level of requirements to a complete specification of the implementation. Once you have this complete specification, more of the later implementation and verification stages can be automated. For example, the production source code can be automatically generated from the model. On the verification side, the model is a reference for the expected software behavior. Independent tools can then check automatically for equivalence between model and source code.

Models are often used today as a design aid to supplement a written specification, rather than being the central specifications for the system itself. DO-178C provides a set of guidelines to show how to fully integrate the models into the design process. This improves the development and review of designs, enhances communication between teams or across the supply chain and opens up additional opportunities for automation. This helps engineering teams manage the ever-increasing complexity while working to the highest DO-178 Design Assurance Levels. ▮

> **"A review of a specification model can be supplemented by other forms of analysis, such as simulation"**

The student engineering culture

TWO FORMER STUDENTS FROM THE FLIGHT SCIENCE AND TECHNOLOGY GROUP AT THE UNIVERSITY OF LIVERPOOL DISCUSS WHAT UNIVERSITIES CAN NOW DO TO CUT COSTS AND ASSIST IN TEST PROCEDURES AND ENGINEERING FOR COMMERCIAL COMPANIES

Garnet Ridgway

Garnet Ridgway has a PhD from the University of Liverpool. He has designed cockpit instruments for Airbus, and is currently a senior engineer at a leading UK-based defense company

Sophie Robinson

Sophie Robinson has a PhD from the University of Liverpool and currently heads up its Flight Science and Technology research group, based within the Centre for Engineering Dynamics. In the course of her research, Sophie regularly works with test pilots

As the aerospace industry progressed through its adolescence, the majority of design engineers became necessarily removed from the actual testing of their machines. This trend was accelerated by the advent of more sophisticated simulation and modeling tools, which notionally enable a new product to be 'right first time'; relegating testing to the status of a superfluous, expensive obligation.

The use of tests in modern aerospace projects as contractual milestones adds weight to this impression; a test can be 'passed' or 'failed'. An extension of this way of thinking presents the engineer with a conundrum: the test must be passed, and there are two ways of achieving this. Firstly, design an excellent product; secondly, make the test easier. The former option is not always possible within time and budget constraints, and the second is clearly not in the best interests of the project.

There is, however, an upside to this shift away from real-world testing. Firstly, highly capable simulation tools have moved within the budgets of many universities. A properly validated, high-fidelity flight simulator can effectively put a fleet of test aircraft directly into the hands of specialist researchers. Although such facilities cannot necessarily be described as 'cheap', they are a fraction of the cost of their real-world equivalents. This enables research to be undertaken in the peer-reviewed, knowledge-driven environment of academia, rather than in unpublished, company-eyes-only documents.

An additional advantage of the availability of flight simulation to universities is the potential for its use in teaching. For many years, it has been possible to graduate from a good university with a degree in aerospace engineering without ever leaving the classroom. Obviously, there are some good reasons for this; aerospace products are extremely complicated, and their comprehension requires an extensive knowledge of theoretical subjects. There is, however, something deeply appealing about the idea of 'just giving it a go', and testing a solution without needing an understanding of every last detail of the design; a sentiment of which many of the early pioneers would have thoroughly approved. Simulation provides students with a feasible way of doing this, bringing a testing-based design methodology into the classroom for the first time.

It would appear, therefore, that there is an opportunity to reverse the aversion to testing in engineering culture. By encouraging students to leave the classroom in a virtual sense, it is possible that testing will again become a natural part of the skill set of young engineers. The challenge for industry will be to make effective use of this while maintaining the appropriate theoretical skills base. ▮

Fully briefed and prepared, the test pilot steps into the aircraft for the first time. Familiarization with the cockpit is complete, and the pilot is ready to begin the first test maneuver.

"You have control," announces the flight test engineer.

"I have control," replies the test pilot.

This situation will sound familiar to flight test engineers around the world; what is different about this particular scenario is that it isn't taking place on a windswept airfield or in a top-secret military facility; it is happening in a simulator at the University of Liverpool, UK. The flight test engineers are undergraduate students who have designed and built a simulation model of a novel aircraft. This flight test represents the culmination of their 'capstone' project, designed to consolidate all the theory and technical knowledge they have acquired during their years of undergraduate study and apply it to a real-world design brief.

For many, if not all of the students, this will be the first time they've experienced testing in an engineering context. The process of conceiving, designing, implementing, and actually operating their aircraft presents many challenges. The real-time nature of testing can present time-critical challenges; previously, questions posed may have to be answered within a three-hour exam or before next week's lecture. In the testing environment, solutions must be generated in a matter of minutes or risk a failed test. Of course, in the simulator environment the financial impact of a failed test is reduced, but the skills acquired by the students will prove invaluable when they move into the world of professional engineering.

Testing also provides the students with ample opportunity to develop their existing communication skills and develop new ones. Up until this point, students will primarily have been interacting with their peers – people with the same knowledge and experiences as themselves. Planning and implementing a flight test necessitates interaction with individuals outside that sphere; namely test pilots and technicians. This requires them to effectively adapt and develop their method of communication (in both the verbal and written sense), a skill that is highly sought-after by employers.

Being involved with testing at this early stage in their careers has myriad benefits for young engineers, problem-solving and improved communication being just the tip of the iceberg. There is also another upside to testing, if student feedback is to be believed; it's fun. ▮

Rapid Control Prototyping | Autocoding | HIL Testing

Hardware-in-the-Loop Testing with dSPACE – For Certain Success

With the complexity of today's highly-integrated vehicle systems, testing is more important than ever. In "iron birds," integration test facilities, and model-testbed applications, dSPACE hardware-in-the-loop (HIL) systems, emulators, and model-driven testing tools are best-in-class when it comes to performance, quality, and value. dSPACE products have set the standard for quality for over 20 years. Whether the application is for air, land, sea, or space, dSPACE has provided world class support on programs as diverse as Joint Strike Fighter, the USS Makin Island, Future Combat Systems, and the Joint Polar Satellite System.

When quality, reliability, and performance are critical, you can rely on dSPACE.

Embedded Success dSPACE

Room with no echo

SITTING IN THE SWELTERING MOJAVE DESERT ON THE EDGE OF EDWARDS AIR FORCE BASE IS A HUGE HANGAR. IT IS THE LARGEST ANECHOIC FACILITY IN THE WORLD AND *AEROSPACE TESTING* HAD DIRECT ACCESS TO ITS DIRECTOR OF OPERATIONS

BY CHRISTOPHER HOUNSFIELD

No strangers to testing electromagnetic interference on any type of airframe, the 772nd Test Squadron (TS) at Edwards Air Force Base specializes in determining the electromagnetic compatibility of an airplane's systems, one test at a time. To do so it operates and uses the largest anechoic chamber in the world: the Benefield Anechoic Facility (BAF).

On June 8, 2012, the 772nd TS, with the help of multiple organizations, ventured for the first time to complete a series of tests on multiple systems simultaneously on an F-16 that carries an Advanced Integrated Defensive Electronic Warfare Suite (AIDEWS). This is an integrated radar warning and jamming countermeasure system.

Aside from testing antenna patterns on the F-16, the team tested system interoperability between the fire control radar and the AIDEWS jamming pod, along with radar warning receiver (RWR) testing, which gives pilots situational awareness by allowing them to detect, identify, and track threats.

The Benefield anechoic chamber is tucked away on the southern perimeter of the vast Edwards site, the largest test base in the world, which is situated within the hot, dusty, dry lakes of the western Mojave Desert. It is located in this harsh environment not only because it is away from prying eyes, but also because the area has near-perfect, clear flying conditions virtually every day. It was here that Chuck Yeager broke the sound barrier and the Space Shuttle made its first landing.

The BAF, completed in 1989, was named after Tommie Benefield, who was killed in the desert in 1984 during a B-1 Lancer flight test. The B-1B program was the driving force that started the BAF.

The BAF is a ground test facility used to investigate and evaluate anomalies associated with electronic warfare (EW) systems, avionics, tactical missiles, and their host aircraft. Tactical-sized, single or multiple, or large vehicles can be operated in a controlled electromagnetic (EM) environment with emitters on and sensors stimulated while radio frequency (RF) signals are recorded and analyzed. The largest platforms tested at the BAF have been the B-52 and C-17 aircraft. The BAF also supports testing of other types of systems such as spacecraft, tanks, satellites, air defense systems, drones, and armored vehicles.

If the BAF were a normal hangar its statistics would be impressive; coupled with the vast array of test technology and the surreal dark anechoic wedges that clad the interior roof, floor, and walls, the stats become almost incredible. The chamber is 264ft long, 250ft wide, and 70ft high. It has two 40-ton hoists, and one 175-ton, 80ft-diameter, unique turntable, and has a quiet zone isolation of 18Ghz.

Free space

The 772nd TS squadron director is David Krohman and its director of operations is Major Clint Armani, who spoke exclusively to *Aerospace Testing International* about this most secret of facilities.

"Anechoic literally means 'non-echo'. Therefore, anechoic facilities are used to isolate signals," explains Armani. "That is, we keep out extraneous signals, and we keep in the desired signals. Given a large enough space, an anechoic facility can replicate a signal as if it were generated in free space (a significantly far distance from the system under test). The special thing about the BAF is that we create real-world RF scenarios, and test systems installed as they will be used operationally. Given the size of our chamber, we can generate free-space signals and perform testing in a controlled and repeatable environment."

The BAF provides a test environment that has a number of uses. Evaluation of radar warning receiver (RWR) systems is one. The BAF can generate both free-space and 'direct-inject' signals to test RWR systems, provide real-time environment monitoring, and can record both the simulated signal environment and system under test (SUT) emissions.

On the defense side, the BAF can simulate evaluation of defensive avionics system testing: communication, navigation, and

MAIN: A series of simultaneous tests on multiple systems on an F-16 that carries an Advanced Integrated Defense Electronic Warfare System were completed in June 2012. The AIDEWS is an integrated radar warning and jamming countermeasure system

ABOVE: A C-130J sits in the Benefield Anechoic Facility at Edwards for defense systems testing

"Tricking the modern aircraft systems is much more difficult than previously. Nevertheless, we have been successful so far"

identification (CNI) and identification friend or foe (IFF) testing.

The facility can measure the antenna patterns of both installed and uninstalled systems. It can also perform electromagnetic interference/electromagnetic compatibility (EMI/EMC) testing.

Test requirements at the BAF are increasing in complexity with the development of sophisticated manned and unmanned systems; as a result, ways to improve existing test methods are important.

"In a nutshell, we provide a cost-effective way to test advanced electronic systems," says Armani. "With the world's largest anechoic chamber, we test complete end-to-end installed systems by generating RF signals within the battlespace environment.

"By testing the installed system [aircraft], we can provide the data to determine if the system under test is performing as designed before the aircraft spends valuable time and money on open-air range testing. This allows the test program to mature and validate the system before flying in open-air range. Additionally, we have the ability to provide signals and signal densities that cannot be achieved in open-air testing."

The prime systems tested on an aircraft are: radar systems, communication and navigation, GPS, identification friend or foe (IFF), radar warning receivers, electronic countermeasures (onboard and offboard), electronic interference and compatibility, radar cross-section, antenna pattern, and network-centric systems of systems.

ABOVE: An X-51 Scramjet-Waverider mock-up hangs inside the BAF during the vehicle's antenna testing (Picture: USAF)

Electronic warfare and info

The BAF RF infrastructure supports test and evaluation requirements of diverse RF systems. Major Clint Armani says, "Our controlled test environment is very effective at testing installed electronic systems. As we go into the future, we will have to keep improving and increasing the number of test resources used to test in a highly dense RF environment. The RF element is a huge asset to electronic warfare (EW)/information operations (I/O) and is an area that BAF is expanding on. This includes: radar warning receivers; electronic support; SIGINT/ELINT/COMINT; onboard and offboard electronic attack (EA) (jammers); radar systems; antenna systems for all types of avionics and systems; and datalinks and satellite communications.

Typical EW/IO test requirements that can be satisfied include: situational awareness – dense electromagnetic environment (EME); threat detection, identification, processing, and response; jammer system functionality; angle of arrival or direction-finding (DF) measurements; antenna performance; suitability; subsystem interoperability/compatibility testing – intra/intersystem isolation; threat parametric measurements; and minimum discernible signal measurements.

Hypersonic focus and antennas

The BAF has played a major part in most experimental ('X') aircraft, the most recent being the X-51; this has now successfully been flown, having had its most recent and third flight test in August 2012. An essential element of flight-test build-up was signal and antenna training, essential to the performance and early success of the scramjet in 2009. The purpose of the month-long test was to make sure all of the X-51's antennas and communication systems were working properly. It was vital that the craft had good receiving and transmitting antenna and good coverage of antenna patterns, spectrum of frequencies, and bandwidth.

The team looked at two types of antennas: a flight termination system antenna and a telemetry antenna that streamlines all data from the X-51, including performance, air, and engine data. The Boeing test team mounted the antennas on an X-51 mock-up. An antenna in the BAF sent signals to the mock-up, while an engineer determined if the aircraft received.

The data gathered at the BAF helped determine that the antennas met the requirements.

BAF can handle just about all types of craft, but there are some limitations, as Armani observes: "We can test aircraft of many sizes, from fighter to bomber to transport. The only aircraft in the current USAF inventory that we cannot physically fit is the C-5, due to the height of its tail. The challenge with various aircraft is the different power, cooling, and hydraulic requirements. Additionally, various aircraft have different slings and lift points for hoisting the aircraft once inside the chamber. Lastly, there can be near- and far-field RF issues depending on where the antennas are installed on the aircraft. In the end, our team has successfully adapted to each of these requirements."

The difference in testing today

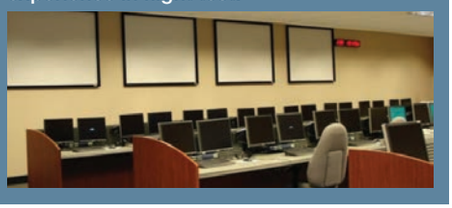
Armani is keen to highlight how integral RF, EM, and EW are to its operations: "Currently, we are conducting a number of electromagnetic interference (EMI) tests and installed antenna pattern characterizations. EMI testing focuses on the interoperability of onboard systems with the goal of multiple systems working as designed without undesirable interference with one another. Additionally, with the recent growth in new antenna technology and receiver/processor sensitivities, the installed antenna characterization has been a popular test of interest right now.

"The extreme environments that we test for are the dense RF environments," he continues.

Under control

Tests are conducted, controlled, and monitored from the integrated Test Control Room (TCR) within the BAF. This has the capacity for: the system test director; the test conductors; up to 26 test stations for assistants, specialists, and technical staff; test advisors; observers; intercom to system under test (SUT); digital video recording; real-time displays; cockpit and relevant test equipment and MUX Buss Data.

Major Clint Armani puts this into context: "Testing environments are very unique to each customer and aircraft. Therefore, we are constantly modernizing our testing equipment and capabilities as aircraft systems mature. However, we operate tests in a very similar manner to flight testing. We control the test from a mission control room, and we provide the data to our customers in formats for which their analysis tools are built. Therefore, the execution of the test and the data products are very analogous to what they will experience in flight test."



"We are able to script and control a wide variety of RF signals including communication, radar, and datalink signals."

He emphasizes that the 772nd TS does "much more than just operate the BAF". The squadron, he says, is "heavily involved in virtual battlespace environments through the use of modeling and simulation, systems integration, and hardware-in-the-loop facilities".

The facility has also had to move on with regard to the advancement of aircraft technology: "Back when aircraft systems were federated and more independent, tricking the aircraft into thinking it was in a flight regime was much easier. Today's modern aircraft utilize more fusion of various systems. Tricking the modern aircraft systems is much more difficult than previously. Nevertheless, we have been successful so far," explains Armani.

BELOW RIGHT: The V-22 Osprey spent about three months suspended from the ceiling of the facility while the integrated test team checked out the electronic countermeasures package, called the suite of integrated radio frequency countermeasures

BELOW: The BAF sits on the southern edge of the vast dry desert lakebed that makes up Edward's Air Force Base

The future

Benefield is not just a facility for experimental aircraft, spacecraft, or US military aircraft. Many other projects have been conducted there, some involving rotary-wing aircraft or foreign military services, including the UK, Germany, Israel, Australia, and Pakistan.

Commercial aircraft from Boeing and cars have also been tested at Benefield (BMW has conducted extensive automotive tests there), and the facility has even featured in films such as *Armageddon* and *Transformers*.

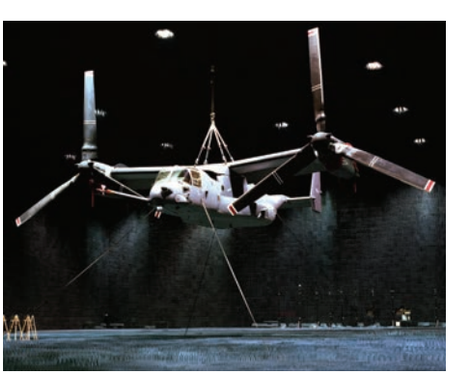
Asked why commercial aircraft do not use the facility more, Armani replies, "They do not have the [same] systems or requirements as military aircraft. For instance, commercial aircraft don't have fire control radars, jammers, or radar warning receivers. Common commercial systems are weather radar, GPS, and IFF. Basic interoperability testing is common for commercial systems. However, the different missions of commercial compared to military aircraft drive very different requirements for avionics and systems testing."

Armani predicts that the use of this type of facility can expand only as the cost of flight tests gets higher and electronics become more complex. He thinks the technology will continue to develop. "Testing of advanced electronic systems will continue into the future. In fact, the complex integration of such systems only increases the need for wise and effective test techniques. In order to perform controlled free-space RF testing, a large anechoic facility is required. In theory, a larger or even spherical facility would be an improvement (the RF physics won't change), but the cost to build a more capable anechoic facility would likely be prohibitive in today's budget environment."

The BAF does not and cannot replace flight testing but it is an amazing facility to carry acoustically and electronically aircraft swiftly to that stage, and to test systems that otherwise would have needed many flight hours on something as straightforward as antennas.

"In general, our customers are constantly surprised at how much they learn about their system by bringing it into the BAF. The preconceived notion is that they will get a little data for a lot of money. However, customers commonly do not want to leave once they get started and see the type and amount of data we are producing on their system," explains Armani.

"As the RF environment gets more crowded and as flight test airspace continues to get encroached upon, the BAF is an excellent facility to gather system knowledge. Again, we are not a replacement for flight tests. There are many things that we do not replicate, such as engines running, g-forces, heat, vibration, and rapid aircraft geometry changes. Actual flight test on open-air ranges is where these are combined with the aircraft systems to evaluate. Yet, the BAF is the place that can mature a system so that flight test is more efficient and the program risk is reduced. ▮



SPACE TECH EXPO

DESIGN • BUILD • TEST

LONG BEACH CONVENTION CENTER
LONG BEACH, CALIFORNIA, USA
MAY 21-23, 2013

NEW FOR 2013!

- Satellite Technology Pavilion
- Open Tech Forum
- Small-Satellite Conference Track
- Space Experience Park

EXHIBITION & CONFERENCE

Bringing together global decision makers, buyers and engineers involved in spacecraft, satellite, launch vehicle and space-related technologies

BOOK NOW

EXHIBITION SPACE LIMITED

www.spacetechexpo.com

t: +1 877 842 6289 | e: info@spacetechexpo.com | w: www.spacetechexpo.com

A class above

BIZJET OWNERS HAVE HIGH EXPECTATIONS – A FACT NOT JUST REFLECTED IN THEIR DESIGN AND ONBOARD COMFORT, BUT ALSO IN THEIR TESTING

BY PAUL E. EDEN

Wichita Mid-Continent Airport houses Bombardier's 1,240,000ft² (115,200m²) Learjet manufacturing facility, as well as its flight test center, home for all its business jet experimental flight-test programs. Over the summer of 2012, Bombardier has been running concurrent test programs for its revised Learjet 70 and Learjet 75, and the all-new Learjet 85. It also has its range-topping Global 7000 and Global 8000 in development, offering the latest levels of comfort and performance.

Given the unique requirements of business aviation, where customers demand not only luxury but also connectivity, practicality, robust economics, and high performance, Bombardier expends a great deal of time, money, and effort in insuring that its business aircraft undergo the most stringent of test programs, both for airworthiness and durability. As Richard Doyon, section chief project engineering and flight test team chief, puts it, "We want to find any problem with the cabin before our customers do." Compared with Bombardier, which began building business jets in the mid-1980s when it absorbed Canadair and its Challenger line, Embraer is a relative newcomer to the sector. The Brazilian airframer launched the Legacy 600 derivative of its ERJ135 regional jet in July 2000, basing its development and flight test operation out of its corporate headquarters at São José dos Campos, Brazil.

Speaking to Embraer's Marco Tulio Pellegrini, senior vice-president operations and chief operations officer, executive jets; and Alexandre Figueiredo, VP ground and flight tests, it is immediately obvious that the South American approach to bizjet testing has inevitable similarities to that in the north – but also some key differences.

Recipe for success

Rich Doyon explains how Bombardier's test campaigns are crafted: "We have a recipe book that we call the Bombardier Engineering System. We've been developing it over the past 20 years and it has seven stages, from concept through to service entry. The flight test portion is very small, happening in the sixth stage of the process. The previous five stages are all

The Global 8000 will be Bombardier's flagship, with first deliveries scheduled around 2017. Both the new Global 7000 and 8000 will bring fly-by-wire to the airframer's bizjet range (Bombardier)

The aircraft above is the second prototype of the Embraer L500 under fly-by-wire system testing

about development from initial concept and putting our arms around what we need to certify and how we're going to do that. Typically it's two years before we start ground tests and work toward first flight.

"Taking the Challenger 300 program as an example, roughly three years prior to the process of flying the airplane, we went through conceptual definition, detail definition, and so on. So the engineering team has defined the airplane and we've built the airplane and understood every piece of regulation. At that point we start the ground test portion and integration of various systems with the engineering team and pilots," he says.

Michel Korwin-Szymanowski, director of Bombardier's flight test center, says that although the test process is well defined, the way they do business is changing: "We're making greater and greater use of rigs and other tools, to make sure that flight test is more a validation process than a big discovery of problems. We work with our suppliers to run test rigs ahead of time, while rigs run by Bombardier integrate supplier systems to make sure all the parts work well with one another. In fact, 85 to 90% of the program is complete by the time we reach flight test."

Ground testing is carried out on the airframe with power on, as well as using lab systems, including rigs and non-moving simulators. Reflecting the changing focus of flight tests, Korwin-Szymanowski says, "If we go back to the 1960s and 1970s, handling qualities and performance consumed the vast majority of a test program, both in the air and in the wind tunnel. Now, with the systems we have in the airplanes, our better understanding, and the predictive tools that we employ on handling qualities and performance, although we still do a lot of wind tunnel work and a lot of CFD [computational fluid dynamics], we generally get the results we anticipated. This means that the ratio of systems testing is now much greater than it used to be."

Scott Whitley, senior engineering test pilot, adds his perspective to the changes: "Over the past several programs, Bombardier has been elegantly sliding into a project transformation, where we're doing many more things prior to flight. We're also evolving engineering simulators that have very high fidelity, hardware in the loop, and are very representative of the flying characteristics, flying qualities, and handling of the airplane. We use those simulators months before we get near the flightline with the actual aircraft. It's very important for the Global 7000, Global 8000, and the CSeries airliner, since we're evolving their fly-by-wire technology."

Bombardier has constructed a complete integrated aircraft systems test area to support CSeries development, both before and during the flight test program. Now it is beginning to apply similar concepts to its bizjets. So have all potential problems been identified and fixed by the time the aircraft launches on its maiden sortie? "In the perfect theoretical case we shouldn't find any problems when we start flying, but I think we'll always find something and that's why we have to flight test," says Whitley.

Future products: Bombardier

Type entry	Status	Projected service
Learjet 70	In flight test	Q3/4 2013
Learjet 75	In flight test	Q1/2 2013
Learjet 85	Proceeding to flight test	2013
Global 7000	In development	2016
Global 8000	In development	2017

> **"We have a very lean test campaign, but we go much further than is required for certification"**

Once a flight test program is up and running, specific tasks are frequently allocated to particular airframes and designated crews. Whitley explains, "With our new programs, our flight test vehicles are each defined for certain tests. The flight crew – pilot and engineer – will be assigned according to their strengths, qualifications, and forte. They'll be assigned to particular flight test vehicles, probably for the majority of the program."

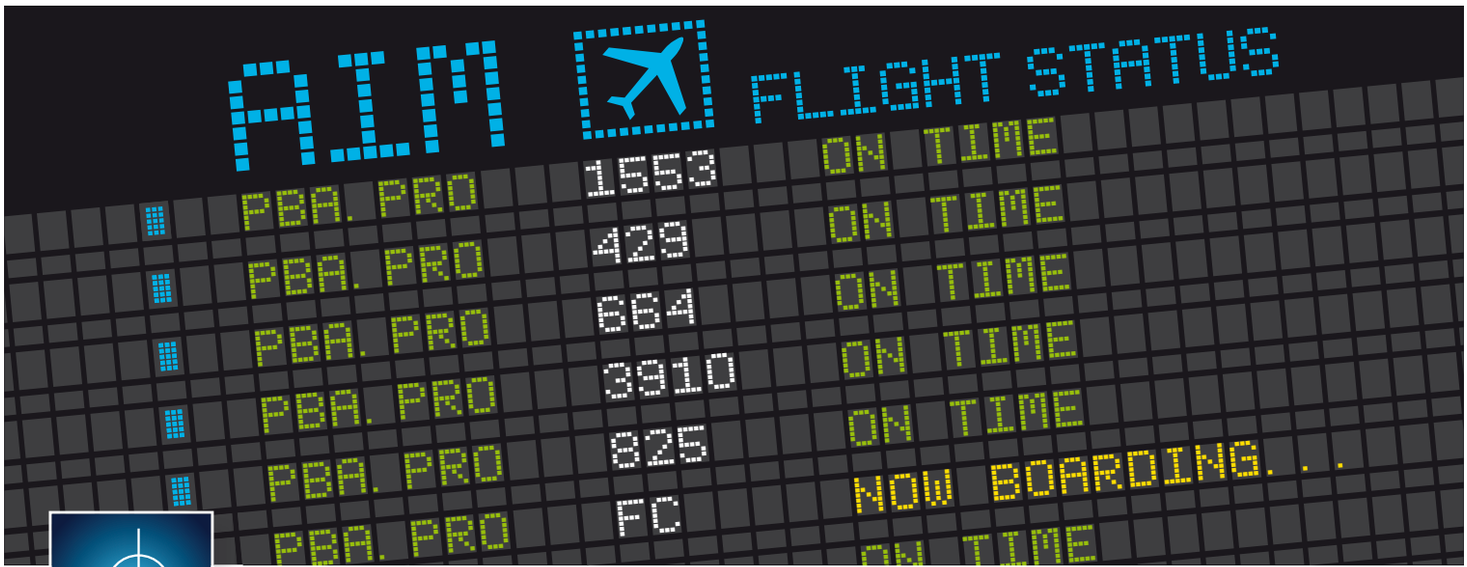
Figueiredo explains Embraer's similar approach to testing an all-new airframe: "We start with component tests, working with our suppliers, then we move on to component integration, where roughly half the work is done in-house. We do the systems integration using several rigs, so that before we fly we have all the systems running together. In fact, we have an iron bird with all the systems running. We generally assign dedicated test teams to a program, with flight test teams allocated according to their subject expertise.

"Normally we have the systems cleared for flight before the first prototype flies, and that flight then becomes a validation of our simulations. Typically, we keep that first aircraft flying after certification, using it for the integration of new systems and equipment for various future upgrades."

Certification challenges

Asked to define the key differences between the certification process for a bizjet and a commercial aircraft, Korwin-Szymanowski says that for Bombardier they are negligible. Basic certification for the company's entire bizjet line is to Part 25, the Transport Category, as it will be for the CSeries. He notes, "The burden of

BELOW: **Global Vision testing early in 2011 included this rather daunting approach to land. The Vision Flight Deck integrates the Rockwell Collins' Pro Line Fusion suite with head-up displays, a synthetic vision system, an enhanced vision system, and other advanced technology (Bombardier)**



Right on Target

The leading manufacturer of Avionics Test & Simulation Products for all applications

Get on Board!

PBA.pro software - takes you where you need to be for all your Avionics Databus Test, Analysis and Simulation needs.

The **PBA.pro** - a Modular, Scalable and Integrated solution for a wide range of avionics test applications. From stand alone Databus Analysers right up to Test Benches or Avionics Integration/ Simulation facilities.

PBA.pro - testing for the future - Today!

www.aim-online.com

AIM Office Contacts:

AIM GmbH - Freiburg
tel: +49 761 45 22 90
email: sales@aim-online.com

AIM GmbH - München
tel: +49 89 70 92 92 92
email: salesgermany@aim-online.com

AIM UK - High Wycombe
tel: +44 1494 446844
email: salesuk@aim-online.com

AIM USA - Trevose, PA
tel: 267-982-2600
email: salesusa@aim-online.com

AOS S-MIZE EM: same performance – half the size

A high-speed digital camera designed for airborne and defense applications

The S-MIZE EM digital high-speed camera is specifically made for airborne and defense applications, such as:

- Store separation tests: the camera meets and exceeds standards for most airborne applications. Integrated in an ultra-robust enclosure, the camera can be installed in or under the aircraft without the need for an additional camera housing, thus making positioning to record store separation simple.
- UAV/UCAV: where it is necessary to transmit live data recorded by the camera to the ground station for reviewing, S-MIZE EM integrates into the aircraft telemetry system through the built-in gigabit Ethernet interface and manageable bandwidth control.
- High image resolution, frame rates up to 100,000 fps, built-in image memory (up to 10.4 GB), and a non-flammable battery are just some of the highlights of the S-MIZE EM camera.

S-MIZE EM – designed for airborne applications

AOS now presents the S-MIZE EM, an ultra-compact camera almost half the size of previous cameras. The camera can be positioned in tight spaces where other cameras will not fit, and its weight has been reduced to less than 900 grams.

Designed for a purpose: the S-MIZE EM is a ruggedized camera designed for working in tough environments. The camera complies with standards MIL 810, MIL 461, and DO 160.

Minimal changes to the airplane and test procedures

The S-MIZE EM can be configured to adapt to the aircraft-specific interface, resulting in minimal modifications to the airplane and test procedures. Existing hand-shake routines can be duplicated by a number of programmable status lines.

AOS Technologies AG
CH-5405 Baden-Daettwil
Phone +41 56 483 34 88
www.aostechnologies.com
info@aostechnologies.com

AOS Technologies AG

Imaging for smart decisions

LEFT: In September, the Gulfstream G650 business-jet aircraft received a type certificate from the FAA. The certification now verifies the airworthiness of the aircraft's design

Gulfstream on course

US FAA pilots have completed all the scheduled flying required for the certification program for Gulfstream Aerospace Corp's ultra-large-cabin, ultra-long-range Gulfstream G650. In addition, the European Aviation Safety Agency test team finished the flight testing required for its validation of the FAA's type certification.

Back in November 2011, the G650 received a provisional certificate from the FAA, and is in the process of completing the final certification tests with the FAA to support entry into service later in 2012. As of July 2012, the test fleet had flown more than 3,800 hours during more than 1,160 flights.

The final certification tests included completing the field performance tests, evaluating the aircraft's performance in natural icing conditions and conducting function and reliability testing.

demonstration is exactly the same, so we use the same tools. These tools cost a lot of money, so we want to leverage the money we spend on developing a tool onto many programs." There is also little difference between the certification process for a Learjet and a Global, for example, save for variations relating to aircraft size and take-off weight.

"Our industry is certified either to Part 23 or Part 25. Part 23 is more for general aviation and many business jets fall into that category. Part 25 was approved as a separate category in the early 1960s and Learjet made a strategic decision back then to certify all of its business jets to Part 25. In fact, the Learjet 24 was the first Part 25 aircraft ever certified, on March 17, 1966.

"Given this tradition, we've never looked back, so all Bombardier airplanes are certified to the highest standards of the Transport Category requirements. That's why we're saying that bizjet and commercial certification are similar, but they are not necessarily similar for our competitors. Some of their smaller bizjets will be to Part 23, which has fewer requirements and may require less flight testing than we put our airplanes through.

"It's a selling point, because it allows us to say that a Learjet is certified to the same standards as a Boeing 787. In effect, it's certified as a small airliner," he says. "One of the requirements of Part 25 is that it increases the amount of redundancy, ensuring that airplanes have back-ups for critical systems. And that includes the pilot, because Part 25 airplanes are typically certified for two-pilot operation and Part 23 may be a single-pilot airplane. All Learjets are two-pilot aircraft."

There are differences at Embraer, where some certification is done to Part 23 standards, as Figueiredo reports: "Certification depends on the airplane; most of our aircraft are Part 25. The Legacy 500 that we are starting on now will be Part 25, but when we do Part 23 certification, we go much further than required. Our test campaign for Part 23 is actually not much different to Part 25. However, the aircraft will be less complex and smaller, so the test campaign can be shorter.

LEFT: Here the Embraer second prototype of the L500 undergoes system testing

"After we've completed iron bird testing, we usually commence flight testing with three air vehicles. We normally have two static airframes as well – one for structural testing and one for fatigue.

"Individual flight test aircraft are usually focused on low speed, flight qualities, and performance; flutter, high speed, and systems; and a third aircraft with full interior and entertainment, environmental control, and noise reduction systems. This last aircraft is used for function and reliability testing. We normally also fly a fourth airplane with a focus on maturity, so that we can guarantee a smooth entry into service," he says.

"A flight test campaign for Part 25 would usually be around 2,000 hours and Part 23 about 1,700 hours. It's about 20% less, but that's down to the reduced complexity of the airplane. Normally Part 23 allows single-pilot operation in service.

"We have a very lean test campaign, but we go much further than is required for certification. We consider certification as something that we have to comply with, but it isn't sufficient to ensure that we have a good quality, reliable product. Our focus is on providing a great product that is mature and offers the highest standards of safety," Figueiredo concludes.

Bizjet specifics

The utility and integrity of cabin fittings, connectivity, and other critical 'back end' equipment is clearly essential to bizjet operators. As such, Bombardier is scrupulous in its cabin test procedures. Richard Doyon says, "The cabin is obviously a major part of what sells the airplane and testing the cabin is part of what we do toward the end of the program, when we have an

airframe that's more or less there. We take an aircraft with a completed interior, put it through its paces, and then keep using it."

Embraer's approach to cabin utility is slightly different. According to Figueiredo, the in-service fleet becomes the barometer for long-term cabin utility very soon after the company begins customer deliveries. "We follow all the aircraft in the fleet and understand what is going on in the industry. We also stress the systems and equipment in corners of the envelope that our customers never go," he says.

Customers demand a range of options to complete their ideal cabin and the manufacturers offer a comprehensive catalog of optional materials, fittings, and equipment. All of these add additional burden to the test program, but as Doyon notes, "We can't give a customer something that hasn't been certified, so at the time the airplane is certified, everything in the catalog is also certified. Then, as time progresses and you add new options, the certification process continues.

"We also work hard to satisfy particular customer needs with our extended testing. Part of our cabin certification and extended testing is to lead the fleet, finding and catching problems before our customers do. But we'll often cater to a particular customer need. "Some customers are positioned quite far north and fly polar routes, for example, so we take our airplane and check the satellite provider's coverage – we just took a Global across the North Pole. We test our system in accordance with what a customer would normally be expected to do and we do a lot of deployment worldwide to help customers certify their operations.

"An OEM [original equipment manufacturer] takes great pride in certifying an airplane, but once it's given to the customer, the customer has to be able to use it to satisfy their needs. So, as an example, we're going to take our airplanes and crews, and help a customer get certification for steep approach operations into London City Airport. And, of course, we take our airplanes away and do hot-and-high, as well as cold weather testing."

Embraer uses its third and fourth flight test airframes to certificate optional items of avionics and cabin equipment, while testing options such as exterior finish on the ground. Certification of airframe and equipment can include work in Brazil; Key West, Florida; and Alaska.

Derivative testing

Product lives can be extended and customer appeal increased through upgrade and performance enhancement. Bombardier is upgrading its Learjet 40 and Learjet 45 line as the Learjet 70 and Learjet 75, using the older platforms to flight test various Learjet 70 and Learjet 75 features, including the Vision Flight Deck. According to Korwin-Szymanowski, "An upgrade can be a very powerful tool for customers and the industry. It enables us to take a great airplane and introduce new technology or new capabilities that weren't available before. In the Learjet 70 and Learjet 75, which are actively in flight test, we're able to improve performance and provide a brand new cockpit and interior."

The test campaign for an airframe upgrade, which might include avionics as well as cabin, aerodynamic, and engine enhancements, is very different to that for an all-new aircraft. "The guys on the program come to us almost with a statement of work and we're left to make the necessary flight tests," says Korwin-Szymanowski. "For the level of improvement on the Learjet 70 and Learjet 75, the amount of flight testing is significantly less than for a brand new airplane, but this depends on the level of change we're doing and what we need to revisit. We break the testing into different phases to address specific changes as they're being done." ▮

Paul E. Eden is a UK-based writer for Aerospace Testing International and also a specialist freelance writer and editor in the aviation industry

BELOW: Embraer rolled out its first Legacy 500 prototype on December 26, 2011, enabling pre-flight ground test work to commence. The aircraft completed ground vibration tests, in Geneva, during May 2012 (Embraer)

BOTTOM: Embraer was conducting taxi trials with the Legacy 500 in March 2012. Three prototypes of the clean-sheet design will be built, with aircraft No. 3 the first to be fully outfitted for cabin testing. The latter will look at the galley and Honeywell's Ovation Select IFE system, as well as cabin fixtures (Embraer)

Future products: Embraer

Type	Status	Service entry
Legacy 450	In development, fabrication began 13 August 2012	2015
Legacy 500	Proceeding to flight test in Q3 2012	Q4 2013/Q1 2014

sentinelEX

UNRIVALED PERFORMANCE
UNRIVALED SIMPLICITY

INTEGRATED DATA ACQUISITION SIGNAL CONDITIONING SYSTEMS

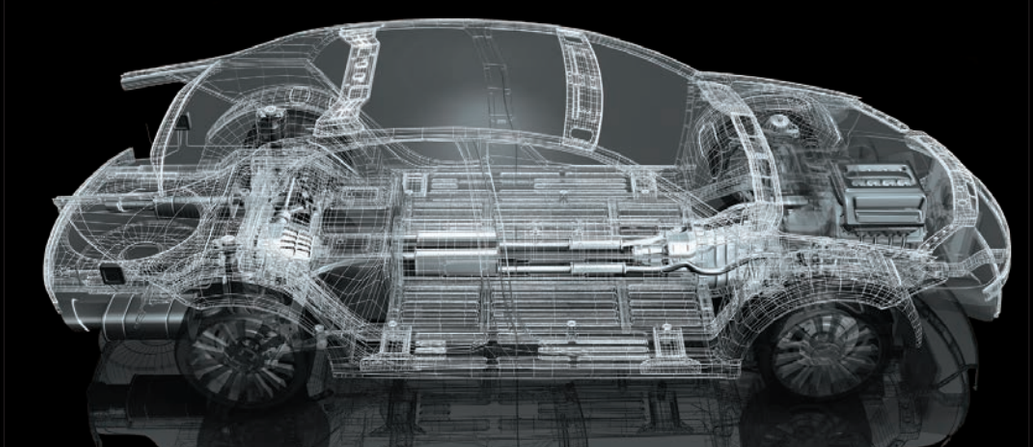
SentinelEX™, VTI Instruments' 4th generation of "Smart" dynamic and static data acquisition instrumentation, builds upon a proud legacy, established in the 1980's, by continuing to deliver trusted solutions to the marketplace.

Part of the largest worldwide install-base of precision data acquisition instrumentation, these innovative products are truly the gold standard for physical measurements, delivering unmatched confidence and performance.

- FPGA-based synthetic instrument customization
- Corporate wide "cloud" data management and access
- Flexible open architecture hardware and software designs
- Exceptional analog measurement and excitation performance
- Comprehensive health monitoring and run-time self-calibration
- Precision distributed measurement synchronization and control

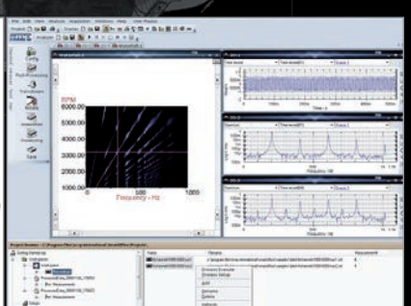
SentinelEX Series solutions are the perfect fit for a broad range of applications including noise, vibration and harshness (NVH), temperature, strain, voltage, parallel high-speed acquisition, and pyroshock.

DOWNLOAD COMPLETE SHORTFORM TODAY AT :
http://www.vtiinstruments.com/SentinelEX.aspx



VTI Instruments

High-Speed
Modal or GVT
Shock Testing
Vibration Testing
Order Analysis
Rotating Machinery
Acoustics
Temperature Monitoring
Structural and Fatigue



RELIABLE DATA FIRST TIME EVERY TIME

Ministries of sound

A 175DB NOISE LEVEL IS CREATED BY BAE'S WARTON SITE TO RECREATE THE SOUND OF AN F-35 DURING VERTICAL TAKE-OFF. HOWEVER, THERE IS MUCH MORE TO ACOUSTIC TESTING THAN JUST PRODUCING HUGE SOUND LEVELS

BY PAUL E. EDEN

Acoustic testing is all about reducing airliner noise signatures and making helicopter cabins quieter, isn't it? Well, yes, in part, but there's much more to it than just that.

At its complex in Savannah, Georgia, USA, Gulfstream runs an acoustic test facility (ATF) dedicated to proving the cabin environment of its business jets, while over in the UK, BAE Systems has built a bespoke acoustic fatigue facility (AFF) at its Warton site and a thermal acoustic facility (TAF) at Brough. With their comprehensive acoustic and thermo-acoustic test capabilities, the AFF and TAF were designed to undertake acoustic fatigue testing in support of the Lockheed Martin F-35 Lightning II.

Relax...

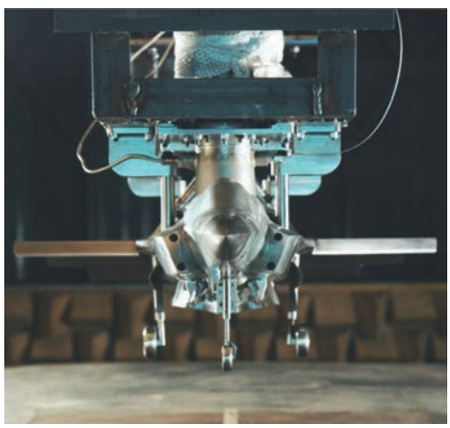
Gulfstream's ATF is capable of a full range of acoustic tests, up to a simulated 45,000ft (13,716m) cruising altitude. John Maxon, group head, acoustics and vibration, explains the ATF's capabilities and its primary functions: "The ATF is capable of simulating the temperatures experienced by materials or components during cruise conditions in both our environmental test chamber and the transmission loss window between our reverberation chamber and hemi-anechoic chamber.

"The purpose of this enhanced feature is to insure we get the appropriate material properties to help improve our analytical modeling and acoustic prediction capabilities," he says. "Temperature can affect a material's ability to transmit or absorb energy, which can then become unwanted noise in the cabin interior. It's important to assess material properties at the appropriate temperatures to insure that our models accurately represent the materials we'll be testing in the aircraft. An accurate prediction ensures that we have the best acoustic results for the lowest weight impact."

Weight is a driving factor behind Gulfstream's thermo-acoustic testing. Its customers demand an exceptional cabin environment conducive to work, relaxation, or both, but they also expect optimal, cost-effective performance, ruling out the installation of heavy thermal acoustic insulation systems. Maxon concurs with this: "Our customers expect that a Gulfstream will be much quieter than an airliner or military aircraft and have virtually no perceived vibration. It's critical that we reduce any prolonged exposure to noise and vibration, since these could lead to increased passenger stress and fatigue, reducing concentration. We want our customers to be more productive in flight and to arrive at their destination feeling well rested.

"We use the ATF to help design an effective lightweight thermal acoustic package to achieve

F-35 model in the thermal acoustic facility at BAE Systems, Brough site, UK



BELOW: In its VTOL mode, the F-35B generates a particularly harsh noise environment. BAE Systems' acoustic test work has examined the effects of this noise on the aircraft's structure, as well as its impact on the ground and ground crew operations

these goals. We can't add a heavy thermal acoustic package, so the ATF plays a vital role in helping us design an extraordinarily quiet and vibration-free interior without excessive weight."

...and lift

BAE Systems operates to a radically different set of test parameters aimed at proving customer-specified test points. Colin Lattimore, capability lead at the structural test facility, notes that the AFF is capable of operating at noise levels up to 175dB. Of course, the F-35 can generate very high levels of noise. "The vertical take-off and landing variant produces high acoustic fields, particularly at take-off and landing, and when the bays are open in flight. It is in this acoustically harsh configuration that the aircraft components are tested, to ensure their structural integrity during service," he says. Nevertheless, he adds, "The AFF is designed to replicate the acoustic loading on aircraft structures and does not provide any representative indication of the broader environmental impact of the noise generated by these air vehicles."

Lattimore explains that the last of the F-35 thermo-acoustic tests – including work on the nozzle bay door, wing bay, and horizontal tail – were completed more than four years ago. "The thermal acoustic testing is now complete, with the Brough facility being decommissioned. F-35 testing was undertaken on 1/15th scale models, simulating jet effluxes at full-scale temperatures and pressures in order to representatively simulate the near-field environment and facilitate predictions of the operational limitations of the aircraft with respect to ground crew operations and vessel superstructure.

"The principle purpose of subjecting aircraft structures to extreme acoustic loading is two-fold," he says. "Firstly, testing provides the structures team with empirical data to validate the finite element models, enabling them to be enhanced, improved, or corrected, and to highlight mechanisms and/or locations of structure failure. The test facilities are also used to provide evidence of structural integrity, or functionality of structures or avionics."

Although the dedicated thermo-acoustic testing capability has been decommissioned, the progressive wave tube and reverberation chamber has been used on other programs. Over the past two years, this has included work in support of GE Aviation – Electrical Distribution Unit and Power Panel 3 acoustic tests – and Ultra Electronics – High Pressure Pure Air Generator 2200 Mk1 acoustic tests.

Form and function

Gulfstream's ATF falls under its acoustics and vibrations department, within which a dedicated

DNW case study

FAIST ANLAGENBAU GMBH HAS RECENTLY HELPED MODERNISE THE ACOUSTIC WIND TUNNEL FACILITIES OF DNW (THE FOUNDATION OF GERMAN WIND TUNNELS)

German sound proofing specialist Faist Anlagenbau recently received an order from the Foundation of German Dutch Wind Tunnels (DNW) to update its wind tunnel facility, currently being used to test scale models of aircraft and components such as landing gear and turbines for their aero-acoustic properties.

Based in Braunschweig, Germany, DNW recently converted its aerodynamic wind tunnel into an aero-acoustic wind tunnel, with the goal of reducing wind noises of components or complete aircraft. Per Schneider, sales engineer at Faist Anlagenbau, picks up the story: "One of our tasks was the fabrication and assembly of the more than 7m-high turning vanes at the four corners of the tunnel. They guide the airflow, which has a speed of up to 90m/s, in such a way that no turbulence and only low pressure losses arise and the noise level is effectively reduced."

The result of this design work, which was done in cooperation with experts for aerodynamics and acoustics at DNW and DLR, are individually designed aerodynamic and acoustically optimized profiles that precisely guide the airflow while absorbing the sound. This task is undertaken by turning vane silencers consisting of an external cladding made of perforated sheet metal and an internal absorber. The complete construction is held by an inner steel skeleton comparable to the inner construction of an airplane wing.

Accuracy and flexibility

The manufacturing of these elements was a challenge. Vlado Lazic, head of project management for acoustic measurement rooms and test cells at Faist, explains: "Angle of attack, height and cross-sections of a total of 27 turning vanes were individually defined. The turning vane contour had to be shaped in an aerodynamic way." Values calculated by a CFD program by DLR were applied to determine the perfect contour. These data sets were the basis for implementing the design planning. Complex details of the design were made by CAD and then imported into the CAM production system.

Faist produced various prototypes that were checked by the customer and then released for series production. The installation of the modules was at least as demanding as the manufacturing. Vlado Lazic notes, "The challenge was the fact that the floor only had a limited load capacity and the turning vanes could neither be fixed at the top nor to each other. So the force had to be equally distributed into the floor and the turning vanes had to guarantee a very high stability because wind loads of 13kN act on the individual turning vanes under operation."

Fan discharge silencer

Together with the company TLT, Faist also manufactured a fan tailcone designed as a silencer downstream of the fan, the tailcone has a diameter of almost 5m. Per Schneider says, "Its task is to absorb the noise emission of the fan already at its source. This especially applies to low frequency ranges, which set specific demands on noise reduction. At the same time it is the task of the tailcone to act aerodynamically and to ensure the high efficiency of the fan. The flow-optimized contours create a significantly reduced pressure loss enabling a reduced energy consumption at the fan drive, and so positively influences the operating costs of the facility."

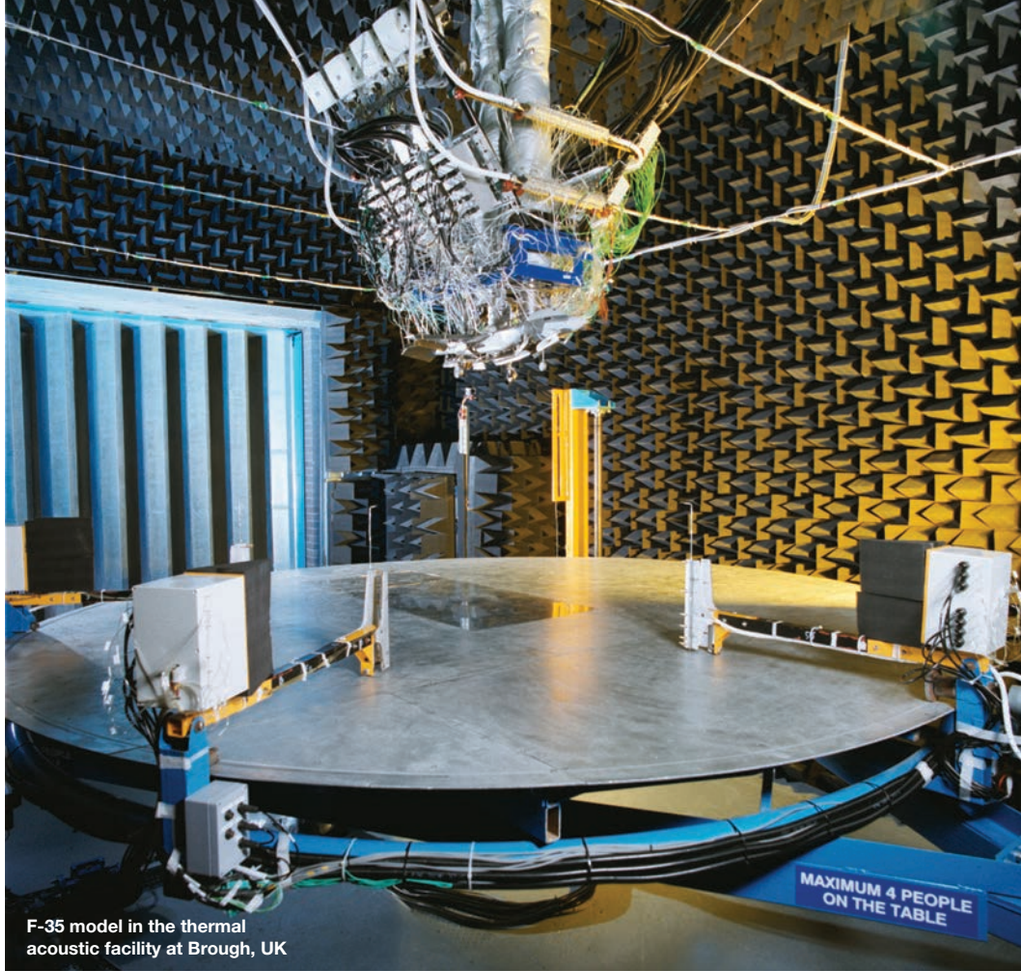
Dr Andreas Bergmann, head of DNW-NWB in Braunschweig,

ATF lead test engineer is assisted by other engineers in the group depending on the size and scope of the testing underway. The facility has all the regular capabilities of a typical engineering grade installation, but testing for external noise is not significant. Maxon says, "Our facility can test absorbent materials that can be used to help reduce exterior noise, but we primarily focus our efforts on interior noise reduction.

"The ATF can also perform sound transmission loss, sound absorption, sound power level, and noise emission testing. In addition to this standard testing, we also use the facility as an engineering research and development laboratory. Mock-ups and prototypes can be quickly redesigned and tested to determine acoustic improvements prior to flight test," he says.

The ATF's work is all about ensuring and optimizing the customer experience, and very rarely has any impact on certification testing. Nevertheless, it is vitally important to Gulfstream's overall test effort and surprisingly varied in its focus, as Maxon is keen to point out: "We try to test every material and isolate every potential noise source that can make its way onto our aircraft and be transmitted into the cabin, from interior decorative coverings to exterior wing-to-body air vents," he says.

"If a component has the potential to make noise, we test it. We've tested operating air



F-35 model in the thermal acoustic facility at Brough, UK

comments, "In order to meet the noise requirements on future airplanes, it is necessary to be able also to detect noise sources of the lowest intensity which make up the total noise emission in their sum. At the moment this is only possible in the ultra-quiet wind tunnel DNW-NWB."

Sound absorption

The first wind tunnel has an acoustic performance with a sound pressure level of 55dB(A) at a maximum air flow of 717m³/s generated by a 2MW fan. At this wind tunnel, and also at others, especially in the plenum and the tunnel, the technology of the broadband compact absorbers (BCA) is applied. This technology reaches a sound absorption of as=0.99 acc.

This acoustic cladding consists of modules in a sandwich structure with a smooth surface that does not reveal its sound-absorbing function when you look at it. Its intelligence is hidden in the sandwich structure of the modules. Layers of open-cell absorption material are built in an acoustically transparent perforated sheet-metal basket. The layer next to the wall consists of a sheet-metal resonator fixed on an additional acoustic layer. These two components in combination build the compound panel absorber (CPA), a mass–spring system. The unique combination of the CPA for low frequencies and the open-cell absorber for medium and high frequencies is called the broadband compact absorber (BCA). The BCA provides sound absorption efficiency over a wide frequency range.

Depending on the calculated mode field of the unclad test room, which mainly depends on position and frequency of the noise source, the free field conditions, especially in the range of low excitation frequencies, are ensured by variable resonators and their selective positioning in the test room. These assessments guarantee free field conditions down to the required cut-off frequency.

BELOW: The fan tailcone (NWB Braunschweig)

> **"It is possible to operate the test facility at night, without fear of disturbing local residents, even at its full 175dB output"**

gaspers and noisy door-latch mechanisms. We've mocked-up and tested full cabin air distribution systems. We've tested aircraft acoustic folding curtains to determine not only the best materials to block sound, but also the best way to stitch the materials together to ensure that the sound doesn't leak through the stitching. Basically, we test every material used in the production of an aircraft for its potential to either block or absorb cabin noise."

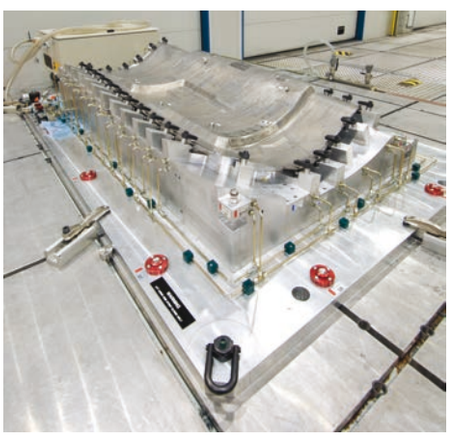
At Warton, acoustic testing falls under the remit of BAE Systems' structural and dynamic test department, itself part of Air Systems Engineering, Engineering Integrated Solutions. Lattimore reports, "The AFF has a dedicated three-man team consisting of two technical specialists and a senior engineer. This team works with the customer to determine test conditions, install and commission test specimens, operate the facility, and complete post-test data reduction and analysis. The team also facilitates maintenance, which can be quite onerous, since the facility generates an extremely harsh environment that stresses equipment and instrumentation.

"For acoustic fatigue testing, the customer provides a statement of work detailing the method of attachment of the test article, location of transducers, test phases, and acoustic spectrum," he continues. "All test work is undertaken in close cooperation with the customer and changes to the test program are iteratively made if deemed necessary, to meet the test objectives."

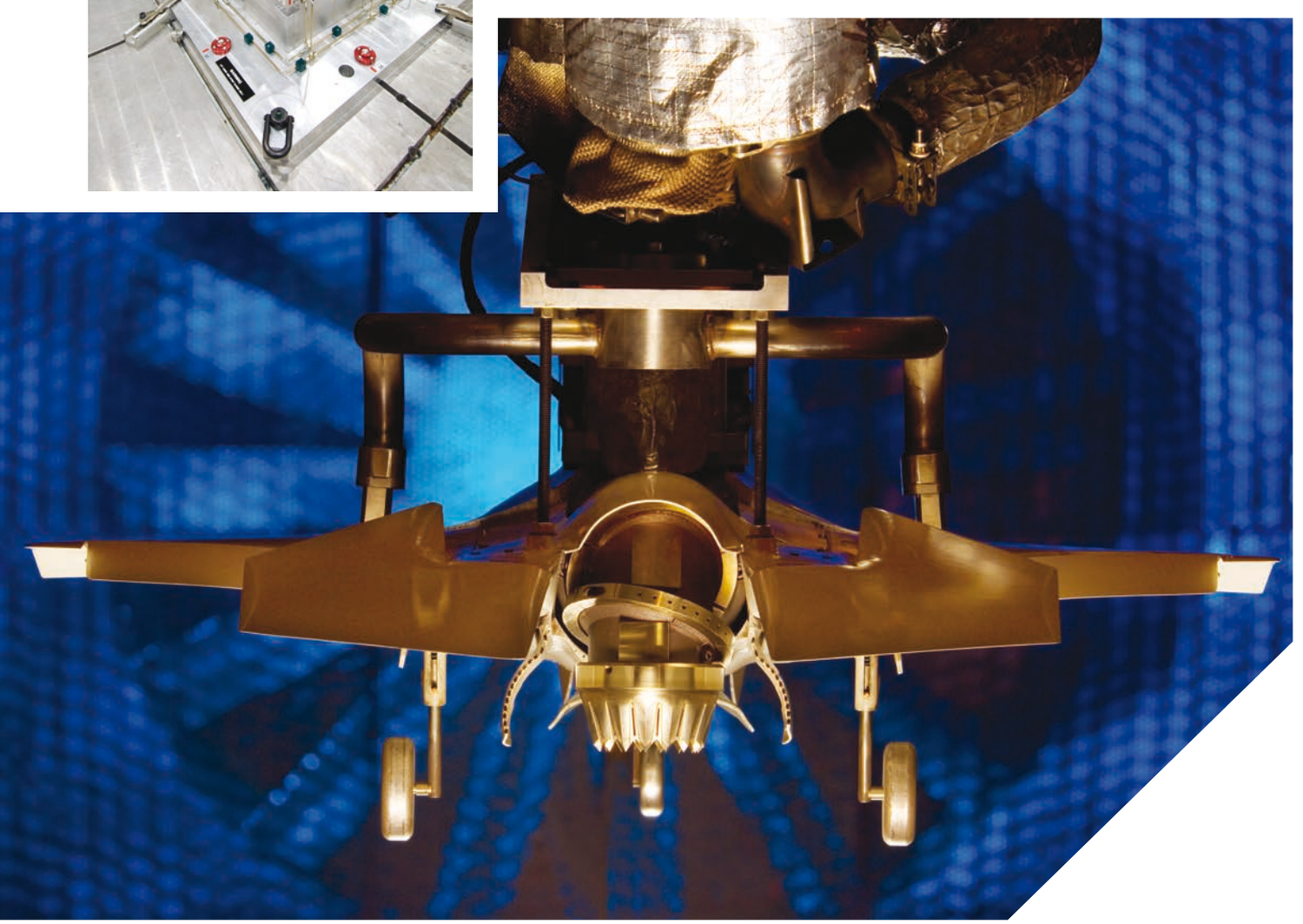
During thermo-acoustic operations, an F-35 scale model, or test component, was fixed above a circular table. The table was then moved up and down remotely, simulating changes in aircraft or component attitude, while probes mounted on moving arms were swept around the test item, gathering data.

Fortunately for those living near the AFF, it was designed and constructed in such a manner that the building inherently protects the local environment from unwanted noise and therefore it is possible to operate the test facility at night, without fear of disturbing local residents, even at its full 175dB output. ▮

Paul E. Eden is a writer for Aerospace Testing International. *He also a freelancer, specializing in the aviation industry*



BELOW: BAE Systems submitted the F-35 nozzle bay door to a full acoustic test regime. A pair of the doors opens below the rear fuselage to allow the vectoring main engine exhaust nozzle to rotate downward



From the publishers of Aerospace Testing International magazine

transportation weight loss diet conference 2012

The Transportation Weight Loss Diet Conference is a unique event that will bring together key innovators from across the automotive, aerospace and rail industries, as well as leading academics, to highlight major breakthroughs in mass reduction.

CONFIRMED SPEAKERS TO DATE:

Matt Zaluzec manager Materials Research Advanced Engineering Department, Ford Motor Company • Dr John Fish senior manager Airframe Technology Lockheed Martin Aeronautics Co • Tomasz Krysinski chief engineer PSA Peugeot Citröen • Robert McIntosh chief engineer - Weights Boeing • Jacques Belley, Director R&D, Standardization and Innovation Bombardier Transportation North America • Oliver Walter Responsible Product Manager BMW i3 BMW • Dr Srikanth Ghantae senior technology specialist - Plastics Volvo Trucks North America • Dr Ley Richardson principal application research associate - Aerospace DuPont Protection Technologies • Pradeep Kumar Manager - Global Bus & Coach Programme Ashok Leyland Limited • Toru Yamanaka General Manager Automotive Center Toray Industries Inc • Ramkisan Gite PAT lead - Weight Reduction Tata Motors • Phillip Bell product line manager Corning Incorporated • Scott Blake president Assembly Guidance • Byron Bloch director Auto Safety Expert LLC • Jonas Braam research engineer Sapa Technology • Mike Brock market development manager Rogers Corporation • Daniel Buckley manager of R&D AGFM • Ravi Chilukuri director EASi • Antonio Coelho R&D director Amorim Cork Composites • Freddie Colsoul account manager LMS North America • Prof Glenn Daehn professor Ohio State University Materials Science and Engineering • Nico Den Ouden sales and marketing director E-Leather Group • Dr Jorge F. dos Santos head of department Helmholtz-Zentrum Geesthacht • Ramkisan Gite PAT lead - Weight Reduction Tata Motors • Neil Gross president Acme Mills Company • Phil Hall managing director Caterham Composites • Georg Heidelmann president Adapt Laser Systems • Prof Santiago Hernandez professor University of Coruna • Prof Pete Hylton director of Motorsports Engineering Indiana University Purdue University Indianapolis • James Jones CCG manager - Americas Composites Consulting Group • Greg Kolwich manager Value Engineering Services FEV Inc • Prof Konstantinos Kontis professor and deputy director The University of Manchester • Oliver Kuttner CEO Edison2 LLC • Prof Khalid Lafdi professor Department of Chemical and Materials Engineering UDRI and Wright Brothers Institute Endowed Chair in Nanomaterials • Donald Lasell president and chief engineer Think Composites • Michael Lee Project Manager EASi • Mogens Løkke CEO ECOmove ApS • Dr Ralph-Dieter Maier manager Aerospace Technologies BASF Corporation • José Rui Marcelino design manager Almadesign • Cameron May director GfE Materials Technology Inc • Patrick McGowan vice president GT Alloys • Prof Shaker Meguid Professor and Director Engineering Mechanics and Design Laboratory. Department of Mechanical and Industrial Engineering University of Toronto • Dr Mohammad Moniruzzaman product development engineer SABIC • Dr Dries Moors innovation manager Bekaert • Jeff Moyer Meridian Lightweight Technologies • Anthony Norton senior director Global Automotive & Off-Highway Vehicles Altair • Ms Gulsen Oncul A350 Ailerons EPM TAI • Tony Padula product manager Amphenol Pcd • Vasant Pednekar senior engineer Application Development Lanxess Corporation • Gregory Peterson senior technical specialist Lotus Engineering Inc • Alexander Pozzi vice president Advanced Design Group Seating Products B/E Aerospace • Paul Priestman director Priestmangoode • Javier Rodriguez Director Vehicle Integration & E/E EDAG Inc • Alasdair Ryder business unit manager - High Volume Manufacturing Umeco Structural Materials • Greg Schroeder research analyst Manufacturing Engineering & Technology Center for Automotive Research • Gary Seale managing director Cobra • Steven Sopher technical director JSP • Richard Strout president Leading Edge Motorsport • Gerret Suhl head of Sales Car Trim GmbH • Manoj Surana manager - Engineering Research Centre Tata Motors Ltd • Ashutosh Tomar senior researcher Jaguar and Land Rover • Dan Williams product manager - Automotive Granta Design Ltd • Ingo Wuggetzer vice president Cabin Innovation and Design Airbus Operations GmbH • Dr Robert Yancey senior director - Global Aerospace Altair Engineering • Dennis Sieminski PE NEI Sofware • Janice Grzywa market development manager Victrex

If weight reduction, fuel efficiency or environmental impact matter to you, then you need to attend this conference!

OCTOBER 24-25, 2012 BOSTON, MA, USA

GO ONLINE NOW TO BOOK YOUR PLACE!

www.TransportationWeightLossDiet.com

Eyes wide shut

PILOT FATIGUE IS A MAJOR POTENTIAL SAFETY RISK FOR AIRLINES, BUT THERE HAS BEEN LITTLE DEVELOPMENT WORK ON INFLIGHT SYSTEMS THAT MONITOR TIREDNESS IN THE COCKPIT – UNTIL NOW

BY JOHN CHALLEN

Aerospace researchers are dedicating more time and effort into the development of systems that can warn of pilot fatigue

Although it is rarely directly responsible for airplane crashes, crew fatigue is a growing problem facing airlines and the authorities. The subject was addressed, to a degree, in 2011, when a final rule was issued by the Federal Aviation Administration (FAA) that enabled flight scheduling changes to give pilots opportunities for longer periods of rest before entering the cockpit.

The rule came to light in response to cases such as that of Flight 1002, which, in 2009, flew over its destination – Hilo International Airport in Hawaii – at 21,000ft because the captain and first officer both fell asleep with the airplane on autopilot. However, a more recent story has brought the issue back into the spotlight. In the UK in May, an Air Berlin Airbus A330 from Munich to Majorca was switched to autopilot by the pilots, after they issued a message to air traffic control saying they were too tired to land it. In this instance the system landed the airplane without incident, but the event highlights the potential safety risks of pilots not being fully in control.

Possible systems

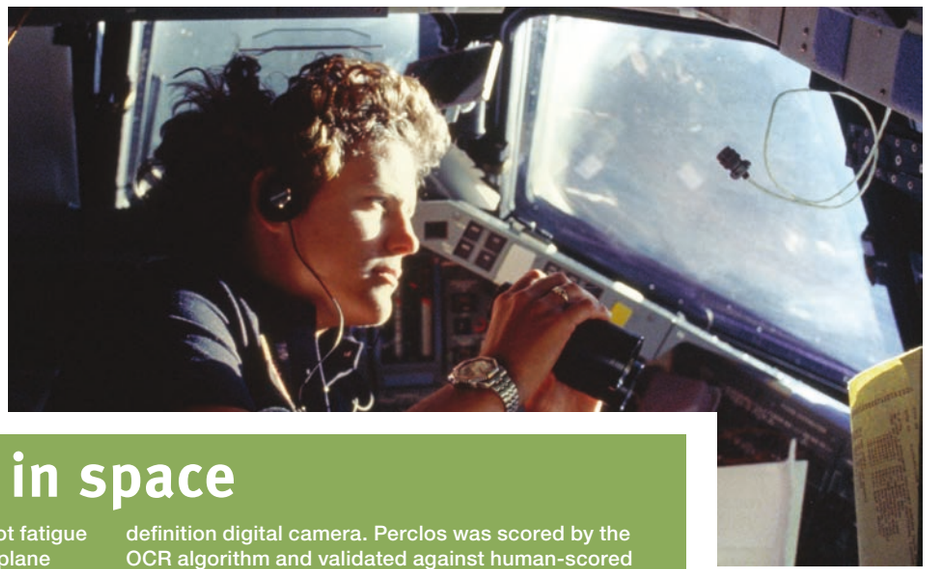
There are many reasons why, up until now, systems that monitor pilot fatigue have not been developed – and subsequently introduced. They range from the high costs involved, to the resistance of pilots to such technologies being used, to the complexity of getting accurate data from a test scenario.

One man who has had experience in the field is Professor David Dinges, a director at the unit for experimental psychiatry at the

University of Pennsylvania. He has spent many years researching short- and long-haul fatigue in pilots, and more recently his research has taken him to more advanced forms of testing. "If you are in a state-of-the-art cockpit, there's not a lot of work to do there," he reasons. "The airplane can take off itself, fly to a destination, land by itself on less fuel, using less brake input and tire wear. During the flight, the airplane is flying itself and the pilot is watching the airplane. So we've got a lot of pilots watching airplanes, but could we improve on fatigue and human error by having the airplane watch the pilot?"

The above scenario is easier said than done, especially when pilots are very much against any kind of monitoring or recording of their behavior. But one area that Dinges does see potential in is optical computer recognition (OCR) – tracking facial features with near invisible cameras, such as those you would find in a laptop. It is a field in which he has plenty of experience, dating back to 2000, when he was asked to pass judgement on a number of driver alert technologies for the automotive market. What he learned then has proved vital as he continues his test work for the aerospace industry.

"I was looking at a number of 'solutions' where there were sensors on the forehead, a sensor that you put on your brain, glasses you wear that measure how often you blink, and another one that used a Doppler to measure if your head drops," he recalls. "But none of them showed you any data that could, with a high degree of accuracy, predict when someone was truly sleepy, and going to make a mistake. We needed to know what you could use to measure



The Sleep-Wake Immune Functions (SWIF) experiment has been a two-year study of astronauts and cosmonauts aboard the Mir space station. Many factors are believed to affect the sleep/wake schedule in space. Some are environmental, such as magnetic fields, the absence of earth's gravity or trying to cope with 17 sunrises and sunsets every day

Taking a snooze in space

David Dinges' work into sleep analysis and pilot fatigue has now taken him beyond the commercial airplane world, and into a project being conducted by the NASA human research program investigators' workshop, dedicated to unobtrusive tracking of the Perclos system as a measure of sleep-related fatigue.

The study arose after a need was identified for a technique that objectively, continuously, and unobtrusively identifies the presence of sleep-related fatigue when astronauts are performing critical tasks in space. Double-blind controlled trials of various technologies have found that tracking slow eyelid blinks/closures is one of the most reliable ways to detect lapses of attention – the tell-tale sign of sleep-related fatigue. The aim of this study is to develop and validate a model-based tracker of Perclos, using OCR that reliably identifies Perclos from sleep-related fatigue during performance tasks.

In order to validate an OCR algorithm, healthy adult subjects completed a 20-minute psychomotor vigilance task (PVT) every two hours while awake during a two-day period in the laboratory. Subjects were randomized to either a night of total sleep deprivation or no sleep deprivation (time in bed: nine hours). Video recordings of the face were continuously recorded during each 20-minute period of PVT performance by a single high-definition digital camera. Perclos was scored by the OCR algorithm and validated against human-scored Perclos, as well as PVT performance lapses.

Preliminary data from 1,900 minutes of PVT performance indicate that the OCR algorithm successfully tracked Perclos relative to human-scored Perclos. As importantly, the OCR algorithm tracked PVT performance reliably, while the OCR Perclos index for sleepiness correlated with both PVT performance lapses.

The results to date suggest that an OCR-based, unobtrusive, automated fatigue-detection algorithm using Perclos derived from video of the face is valid and feasible. The ultimate goal is to achieve this in the operational environment of space flight, using a single-camera system, when astronauts are performing critical tasks. However, a successful OCR Perclos tracker based on a single-camera system requires greater OCR computational sophistication than a dual-camera system.

The group says it will continue to develop the OCR algorithm in order to enhance its facial tracking capability (e.g. when the face is partially out of view) and its quality control features, in order to make it more valuable to spaceflight, as well as operations back down on Earth.

how alert someone was," he explains. "When we conducted the tests, there was a high correlation between fatigue and the likelihood of a performance failure or a lapse of attention," he adds.

Of the six possibilities, Dinges says that one stood out for its potential accuracy: percentage of eye closure (Perclos), which monitors slow eyelid blink movement. "The eye blink is one of the fastest reflexes in the body, it can be anywhere from 50ms to 150ms, but when you get tired, the blinks start to slow down and you get longer blinks, up to a third, or even half a second," he explains. "Those are associated with sleep deprivation, and we've done experiments to time-lock exactly when people make mistakes."

The original Perclos measurements were infrared retinal reflectance devices, but those don't really work for pilots, or on the flight deck, says Dinges. "In the field, the infrared can bounce back from the face because of other light, and if you turn your head, it cannot track you," he says.

> **"We've done experiments to time-lock exactly when people make mistakes"**

Camera system

In the test environment it is a different matter, however, and Dinges' work based around the principle for aerospace is now gathering pace (see 'Sleeping in space' sidebar). He maintains that the camera-based setup used in OCR tracking of sleep-related fatigue has advantages over other techniques, not least the fact that there is no need for pilots to wear EEG or ECG sensors to obtain the information; the time taken to get the information and monitor fatigue levels is less; and that there is a uniform set of results for each subject under analysis.

> **"It knows where the eyes are and measures the length of the blink with a high degree of accuracy"**

BELOW TOP: Extra control for the Airbus A380? The existing portfolio of technologies used by pilots in the cockpit could include fatigue monitoring systems in the future

BELOW: Recent studies have been dedicated toward the development of various methods that can predict pilot fatigue

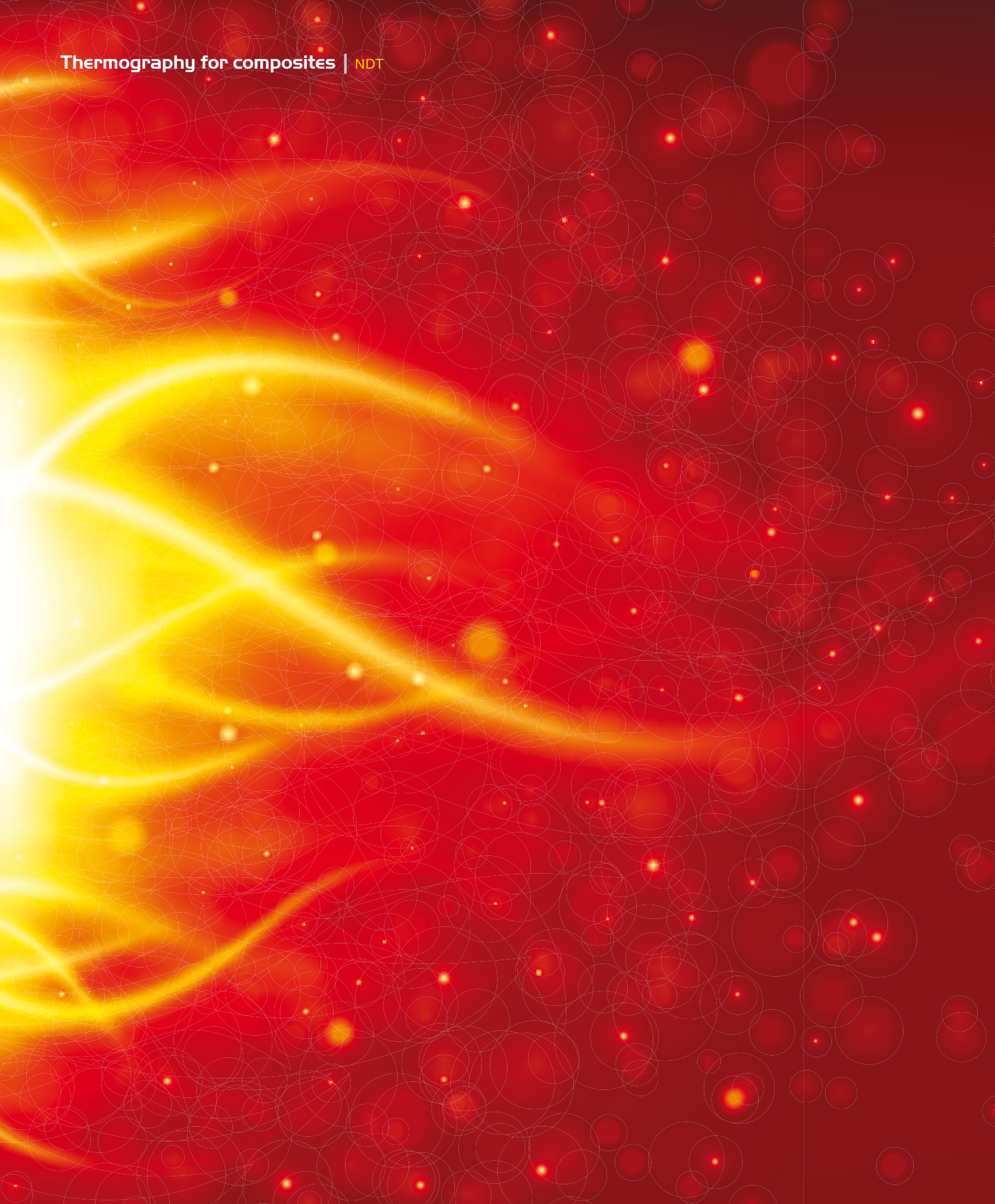
"Intelligent software is used that can track the face in three dimensions, and it knows where the eyes are and measures the length of the blink with a high degree of accuracy," explains Dinges. "That setup has proven to be very effective in the laboratory. We think we are going to see technologies like that [in aerospace] in the future, maybe not exactly like the one we are developing, but some form of 'machine vision'. But it won't be artificially intelligent, and the airplane won't have to think for itself – it has to be and integrated with the avionics.

Within the aerospace industry, efforts have been made by Boeing to address the issue, with promising results, including one technology that is already on board. "Boeing and manufacturers of wide-bodied airplanes have put activity monitors into their aircraft, to look at any inputs being made to any of the systems by the pilot," explains Curt Graeber, chair of the fatigue risk management program for the International Civil Aviation Organization, and a consultant for the aircraft manufacturer. The airline can set the time limits – which is typically anything from 20 to 30 minutes – and if there is no input, an escalating level of alert is triggered. First is the official warning, then, if there is no response, there is another audible warning."

Beyond that, Graeber confirms that Boeing is developing test equipment and hardware for introducing technologies into the airplane that monitor fatigue. While revealing that the work is at an advanced stage, Boeing is staying tight lipped, and issued the following statement to *Aerospace Testing International*: "Boeing has conducted research in the area of crew resource management, some of which was focused on how the design of our flight deck can reduce pilot fatigue."

Graeber offers a little bit more insight, but with development at a crucial stage, cannot give too much away. "Boeing's study is very realistic when it comes to looking at the unobtrusive measures that are used to monitor pilot fatigue," he confirms. "The sensitivity for the pilots is that they don't want to be recorded, but there are ways of getting around that, and what you ultimately want to do is support the crew, and also keep the passengers safe." ▮

John Challen is a UK-based journalist who specializes in engineering and technology in the aerospace, automotive and transport industries



HEAT exchange

ACTIVE THERMOGRAPHY IS A YOUNG YET HIGHLY EFFICIENT AND POWERFUL TECHNIQUE FOR NDT IN AEROSPACE. WITH A FOCUS ON THE INSPECTION OF COMPOSITE MATERIALS IT OFFERS MANY ADVANTAGES

BY MICHAEL WANDELT & MANFRED JOHANNES

The use of composites is increasing rapidly in the design and manufacturing of aircraft. For military and sport aircraft, composites are an indispensable material. In commercial aviation this trend led to new-generation aircraft such as the Boeing 787 and the Airbus A350 with a very high content of main structural elements manufactured from carbon graphite composites.

Although for designers the advantages associated with the use of composites are obvious, these materials present many new challenges for inspection and maintenance practitioners. To ensure high safety standards and cost-effectiveness, advanced NDT methods are required that fulfill a multitude of requirements. These include: accurate detection of the different defects typical for composites; easy operability; rapid inspection of large areas; in-service inspection without extensive disassembly or the need for special facilities; easy analysis of the inspection results independent of the experience of the inspector (less dependence on the 'human factor'), and easy archiving of the results for traceability.

Generally these requirements can be fulfilled by systems based on active thermography. In recent years a great effort has been made to improve this technique and make it user friendly. Thermography has been completely introduced into international NDT standards such as NAS410 and the EN4179. In the aerospace industry active thermography is used in a growing number of applications as the primary NDT method. Although in the past thermography equipment was very expensive, recently developed portable systems are now available at the price of good ultrasonic testing equipment.

Thermography – how it works

Active thermography is based on inducing a heat flow on the part to be inspected. This can be done either by applying energy in a pulsed form (pulsed thermography) or in a harmonic modulated way (lock-in thermography). The propagation of the heat flow inside the object directly affects the temporal behavior of the surface temperature. By recording the surface temperature with an infrared camera and by applying an appropriate mathematical analysis, an image is calculated, which shows the internal structure of the part with the defects.

Active thermography offers different inspection methods as well as a variety of measuring techniques. So the measurement procedure can be optimally adapted to different materials and parts with different structural properties. The inspection methods mainly differ in the type of excitation source used, in the way the thermal energy is applied and in the mathematical analysis.

Some inspection methods best suited for NDT of composite materials on aircraft should be explained.

Pulse thermography

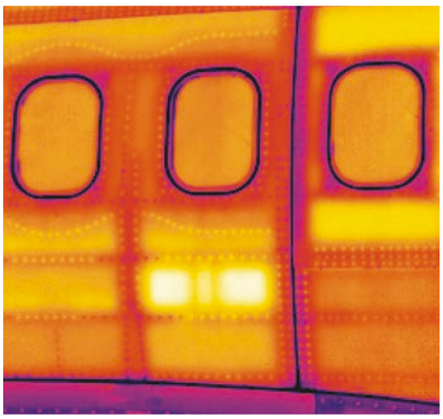
With the pulse thermography method, a short energy pulse is applied to the measuring object. High-energy flash systems are most commonly used. Typical applications are the inspection of thin-walled components or the characterization of thin layers. Main advantages of this technique are the short inspection times (< 1 second, up to a few seconds), and the ability to determine the depth of defects.

Transient thermography

The measuring principle is similar to that of pulse-thermography. However, here the energy is applied in a rectangular form over a longer period of time. This allows the use of low-cost excitation sources such as halogen lamps or hot-air blowers. Inspection times are short and the depth of defects can be determined. Transient thermography is a particularly suitable inspection method for composite

Ice or water

Inspection for ice or water in honeycomb parts (e.g. Boeing Procedure 737 NDT 51-00-01, Airbus NTM 51-10-25). This was one of the first applications for active thermography in the aerospace industry. The technique enables simple and fast inspection. The component to be checked is heated with a hot-air blower or with a halogen lamp. Sections with water inclusions can be easily detected in the resulting infrared image: due to the high heat capacity of water they remain considerably colder than the surrounding area.



LEFT: Thermograpghy of fuselage showing inner structure of Being 737 (seen below)

materials. This is valid for quality assurance during production as well as for inspections (ISI).

Particularly in thin-walled components, defects can be revealed that are hard to detect when using classic inspection methods. With transient thermography the detection of such defects is not a problem.

Lock-in thermography

With lock-in thermography the surface of the test object will be excited with periodical harmonic-modulated energy. Typical excitation sources are, for example, normal halogen lamps or hot-air blowers. The depth range can be set through the modulation frequency of the excitation source, in order to obtain the best possible result. Compared with the transient method, measuring times are considerably longer.

Vibro-thermography

With this method power ultrasound is used as an energy source, which is coupled into the component to be inspected. The ultrasound energy is transformed into heat through rubbing at defect locations where cracks or delaminations are present. Defects therefore act as internal heat sources, while undamaged areas show almost no temperature increase. This gives a defect selective response (dark field method), i.e. only the defects are displayed with a high contrast in the resultant image, which allows for easy identification of same. Another advantage is the superior depth range of this method. However, vibro-thermography is not a contact-free method, as the ultrasound energy source needs to be coupled to the surface or component to be inspected.

Advantages of active thermography for NDT

Classical inspection methods such as the tap-hammer or ultrasound (phased array or single probe) are still widely used for the inspection of composite structures on aircraft. Besides other limitations, such as the dependency of the inspection results on the experience of the inspector, these techniques do not allow for the scanning of large areas in an economically efficient manner. Inspection methods for large area scans, such as shearography or scanning acoustical microscopy (SAM) are not really established and suitable for practical use. This is mainly due to high device-related complexity and limitations for in-situ inspections on aircraft.

Compared with those methods, active thermography offers many advantages. It enables large-area measurements that are performed contact free and fast. The inspection results are presented as high-resolution images, which enable easy interpretation and simple and efficient documentation. Modern inspection systems are easy to operate and do not necessarily require the measurements to be performed by an experienced inspector.

Moreover, adaptation to the size of the inspected part is easily done. A single measurement can cover an area of several square meters. However, parts that have a size of just a few millimeters can be inspected as well. Measuring times are short; a measurement on a thin part will normally just take a few seconds.

Boeing 737

Boeing B737 inspection for disbonds between the fuselage skin and doublers (Boeing 737 NDT Procedure 53-30-01).

This is an example of the advantages of active thermography for economic inspection of large areas. During the inspection, the hull of the B737 is scanned for debonding of doublers.

A high-power panel of halogen lamps with 16kW of power is used as excitation source, which can cover an area of around 2m² per measurement. The inspection time takes around 20 seconds, so even when the handling and manipulation time for the heat-source is taken into consideration, a complete aircraft can be checked in just 100 man-hours. With the use of ultrasound as an alternative technique, this inspection would require around 1,200 man-hours.

Technology and applications

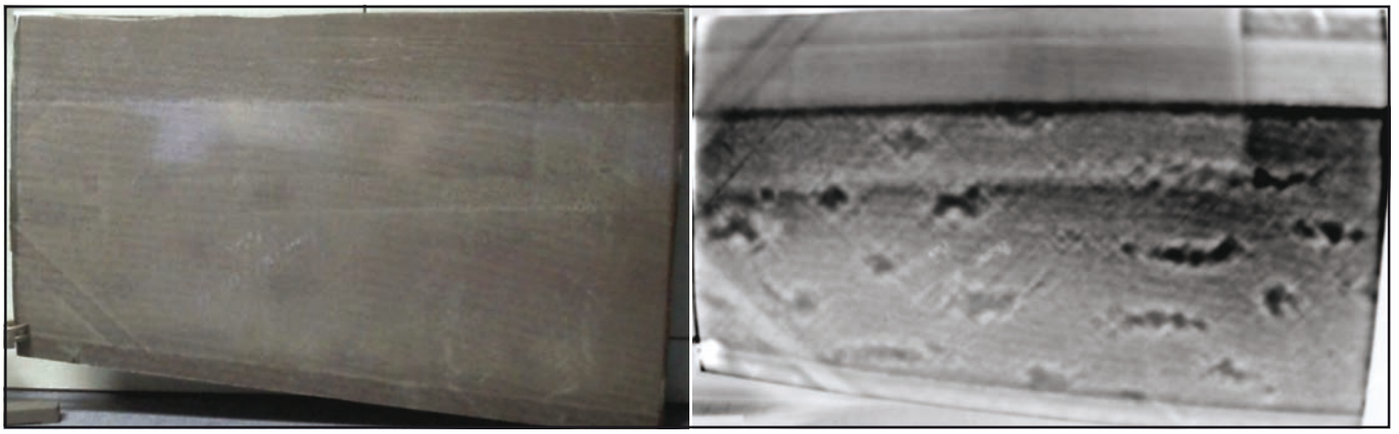
In the past, NDT systems based on active thermography were mostly designed for laboratory use. Due to the demand for in-situ inspection, some devices for mobile applications appeared on the market recently. In military aviation active thermography is already a frequently used NDT technique because here the approval of new inspection methods is normally done internally by the responsible military authorities.

Development and application

A significant landmark for the development of an efficient turnkey inspection system, easy to operate and more affordable, was recently created for an application for Airbus.

Airbus was in need of a system that was both mobile and very easy to use for the quick inspection of large composite areas on its aircraft, to detect and mark Structural Repair Manual (SRM) repairs for further NDT assessment. This was a very challenging task since good repair work generates almost no material inhomogeneity and is therefore very difficult to detect. Some repairs are only one layer thick, and the fact that there can be variations in the paint thickness or decal foils makes the job even more difficult. Above all, the system had be very easy to operate, so that inspections could be performed by airline employees on site and not necessarily by an experienced inspector.

Due to the demanding requirements, Airbus performed a very thorough analysis of the different NDT techniques available, to determine which would be the most effective. Among the different techniques taken into consideration was ultrasound phased array, but it proved to be too complex in the application, the



ABOVE: **Carbon Fiber Reinforced Plastics of a small airplane. The resulting image (on the right) shows the inner structure with debondings as dark spots**

measurements were too time consuming, and the analysis of the inspection results relied too much on the interpretation of the inspector. In the end Airbus chose active thermography as the most appropriate technique, but it discovered that there was no system available on the market that could meet all its initial requirements. Therefore Airbus decided to initiate the development of such an inspection system.

The final system consists of only two components: a measuring head and a tablet computer. The measuring head contains a highly sensitive infrared camera with integrated control electronics, as well as a heat source (halogen lamp) with integrated power electronics. All these components are mounted on a frame that contains three legs with vacuum-driven suction cups. The suction cups are for fixing the measuring head to the surface of the object to be inspected. This enables the inspection to be performed on horizontal and vertical surfaces. The head is designed for one-person operation: with two buttons located on the frame, the suction cups are controlled and a measurement is released.

Sandwich structures

Because of its capacity to perform rapid in-situ measurements of large areas, active thermography is increasingly used for the inspection of honeycomb sandwich. One example is the inspection of floor plates in civil aircraft during their initial acceptance.

Military aircraft

Within the air forces of NATO (e.g. aircraft programs for the US Air Force, German Air Force, etc.) NDT systems based on active thermography have already been in operation for several years. They serve not only for universal inspections on metallic structures of older aircraft, but also for composite structures in the new-generation airplanes.

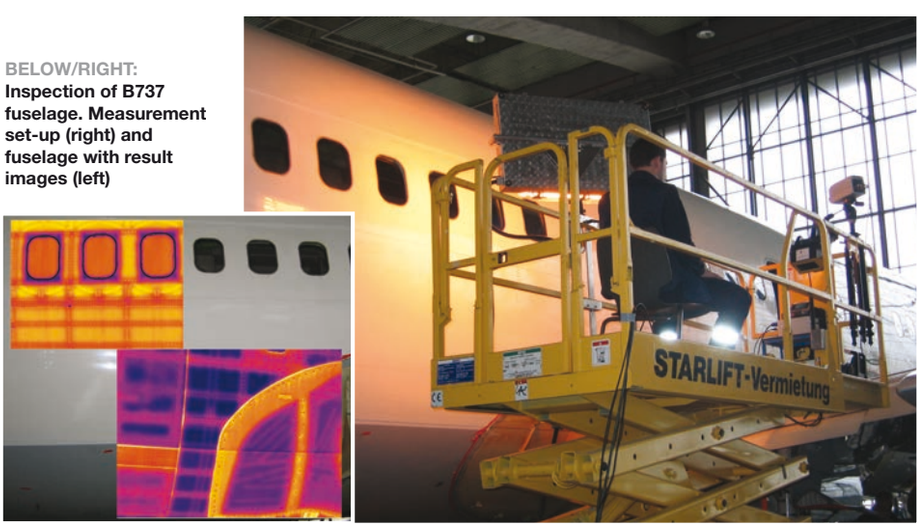
The performance of the system and the required inspection times were checked in a series of tests by personnel without a NDT background. During those tests, the complete side of an A320 rudder could be checked for SRM repairs in just 2.5 hours.

When compared with other NDT techniques, the new system offers considerable advantages in terms of user friendliness, required inspection times, and the required qualifications of the test personnel. That is why Airbus has planned to qualify and use this new system increasingly for other inspection tasks on composite materials.

In the near future the operational use of new-generation aircraft such as the B787 and A350 will set new challenges for aerospace NDT. One example is the question of how the complete fuselage of a Boeing 787 can be checked for damage in a time- and cost-effective manner during a maintenance event. Moreover, the typical damage scenarios for normal operation, such as bird strike, lightning strike, impact of objects during takeoff or landing, or a collision with a ground vehicle also present problem areas for the inspection. These incidents necessitate an immediate and reliable assessment on site, in order to avoid expensive downtime periods. An inspection with phased array ultrasound could be an option; however, this method requires highly qualified NDT personnel, who will often not be available at the location of the incident. In contrast, active thermography offers the advantage of ease of use, which enables less qualified personnel to perform measurements. Since the measurement results are available as digital images, it is possible to send them to experts worldwide for their reliable assessment.

The implementation of remote inspections is also being discussed. Here, the on-site staff would just be responsible for the handling of the inspection system while the measurement and evaluation is carried out remotely by an expert connected through the internet.

International committees, such as the Commercial Aircraft Composite Repair Committee (CARC) have been dealing with these problems for many years. However, many of the questions discussed have not been satisfactorily answered. Recently some large-scale research projects have been initiated to improve active thermography as an inspection technique for large-area inspections on composite aircraft structures. In these projects new approaches are being tested, such as the use of eddy current as excitation source, or the use of robot crawlers for performing automated measurements. ▮



BELOW/RIGHT: **Inspection of B737 fuselage. Measurement set-up (right) and fuselage with result images (left)**

Manfred Johannes is from CSIR (Council for Scientific and Industrial Research) in South Africa. Michael Wandelt is from AT (Automation Technology) in Germany

Test, measurement & inspection comes to Aero Engineering this November

Aero Engineering 2012

The Aerospace Engineering Suppliers Fair & Congress

7-8 November - NEC Birmingham - UK

Composites Engineering Show

Automotive Engineering

UK Plastic Electronics

Hosted as part of
Advanced Engineering UK group of events
www.advancedengineeringuk.com

Incorporating

TESTING MEASUREMENT INSPECTION FOCUS
@Advanced Engineering UK 2012 group of events

This November the Test, Measurement & Inspection Focus at Aero Engineering heralds the arrival on the show floor of even more test engineering professionals, eager to attend specialist presentations addressing the entire test lifecycle across T & E, inspection & quality engineering.

The Test, Measurement & Inspection Focus is part of the Advanced Engineering UK group of events. Each component event provides you with a business opportunity forum and showcase within its own sector, and those of the co-locating events - exposing you to additional opportunities and markets across the UK advanced engineering industries.

For more information on exhibiting and visiting see

www.aeroengineeringshow.com

Media and industry Partners include

ADS · Airframer · Aerospace Testing International · qmt Magazine · Aerospace Manufacturing · eef The manufacturers' organisation · UK Trade & Investment · gtma

So you want to be a maintenance test pilot?

GREAT HELICOPTER MAINTENANCE TEST PILOTS ARE HARD TO FIND, AND THEIR RELATIONSHIP WITH ENGINEERS CAN BE EVEN TRICKIER

BY ROB RICH

The following two anecdotes are a good starting point to help highlight the importance of helicopter maintenance test pilots.

An aircraft salesman went to a hangar to show a client a twin-engined airplane that was coming out of maintenance. Knowing the salesman may want to go on a demonstration flight, the engineer explained that the aircraft was not yet airworthy, the paperwork had not been completed, nor a check flight carried out. In particular, the fuel tanks had been drained for maintenance and only a few liters had been added for an engine ground run. The engineer noted the impatient salesman climbing into the aircraft with the client. He started both engines and taxied toward the fuel truck. However, to the engineer's amazement, the aircraft continued past the refuel point, onto the runway, and with a great roar commenced a take-off run. A few seconds later the aircraft lifted off the runway and then everything went wrong. One engine failed and the aircraft sank toward the ground and turned away from the landing strip. Then a deafening silence after the second engine failed. The aircraft collided with a boundary fence and was damaged beyond repair. Fortunately, the salesman and the client survived, although the client was severely injured. The matter went to court and you can guess who won that!

A civilian maintenance test pilot, contracted to the US Army, had a reputation for being eccentric and careless. He had a complex that resulted in him being described as argumentative and prone to showing off. He loved bucking the system; in particular he took great pride in just skipping checks before flight inspections. He really came to the attention of the authorities when he jumped into a Bell Iroquois helicopter to conduct a maintenance test flight and suffered an engine failure moments after start. The aircraft had also been drained of fuel during maintenance. But the real reason for his sacking was rather spectacular. Always arriving late for work, he rushed through the operations room, grabbed a set of keys, and headed down to a long line of helicopters. It was just before lunch. Jumping aboard, he started the engine and commenced filling out the flight test form. He applied power by raising the collective control in order to come to a hover. To the amazement of onlookers, the main rotor and transmission flew away like a child's toy and bounced along the tarmac damaging other helicopters. The fuselage simply rolled over and our hapless maintenance test pilot climbed out and was sacked on the spot. He had gone to the wrong aircraft! It was undergoing a transmission change and most of the attachment bolts had been removed ready for a crane to lift off the main rotor system. The servicing team had gone to lunch.

What's in a name?

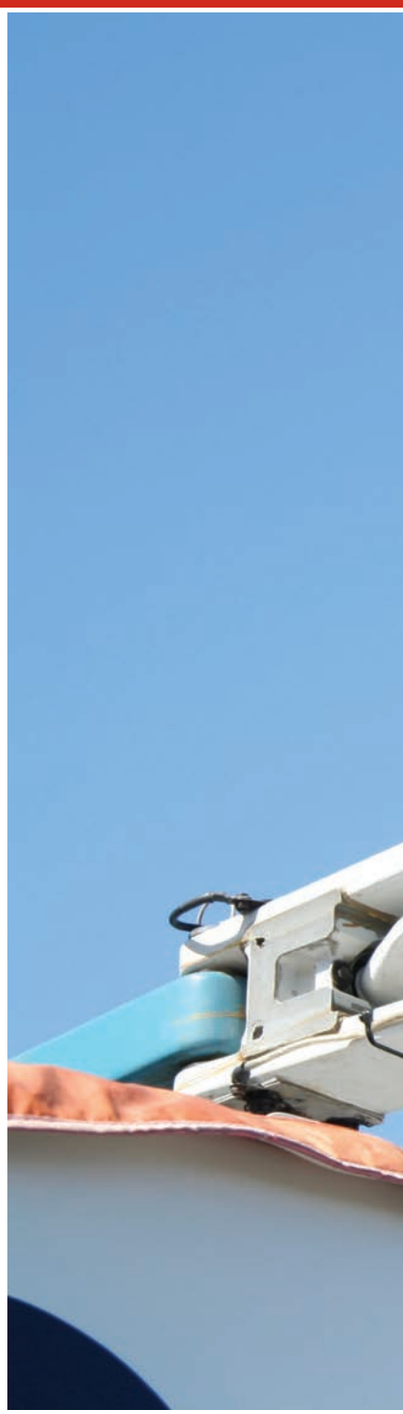
The term 'test pilot' should be used with care because there are three types of test pilot. Experimental test pilots have the highest qualifications and are admired by their colleagues. They are licensed to fly machines not yet certified. These people usually describe themselves simply as test pilots and work for a manufacturer.

Production test pilots test-fly helicopters already certified and have an easier job. They normally work for a manufacturer and prepare aircraft coming off the production line for delivery to a customer.

Maintenance test pilots (MTPs) can be employed either casually or as full-time employees of an MRO. They conduct post-maintenance test flights to insure the helicopter is correctly rigged and flying to the manufacturer's specifications. They may jump from one type to another that has come out of heavy maintenance.

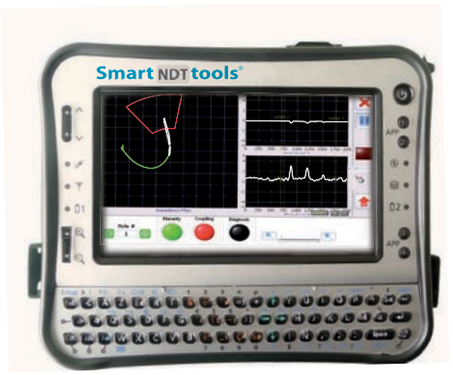
A competent MTP who can identify a problem correctly is worth his weight in gold. Large, heavy helicopters probably have operating costs approaching US$10,000 per hour, when you include the wages of the engineers working on the project. If the test flying program runs three or four hours extra, then the cost to the company can be quite considerable. Take away safety issues, and over a year, a good MTP could easily save the equivalent of his salary in costs.

So who is really suited to the job? Not all people are cut out to be a maintenance test pilot. Junior members of the industry avoid the work because they feel inadequate in their knowledge; they are nervous at the thought of giving a diagnosis of a problem to the engineers. Without being too harsh on the training industry, some junior pilots have received little tuition from schools to prepare them for this role. Mid-career pilots are usually offered this type of work; however, many feel test flying and idle time hanging around is not worth the effort. An MTP has to be a willing volunteer who is can insure he is capable of working with the ground crew.



Australia's abundant sunshine can cause problems with composite structures, such as the blades of the AS350 Squirrel. Although not as fierce as in the Middle East, the ultraviolet radiation should be avoided by providing shade covers

"A competent MTP who can identify a problem correctly is worth his weight in gold"



ON BOARD THE A350 XWB

Smart NDT® tools

A new concept of ultrasound & Eddy current testing tools for simplified inspections and decision making.

Based on application-specific modules with built-in assisted diagnosis, they can be used by non expert operators in **basic mode** and specialists in **expert mode.**

- Software modules dedicated to aerospace applications
- Easy to use, improved traceability with automatic reporting
- Designed for manufacturing & in-service applications

✓ Two modular systems

Smart U32® Phased array & single crystal transducers

Smart UE1® Single crystal transducers, Eddy current probes & resonant sensors

Developped by EADS INNOVATION WORKS Supported by NDT EXPERT

NDT EXPERT

Worldwide Non Destructive Testing Services - + 33 5 34 36 12 03 contact@ndt-expert.fr / www.ndt-expert.fr

---

JACOBS™ is a full service supplier to the Aerospace industry.

Jacobs provides aerospace and defense clients with a complete range of scientific, engineering, and technical services in five core markets:

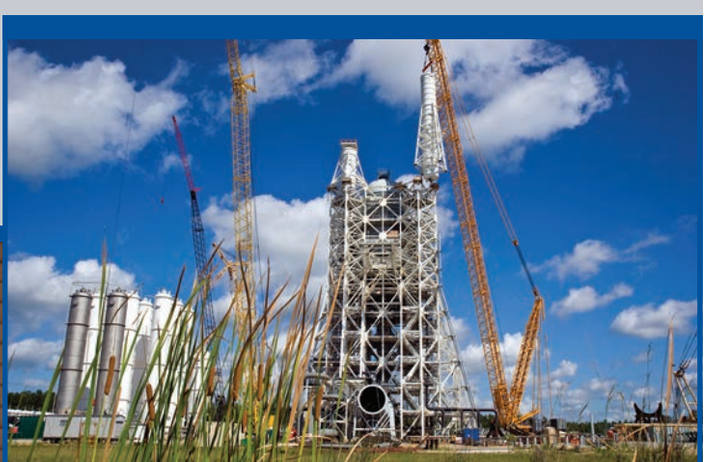
- technical facilities operations and maintenance
- test engineering and science
- program engineering and technical support
- facility design and build
- enterprise information systems

We have developed exceptional capability as we designed, constructed, operated, and maintained specialized technical facilities – wind tunnels, turbine and rocket test cells/stands, and space environmental chambers – and contributed significantly to virtually every major U.S. space and defense program.

The latest release of our automated test measurement and control software, Test SLATE, offers a proven solution for integrating diverse hardware and subsystems, managing test configurations, maximizing test productivity, and transforming test data into meaningful results.

JACOBS™

Jacobs Technology Inc.
600 William Northern Blvd.
Tullahoma, TN 37388 USA
Phone: +1 931.455.6400
Fax: +1 931.393.6211
www.jacobstechnology.com
www.testslate.com



When things go wrong...

When flying larger airplanes or helicopters, pilots and engineers need to brief each other on flight protocols and possible emergencies. This particular action saved an Australian Air Force DHC-4 Caribou from disaster as it started on a stall warning stick shaker test calibration flight, following maintenance by a civilian contractor near Sydney, Australia. Both pilots were actually dual rated on airplanes and helicopters. Lack of currency and experience on an aircraft is a major problem for maintenance test pilots. It had been many months since the pilots had last flown the Caribou and both had low hours on 'type'.

During the take-off run, the troublesome engine operated normally, as the heavily laden Caribou lifted off the runway. This caused the fuselage to flex slightly, and the incorrectly set jettison pins released the rear cargo door, which fell onto the runway. Seeing this happen, the chief engineer jumped to his feet and yelled to the pilots that the door was gone. His announcement was not understood because the starboard engine failed as he spoke. Due to the fact that the Caribou was fully loaded and now lacking one engine, the captain immediately called for the engine failure drills. The most important item was the retraction of the undercarriage to reduce drag to enable a rate of climb.

But there was an unpleasant surprise waiting. The undercarriage would not move! This now created a more serious emergency. Despite full power from the good engine, the aircraft did not want to climb. Using their CRM training, the pilots managed to accurately maintain the best rate of climb speed and eventually gained enough height to turn back to the airport.

But there is always a funny side to any story. Due to the engine failure after lift-off, the pilots were not aware of the rear cargo door falling away. The chief engineer thought the pilots had heard his advice and resumed his seat as directed. A 'mayday' had been transmitted asking for an immediate return to the duty runway, as the pilots were not sure if a fuel leak was occurring. The tower controller was a trainee. In a trembling voice he denied the request by saying, "Caribou test… er, not approved… er… a large piece of your aircraft is lying on the runway… er… blocking it…" This was the first time the pilots became aware of the missing door, as they had been handling a failed engine and a serious undercarriage problem. After watching the good engine nervously, the crew were relieved when the Caribou landed on another runway. It was all over in a matter of minutes.

The budding MTP must be aware there is something of a cultural gap between engineers and pilots; usually because of the differences in salary and conditions. However, today in Australia, skills shortages have resulted in some engineers earning several times the salary of a pilot. The new maintenance test pilot must be prepared to study closely how engineers go about their business so that his interaction is appropriate and not the cause of mockery.

A look at regulation

Many countries are moving from one regulation system to another – usually following ICAO-fostered rule changes. As a result, the sequence of these changes can mean the operational and maintenance rules seem like two different languages. The new MTP must study in detail the legislation applicable to engineers; they can be quite different to the rules he uses when flying. This requires a word of caution.

The MTP must take great care in understanding how the regulatory system works in the workshop – especially who is responsible for the maintenance and signing-off the work sheets. For example, Australia has recently undergone an major overhaul of maintenance rules, and the regulator is conducting in-depth audits on engineering procedures to make sure of compliance with the new standards. This is where the relationship between the MTP and the maintenance supervisor needs to be one of mutual respect.

Manual versus parts catalogs

The first fatal UK helicopter rescue accident, in which a crewman was killed, was caused by a cable cutter being incorrectly assembled during a routine service. The crewman became

ABOVE: Australian Navy AS350 helicopters pushing the flight limit boundaries during a low-level display at the Avalon Airshow. A maintenance test pilot must always know the limits of his machine; many are not capable of these gyrations, being semi-rigid rotor systems. Australia has around 200 military helicopters, by comparison the civilian fleet has more than 2,000. Not bad for a population of 22 million

tangled on the deck of a ship that had smashed into rocks in heavy surf. Later investigation showed the cutter had been reassembled using the parts catalog for reference, and not the diagram in the maintenance manual. Experienced MTPs often comment on this failing, even within the best of workshops.

Engineers are very proud of what they do and some probably suffer the ego problems that are normally attributed to pilots. It is often better to give the list of observations to the engineers and then suggest the cause. This enables them to offer their suggestions, which can then be combined into the correct action – good CRM stuff.

The golden rule is never to miss a pre-flight. Even if you have flown the aircraft just a few hours earlier, and only minor work has been conducted since, you must always complete the near full pre-flight all over again. Experienced test pilots looking back on their careers will tell you hair-raising stories about things they discovered on the subsequent pre-flight. It could be simply be a spanner lying on the engine deck.

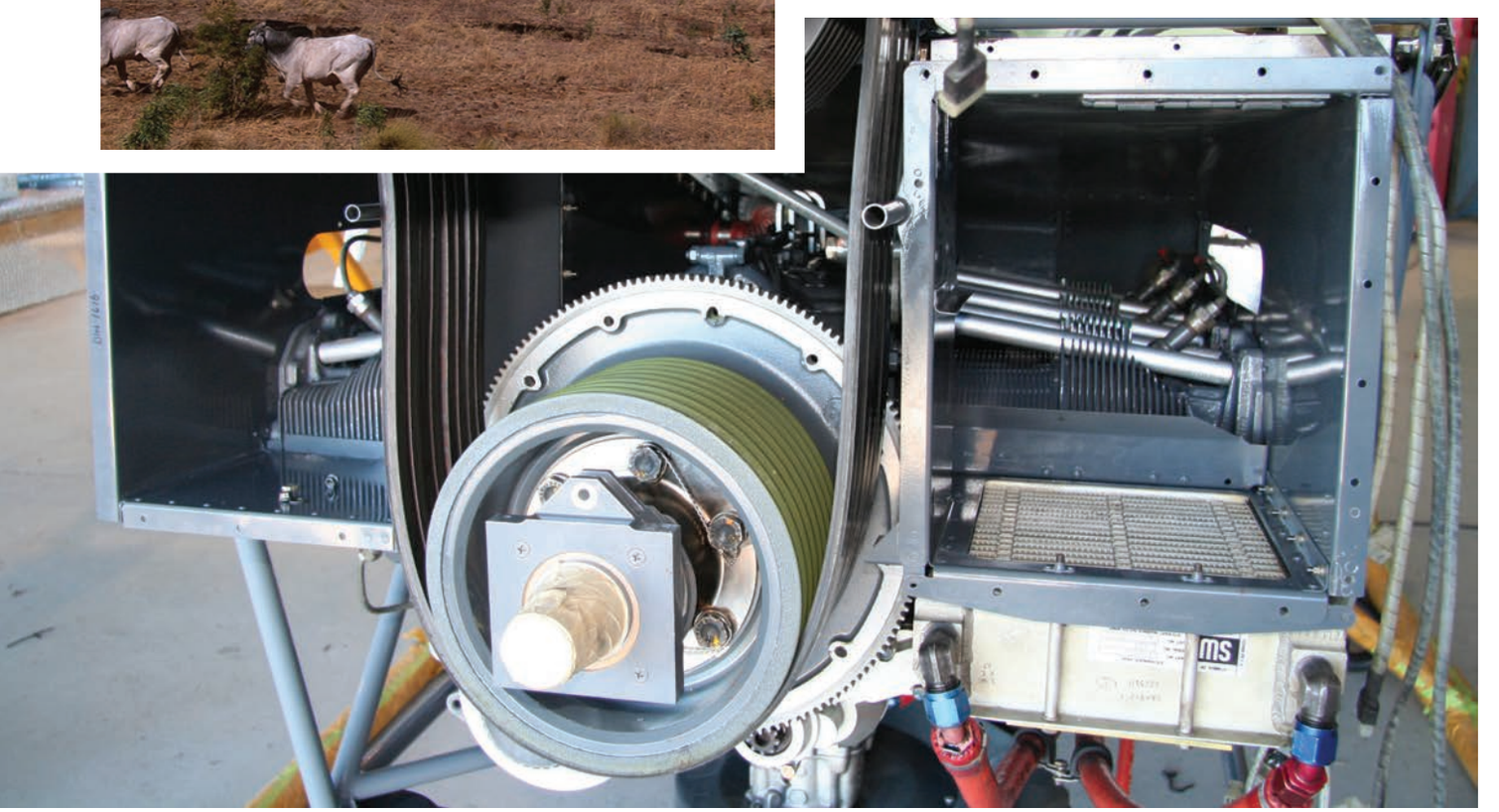
A smart test pilot will go out of his way to socialize informally with the engineers so he can get to know them better. To achieve this you should learn all their names and what they do. Carefully identify the supervisor of each subgroup. One good way to achieve this is to often have lunch with them in their staff room and listen to their discussions. Avoid the tendency to tell your war stories! Listening enables you to learn an enormous amount from the engineers about the various defects that can occur with the equipment.

Humans will always take a short cut where possible. For example, it was said that the Bell 47 helicopter's dual pedals were impossible to fit incorrectly because there is a flange welded onto the component that stops this happening. Right? Wrong! Many tail rotor dual pedals were manufactured with missing flanges; or worse still, they were removed by unknown persons. In Australia at least three Bell 47s have crashed due to the pedals being fitted in reverse, resulting in two deaths and four injuries. They said it could never happen – but it did. So during pre-flight, when dual controls have been fitted, you must move the petals and check that the tail rotor is operating normally.

Working together

A smart maintenance test pilot will always take one of the engineering team working on the aircraft up on each test flight. This is normal procedure and provides the motivation to insure the work is done to the highest standard. Some companies insist this be done; and in fact some maintenance test pilots refuse to fly an aircraft unless one of a maintenance team goes along as an observer. ▮

Rob Rich has worked as a flying instructor with the Australian, British and US armed forces. Leaving the military, he became the Senior Maintenance Test Pilot at Hawker de Havilland (Australia). He is a founder member of the new Australian Helicopter Industry Association



LEFT & BELOW:
Australian maintenance test pilots have to be aware of the unusually abrasive dust existing in Australia. The lovely red color in Australian photos is caused by volcanic-based silica sand, which is extremely hard and causes premature failures of many components. The belt-driven drive chain of the R22 helicopter can suffer damage due to wear within the sheaves of the drive pulleys

ets european test services

We test it!

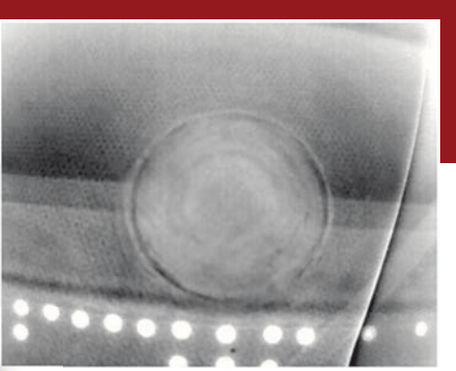
Aerospace Equipment Testing

European Test Services (ETS)B.V. is providing test facility services to European Aerospace Industry by managing and operating the environmental test centre of the European Space Agency. Over the years ETS has proven its competence and experience within Aerospace Industry.
The large variety of facilities enables ETS to test small units up to large and complex structures.

www.european-test-services.net

European Test Services (ETS) B.V. · Keplerlaan 1 · NL-2201 AZ Noordwijk · Phone: +31(0) 71-565 59 69 · Fax: +31(0) 71-565 56 59

The NDT Solution for Composite Inspection



C-CheckIR

Airbus NTM 55-40-50 Inspection Tool

- Efficient Turnkey Solution
- Very easy to Operate
- Portable System
- Designed for Field Applications
- Fulfills the Requirements of several Aircraft Inspection Procedures, e.g.:Detection of Trapped Water, Disbonds, Detection of SRM Repairs

Automation Technology
Vision Systems for Automation

www.C-CheckIR.com

The greater community

AEROSPACE TESTING TAKES CENTER STAGE AT AERO ENGINEERING 2012 IN BIRMINGHAM, UK. WE PICK OUT JUST A FEW OF THE TOP TESTING TITANS EXHIBITING

Bringing together multiple 'high value' engineering and technology streams under one roof, this year's Advanced Engineering UK group of events – one of the fastest-growing engineering and technology shows in Europe – is preparing for a record attendance in 2012.

The event, held over November 7-8, will also host its biggest ever specific test, measurement, and inspection program.

Building on the major attendances of 2011, the 2012 event line-up brings, under one giant roof in the Birmingham NEC's Hall 1, four individually focused yet highly synergetic trade shows targeted at key 'high value' engineering and technology sectors. These shows are: Aero Engineering, the Composites Engineering Show, UK Plastic Electronics Show, and, new this year, Automotive Engineering, which supports the UK's highly resurgent and dynamic vehicle engineering sector.

By co-locating the four shows as a single integrated experience, organizer UK Tech Events will bring together more than 450 British and international exhibitors and some 8,000-10,000 visitors.

Show organizer Ian Stone says, "The disciplines of testing, measurement and inspection are inextricably linked to the advanced engineering environment and it is no surprise that more and more leading domestic and international suppliers of technology and service capability in this sector see the event as a 'must attend' environment." There will be more than 140 free-to-attend presentations over the two days.

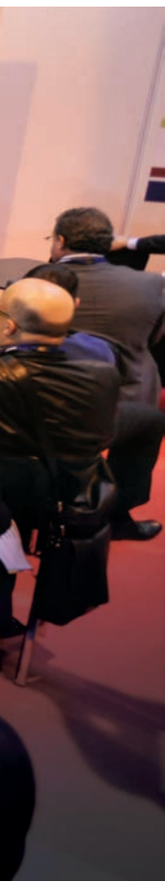
Once again, 'test, measurement and inspection' takes a leading role in the events, boasting more than 100 test-related exhibitors across the interconnected show floor, together with a dedicated stream of supporting technical presentations over the two days. These are supported by key industry bodies including The Chartered Quality Institute (CQI), The British Institute of Non-Destructive Testing (BINDT), *Quality Manufacturing Today* (QMT), MIRA, and Millbrook.

The technology, equipment, and specialist test capabilities on display at this year's event cover the full lifecycle of test, evaluation, and quality engineering applications applied into the aerospace, automotive, and materials engineering sectors.

Stone adds, "From simulation or virtual analysis and testing through to all forms of development pre-production testing and qualification, through to production line metrology, quality management and on to aftermarket inspection, the show floor provides an abundance of the latest state-of-the-art technologies and industry partners."

The test, measurement, and inspection open forum program topics include:·optical 3D measurement for quality control in the aerospace industry; why engage with NDT/CM?; 3D non-contact structured light scanning of aerospace and automotive components; advances in active thermography for inspection of CFRP and GFRP components; optical metrology supporting the complete manufacturing process; and inspection plan software in metrology. ▮

Aero Engineering2012
7-8 November • NEC Birmingham



TOP OF THE TEST MANUFACTURERS

AEROSPACE TESTING TAKES AN EARLY LOOK AT JUST A FEW OF THE TOP AEROSPACE COMPANIES THAT ARE EXHIBITING AT AERO ENGINEERING 2012

Lightning strike

Gary Cooper, marketing, TÜV SÜD

What solutions are you demonstrating at Aero Engineering?
Testing of aircraft components' susceptibility to the indirect effects of lightning according to the new Current Waveform 6 requirement of RTCA DO160G.

What is its relevance to testing?
RTCA DO160G is used by most leading aircraft manufacturers in deciding on their purchase criteria for electronics equipment.

What applications do they have?
Critical systems such as communications and radar need to be tested for their susceptibility to lightning strikes.

What are your projections for testing in your market?
Susceptibility to lightning strikes is a particularly important issue in composite airframes so the demand for testing is likely to grow as aircraft designs increasingly use composite materials.

Fast frame

Olympus is the leading manufacturer and supplier of non-destructive testing and remote visual inspection equipment for engineering and maintenance applications throughout the world.

The company provides industry-leading non-destructive testing technologies including ultrasound phased-array, eddy current, and eddy current array, plus an extensive range of IPLEX videoscopes, fiberscopes, and borescopes for all remote inspection needs. i-SPEED high-speed video cameras, offering up to 1,000,000fps, are also within the company's product portfolio, while XRF (x-Ray Fluorescence) analyzers, with a multitude of applications across industry, including QA or PMI (positive material identification), complete the product range.

Sign of quality

Paul Wilson, CEO, UKQMS

Can you describe what you do?

UKQMS provides quality assurance and business improvement services for small to large businesses. Generally operating within the supply chains of larger businesses, we use high-caliber experienced professionals to implement solutions quickly and robustly.

How does this apply to aerospace?

One of our team has been a manager in a large aerospace company, with the testing of jet engines and the resolution of any issues.

Can you be more specific?

As a service provider, we provide the aerospace standard quality systems that help ensure test requirements through to testing and pass-off are discharged correctly. Our business improvement wing focuses on improving the 'right first time' of processes. However, we are aiming to access the maintenance and overhaul market.

Laser shearography

Rob Wood, application specialist, Dantec Dynamics

What products will you be displaying?

We will be showing the latest laser shearography non-destructive testing (NDT) equipment. Obviously shearography is used to inspect composite materials in aircraft structures.

How do your systems apply?

Applications exist at a production stage for fully automated systems with coverage of meters squared per minute. Also as an in-service inspection tool for maintenance.

How do you foresee your market?

As the use of composites increases, shearography will become a more important tool for inspection of materials. Shearography's speed advantages can help reduce bottlenecks commonly associated with NDT. This speeds up production times and improves safety.

Efficient system

HBM will offer the latest test equipment for the new breed of hybrid engines: PMX, or the new industry standard for measurement technology. Also on show will be the QuantumX MX1615 strain gauge bridge amplifier, an experimental stress analysis tool for engineers; a new type of optical strain measurement, for composite structures; and the revolutionary GEN2i, a high-speed portable data recorder.

The increase in electric motors in aircraft means more efficiency testing is needed. For composite structures traditional methods of structural testing are being pushed to the limit and FBG offers better fatigue life performance, extending the lifetime of the test sensor. MX1615 from HBM is extremely portable and flexible, addressing all structural test needs.

Projections for aerospace testing are pretty healthy and have remained at a good level for HBM. Steve Voth, test engineer at Cessna Aircraft Company, says, "HBM's hardware and software combination gives us the flexibility we need to perform tests ranging from a few channels at high speed to large channel counts. "HBM's hardware is some of the best we've seen, and we appreciate their experience and level of expertise in strain gauge measurement."

Composites testing and Nadcap

Ian McEnteggart, composites marketing manager, Instron

What are you demonstrating?

Our stand will contain a number of static and fatigue test machines for composite and metals testing, including our revolutionary all-electric fatigue tester, called ElectroPuls, and a range of new fixtures specially developed for testing composites. We will also be launching an exciting new Nadcap Alignment test service, specifically developed to support the Aerospace Industry.

How does it relate to testing?

The Nadcap accreditation program has been around in the aerospace industry for a number of years for metals testing, and is well understood within the industry. The introduction of composites in the industry has meant new demands on the testing requirements, and many companies within the industry are finding the requirements complex to understand and difficult to apply to their specific testing needs.

What applications do they have?

Our services include Alignment test of the load string in conformance with Nadcap requirements for: AC7101 for testing metals, AC7122 for testing composite materials; AC7109 for testing of adhesive bond

What are your projections?

We anticipate continued strong growth in aerospace testing, particularly in the composites sector, to such an extent that composites has become one of our four core applications, allowing us to research and develop new products and services.

Describe a breakthrough technology?

The Electropuls systems are a great example of a breakthrough technology in this field. They are the future of dynamic testing; requiring no oil, cooling water, or three-phase electrical power, meaning that they do not have the same environmental impact of conventional servo hydraulic technologies.

How do you work with Nadcap?

Instron systems are intimately involved in the multidiscipline requirements needed to succeed with Nadcap approval. Working directly with Napcap and ASTM to understand the requirements for alignment, Instron can provide the professional services that help a business meet those requirements and remove the complexity.

What services benefit the industry?

The Instron Nadcap service package covers alignment assessment of the load string in a testing frame, and is carried out on-site by our factory-trained and qualified engineers who can verify our material testing systems to the appropriate Nadcap standard. System calibration and a regular preventative maintenance schedule will ensure that measurements and results are accurate and repeatable. Training to reinforce health and safety policies and software support, which enables immediate online intervention ensures compliance and productivity.

From the publishers of Aerospace Testing International magazine

transportation weight loss diet conference 2012

The Transportation Weight Loss Diet Conference is a unique event that will bring together key innovators from across the automotive, aerospace and rail industries, as well as leading academics, to highlight major breakthroughs in mass reduction.

CONFIRMED SPEAKERS TO DATE:

Matt Zaluzec manager Materials Research Advanced Engineering Department, Ford Motor Company • Dr John Fish senior manager Airframe Technology Lockheed Martin Aeronautics Co • Tomasz Krysinski chief engineer PSA Peugeot Citröen • Robert McIntosh chief engineer - Weights Boeing • Jacques Belley, Director R&D, Standardization and Innovation Bombardier Transportation North America • Oliver Walter Responsible Product Manager BMW i3 BMW • Dr Srikanth Ghantae senior technology specialist - Plastics Volvo Trucks North America • Dr Ley Richardson principal application research associate - Aerospace DuPont Protection Technologies • Pradeep Kumar Manager - Global Bus & Coach Programme Ashok Leyland Limited • Toru Yamanaka General Manager Automotive Center Toray Industries Inc • Ramkisan Gite PAT lead - Weight Reduction Tata Motors • Phillip Bell product line manager Corning Incorporated • Scott Blake president Assembly Guidance • Byron Bloch director Auto Safety Expert LLC • Jonas Braam research engineer Sapa Technology • Mike Brock market development manager Rogers Corporation • Daniel Buckley manager of R&D AGFM • Ravi Chilukuri director EASi • Antonio Coelho R&D director Amorim Cork Composites • Freddie Colsoul account manager LMS North America • Prof Glenn Daehn professor Ohio State University Materials Science and Engineering • Nico Den Ouden sales and marketing director E-Leather Group • Dr Jorge F. dos Santos head of department Helmholtz-Zentrum Geesthacht • Ramkisan Gite PAT lead - Weight Reduction Tata Motors • Neil Gross president Acme Mills Company • Phil Hall managing director Caterham Composites • Georg Heidelmann president Adapt Laser Systems • Prof Santiago Hernandez professor University of Coruna • Prof Pete Hylton director of Motorsports Engineering Indiana University Purdue University Indianapolis • James Jones CCG manager - Americas Composites Consulting Group • Greg Kolwich manager Value Engineering Services FEV Inc • Prof Konstantinos Kontis professor and deputy director The University of Manchester • Oliver Kuttner CEO Edison2 LLC • Prof Khalid Lafdi professor Department of Chemical and Materials Engineering UDRI and Wright Brothers Institute Endowed Chair in Nanomaterials • Donald Lasell president and chief engineer Think Composites • Michael Lee Project Manager EASi • Mogens Løkke CEO ECOmove ApS • Dr Ralph-Dieter Maier manager Aerospace Technologies BASF Corporation • José Rui Marcelino design manager Almadesign • Cameron May director GfE Materials Technology Inc • Patrick McGowan vice president GT Alloys • Prof Shaker Meguid Professor and Director Engineering Mechanics and Design Laboratory. Department of Mechanical and Industrial Engineering University of Toronto • Dr Mohammad Moniruzzaman product development engineer SABIC • Dr Dries Moors innovation manager Bekaert • Jeff Moyer Meridian Lightweight Technologies • Anthony Norton senior director Global Automotive & Off-Highway Vehicles Altair • Ms Gulsen Oncul A350 Ailerons EPM TAI • Tony Padula product manager Amphenol Pcd • Vasant Pednekar senior engineer Application Development Lanxess Corporation • Gregory Peterson senior technical specialist Lotus Engineering Inc • Alexander Pozzi vice president Advanced Design Group Seating Products B/E Aerospace • Paul Priestman director Priestmangoode • Javier Rodriguez Director Vehicle Integration & E/E EDAG Inc • Alasdair Ryder business unit manager - High Volume Manufacturing Umeco Structural Materials • Greg Schroeder research analyst Manufacturing Engineering & Technology Center for Automotive Research • Gary Seale managing director Cobra • Steven Sopher technical director JSP • Richard Strout president Leading Edge Motorsport • Gerret Suhl head of Sales Car Trim GmbH • Manoj Surana manager - Engineering Research Centre Tata Motors Ltd • Ashutosh Tomar senior researcher Jaguar and Land Rover • Dan Williams product manager - Automotive Granta Design Ltd • Ingo Wuggetzer vice president Cabin Innovation and Design Airbus Operations GmbH • Dr Robert Yancey senior director - Global Aerospace Altair Engineering • Dennis Sieminski PE NEI Sofware • Janice Grzywa market development manager Victrex

If weight reduction, fuel efficiency or environmental impact matter to you, then you need to attend this conference!

OCTOBER 24-25, 2012 BOSTON, MA, USA

GO ONLINE NOW TO BOOK YOUR PLACE!

www.TransportationWeightLossDiet.com

Transportation Weight Loss Diet Conference

The Transportation Weight Loss Diet Conference will bring together designers, engineers, program leaders, and heads of industry from the global aerospace, automotive, and rail industries for a two-day conference dedicated to cutting-edge research and technologies aimed at reducing weight without compromising safety, efficiency, or performance.

Presentations will include real examples of how challenges and compromises can be overcome and avoided through intelligent design choices and initiatives, as well as new materials and engineering practices.

The conference provides an unparalleled opportunity for a transfer of ideas between transport sectors, highlighting the best new approaches with the greatest potential to reduce weight, save fuel, enhance performance, and lessen environmental impact. Don't delay – make sure you book your place in Boston this October!

PRELIMINARY CONFERENCE PROGRAM

SPONSORED BY EASi An Aerotek Company

DAY 1 Wednesday, October 24

Setting the scene: the future of mass reduction

The opening session of the conference will highlight key trends and motives for mass reduction in the automotive, aerospace, and rail sectors, as well as examining potential future supply issues for lightweight materials.

Keynote presentation
Matt Zaluzec, manager, Materials Research and Advanced Engineering Department, Research and Advanced Engineering Center, Ford Motor Company, USA

Lightweight rail transportation at Bombardier
Jacques Belley, R&D director, Standardization and Innovation, Bombardier Transportation, USA

Less is more: automotive downweighting opportunities with mixed materials
Greg Schroeder, research analyst, Manufacturing, Engineering & Technology, Center for Automotive Research, USA

Lightweight materials

This session will look at a range of materials for use in vehicle mass reduction applications. New-generation meta and para aramids, intermetallic replacements for Ni-based superalloys, magnesium alloys, metal matrix composites, and 'fuzzy fiber' will all be profiled. The session will also cover manufacturing CFRP parts.

Advanced lightweighting materials: Nomex, Kevlar, and beyond
Dr Ley Richardson, principal application research associate - Aerospace, DuPont Protection Technologies, USA

Gamma Ti alloys: commercial solutions for carbon reduction
Cameron May, director, GfE Materials Technology Inc, USA

How metal matrix composites have been redesigned for more machinability and lower cost
Patrick McGowan, vice president, GT Alloys, USA

Passenger environments

Transportation needs to be attractive and easy to use. Transportation operators and manufacturers need to satisfy passengers and customers. Consumers must view mass reduction as an improvement to their transport experience. This session will look at how this can be achieved.

Design-driven innovation and cross-pollination for lightness
José Rui Marcelino, design manager, Almadesign, Portugal

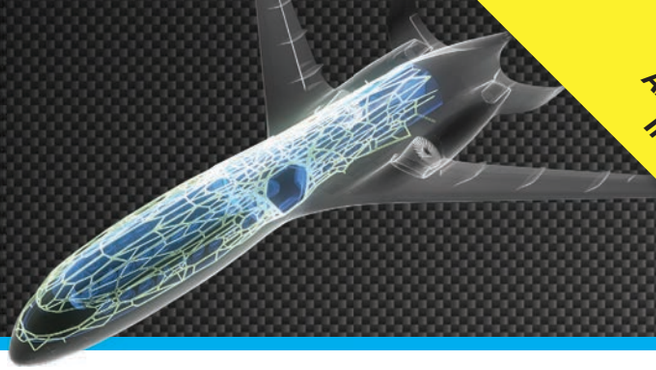
Cabin Concept 2050 based on a bionic structure
Ingo Wuggetzer, vice president Cabin Innovation and Design, Airbus Operations GmbH, Germany

Employing new design techniques to deliver lightweight seats
Alexander Pozzi, vice president Advanced Design Group, Seating Products, B/E Aerospace, USA

Low-calorie light infotainment
Ashutosh Tomar, senior researcher, Jaguar and Land Rover, UK

BOOK NOW AT: www.TransportationWeightLossDiet.com

OCTOBER 24-25, 2012
BOSTON, MA, USA



HiAnt® Simulation: Simulating structural composite hybrid parts made from continuous fiber reinforced plastics
Vasant Pednekar, Senior Engineer - Application Development , Lanxess Corporation, USA

Low-cost multifunctional-use composite to reduce weight
Prof Khalid Lafdi, professor, Department of Chemical and Materials Engineering University of Dayton Research Institute and Wright Brothers Institute Endowed Chair in Nanomaterials, USA

Developing volume manufacturing processes for carbon-fiber reinforced automotive body structures
Donald Lasell, president and chief engineer, Think Composites, USA

Manufacturing with lightweight materials

This session sees presentations covering high-speed automated manufacturing processes and techniques using composites; and looks at how smartphones may deliver new, strong, lightweight glazing solutions to transportation, as well as new mixed materials.

High-volume, high-speed preforming for structural composites
Daniel Buckley, manager of R&D, AGFM, USA

Computer-based tools for designing with new materials
Dennis Sieminski, P.E., NEi Software, USA

Strong, lightweight glass laminates for transportation weight reduction
Phillip Bell, product line manager, Corning Incorporated, USA

EASI: steel cord reinforcement for injection molded parts
Dr Dries Moors, innovation manager, Bekaert, Belgium

Lessons from aerospace: integrating lightweight materials information into engineering workflows
Dan Williams, product manager - Automotive, Granta Design Ltd, UK

Objective composites manufacturing process control: reducing uncertainty, overdesign and weight
Scott Blake, president, Assembly Guidance, USA

Lightening the way ahead
Phil Hall, managing director, Caterham Composites, Germany

Lightweight design of composite structures
Dr Robert Yancey, senior director - Global Aerospace, Altair Engineering, USA

Technologies for lightweight design and performance verification
Ravi Chilukuri, director, EASi, USA & Michael Lee, project manager, EASi, USA

Polyetherimide-carbon fiber as metal substitute in aircraft food tray arms
Dr Mohammad Moniruzzaman, product development engineer, Sabic, USA

Innovative solutions for railway floors and interior panels using cork
Antonio Coelho, R&D director, Amorim Cork Composites, Portugal

Automotive case studies and applications

What are the major vehicle manufacturers achieving in terms of mass reduction? This session looks at specific case studies of vehicles and programs.

VSL Project: sustainable and affordable technology for CO_2 emission
Tomasz Krysinski, chief engineer, PSA Peugeot Citröen, France

Weight reduction lessons and achievements: product development
Ramkisan Gite, PAT lead - Weight Reduction, Tata Motors, India

The BMW i3: a battery electric vehicle – right from the beginning
Oliver Walter, responsible product manager BMW i3, BMW, Germany

Using alternative plastic materials for weight reduction on heavy trucks
Dr Srikanth Ghantae, senior technology specialist - Plastics, Volvo Trucks North America, USA

Use of composites in bus structures for significant weight reductions
Mukul Mitra, program manager, Ashok Leyland Limited, India. Pradeep Kumar, manager - Global Bus & Coach Programme, Ashok Leyland Limited, India

Weight reduction through value engineering
Manoj Surana, manager - Engineering Research Centre, Tata Motors Ltd, India

Light-duty vehicle mass reduction and cost analysis: midsize CUV
Greg Kolwich, manager, Value Engineering Services, FEV Inc, USA

Reducing vehicle weight with composite materials
James Jones, CCG manager - Americas, Composites Consulting Group, USA

DAY 2 Thursday, October 25

Simulation and integration

The design and engineering challenges of integrating composite materials into structures and parts is addressed in this session, with presentations focusing on simulation, design optimization and process control techniques.

Intelligent adhesive bonds that provide an early warning system for structural failures

Prof Shaker Meguid, professor and director Engineering Mechanics and Design Laboratory, Department of Mechanical and Industrial Engineering, University of Toronto, Canada

Design and fabrication of multi-material structures

Prof Glenn Daehn, professor, Ohio State University, Materials Science and Engineering, USA

Laser cleaning pre-treatment for bonding of lightweight metals

Georg Heidelmann, president, Adapt Laser Systems, USA

Achieving weight reduction through design, material selection, and application-specific products

Tony Padula, product manager, Amphenol Pcd, USA and Janice Grzywa, Market Development Manager, Victrex USA, Inc, USA

Mechanical performance of friction spot-welded joints in 2198-T8 alloy

Dr Jorge F. dos Santos, head of department, Helmholtz-Zentrum Geesthacht, Germany

Aerospace materials for aircraft lightweighting applications

Dr Ralph-Dieter Maier, manager, Aerospace Technologies, BASF Corporation, USA

Pioneering a sustainable business model

Stuart Jones, VP Research and Development, Interface Americas, USA

Parametric study and topology optimization for platform concepts

Anthony Norton, senior director, Global Automotive & Off-Highway Vehicles, Altair, USA

Lord UltraConductive film and coatings for lightning strike protection

Ross Zambanini, senior global market segment manager, Aerospace & Defense, Lord Corporation, USA

Experiences with the electrical use of carbon fiber

Walter Kiersch, CEO, Carbon Conduction Technologies (CCT) GmbH, Germany

Automotive case studies and applications

Edison2's Very Light Car: a new automotive architecture

Oliver Kuttner, CEO, Edison2 LLC, USA

Half-weight vehicle with new materials: chassis, body, and driveline

Mogens Løkke, CEO, ECOmove ApS, Denmark

Full vehicle lightweight designing based on CAE techniques

Javier Rodriguez, director Vehicle Integration & E/E, EDAG Inc, USA

Prospective view of CFRP as a technology for weight reduction of automobiles

Toru Yamanaka, general manager, Automotive Center, Toray Industries Inc, Japan

Advancements in Cast Magnesium Structural Components

Jeffrey L Moyer, Vice President, Business Development & Engineering, Meridian Lightweight Technologies Inc, Canada

Automotive safety

One of the key concerns in downweighting vehicles is the issue of safety. This session looks at the issue not from the perspective of how far we can compromise safety for mass reduction, but rather how mass reduction actually increases safety and what lessons may be learned from motorsport.

Enhancing vehicle safety and crashworthiness with weight-loss improvements

Byron Bloch, director, Auto Safety Expert LLC, USA

Designing a lightweight body structure meeting federal impact requirements

Gregory Peterson, senior technical specialist, Lotus Engineering Inc, USA

Characterization of crash properties in aluminum extrusions

Jonas Braam, research engineer, Sapa Technology, Sweden

New materials and design technologies for motorsports

Prof Pete Hylton, director of Motorsports Engineering, Indiana University Purdue University Indianapolis, USA

transportation
weight loss diet
conference 2012

OCTOBER 24-25, 2012
BOSTON, MA, USA

Aerospace design developments

Looking specifically at aerospace, this session considers specific examples of mass reduction developments and the lessons learned in significantly increasing composite percentages in aircraft structures, as well as some interesting designs for drag reduction and innovative uses of carbon fiber.

Future aircraft composite weight savings opportunities and challenges
Dr John Fish, senior manager Airframe Technology, Lockheed Martin Aeronautics Co, USA

Challenges, and opportunities, of introducing composites into the 787 airplane design
Robert McIntosh, chief engineer - Weights, Boeing, USA

Weight opportunities of wide-body aircraft composite ailerons
Gulsen Oncul, A350 Ailerons EPM, TAI, Turkey

Multimodel structural optimization of commercial aircraft
Prof Santiago Hernandez, professor, University of Coruna, Spain

Understanding weight reduction relationships for rotorcraft
Dr Daniel Schrage, professor, Georgia Tech, USA

Drag-reduction technologies for low-speed applications
Prof Konstantinos Kontis, professor and deputy director, The University of Manchester, UK

Multi-disciplinary optimization of a pylon for mass and drag reduction
Freddie Colsoul, account manager, LMS North America, USA

CLOSE

Lightweight seating

Safe, comfortable seats – sometimes in large numbers – are a key requirement for most vehicles, especially aircraft and trains. Hence seating can add significantly to vehicle weight. This session is dedicated entirely to looking at this critical area for mass reduction with a range of approaches and products discussed.

Weight reduction in seat cushions
Mike Brock, market development manager, Rogers Corporation, USA

The use of high-strength polymers for metal replacement
Gary Seale, managing director, Cobra, UK

Lightweight structural solutions for transportation seating using expanded polypropylene (EPP)
Steven Sopher, technical director, JSP, USA

Weight savings through the use of suspension textiles
Neil Gross, president, Acme Mills Company, USA

Weight-saving possibilities on dress covers
Gerret Suhl, head of Sales, Car Trim GmbH, Germany

Win, win, win: lightweight leather
Nico Den Ouden, sales and marketing director, E-Leather Group, UK

CLOSE

DOWNLOAD FULL PROGRAM DETAILS ONLINE AT:

www.TransportationWeightLossDiet.com

BOOK NOW!

BOOK YOUR DELEGATE PASS ONLINE NOW!
TWO-DAY PASS ONLY $995!

www.TransportationWeightLossDiet.com

Get on board

There have been and there will continue to be discussions about how much intelligence and processing power an interface board has to offer on board. This is heavily dependent on the overall system architecture and application. A very typical user case is the deployment of interface cards for pure I/O functionality for avionics communication buses and networks such as MIL-STD-1553, ARINC429, and AFDX/ARINC664P7.

However, from this point of view there are still different ideas and approaches with respect to the handling of bus/network protocol-relevant real-time activities. In the low-cost products arena, interface board functionality is typically reduced to some kind of pure I/O (input/output), which misses powerful, hard real-time support for handling protocol-specific requirements. Of course, even these devices can be suitable and usable, but eventually limitations will surface. These can include performance, concurrent functionality, and throughput.

Interface board designs with clear functional segregations and implementations are the preferred approach. This ensures a solid foundation for a test system from bottom up, and includes the offloading of the host platform and the backplanes from tasks that belong to the front end of an interface. Further migration to other backplanes and hosts is much easier when having such a separation as the core functionality is on board.

Handling of hard, real-time protocol-specifics on board is the minimum on a feature list for an avionics databus or network interface. Such designs are then typically used by test system software environments, which take care of setup and control and especially data I/O to/from the interface through efficient backplane communication techniques like DMA. Today's market is being served with a spread of interface products for filling the requirements for onboard processing and data I/O capabilities for avionics buses and networks.

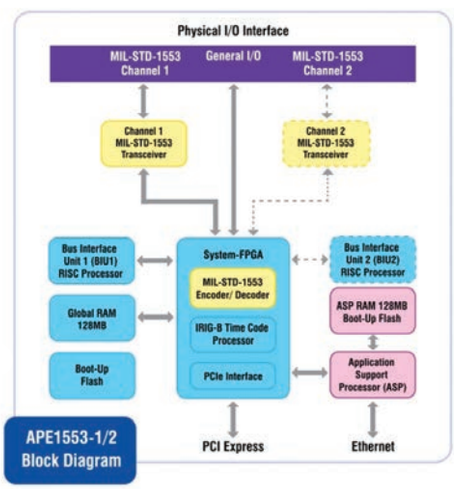
New approach

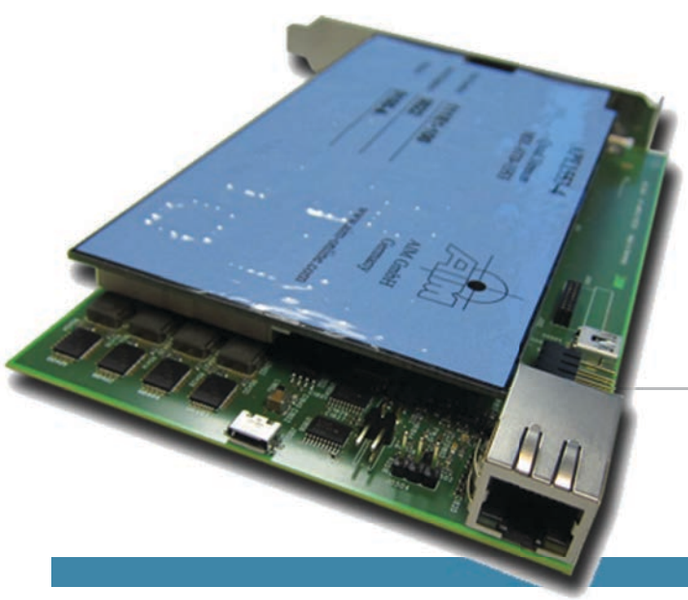
New approaches include smart solutions having portability, scalability, and the flexibility to migrate application-specific tasks into the interface level, which can significantly help cope with the issues relating to the interconnection between a host and interface device. Today there is a trend to use standard connections like USB and Ethernet for databus and network interfaces in preference to the traditional approach of mounting interface boards onto a standard backplane like PCI or PCIe.

Differing reasons have driven this, including the overall attractiveness of easy plug/unplug of devices plus simple sharing of such interface devices between different users. This is mainly due to the portable characteristics and small footprints of the devices. However, the key challenge appearing with this approach is the interconnection between the host and interface and the implied latencies.

One approach to cope with this is to offer further processing power on board in order to migrate application-specific tasks down to the (remote) interface. With today's available hardware and software components it is much easier than years gone by to offer a fully embedded application support processor on interface board level, with a standard software environment for development of onboard applications. The core component for such an implementation is the SOC (system-on-chip) device, which comes with a full microprocessor core, incorporating standard peripheral support like built-in Ethernet MAC.

Such devices can also come with full onboard Linux support including drivers for the SOC peripherals. The question of whether or not a real-time capable Linux is needed on board or not becomes a secondary issue, since in such a platform the system is dedicated to the user's application, and a standard Linux can be ideally stripped to an absolute minimum configuration. At



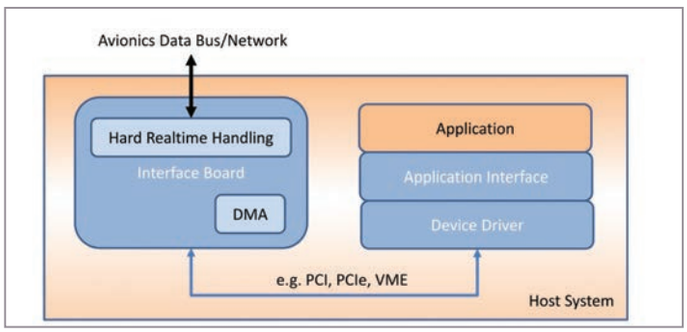


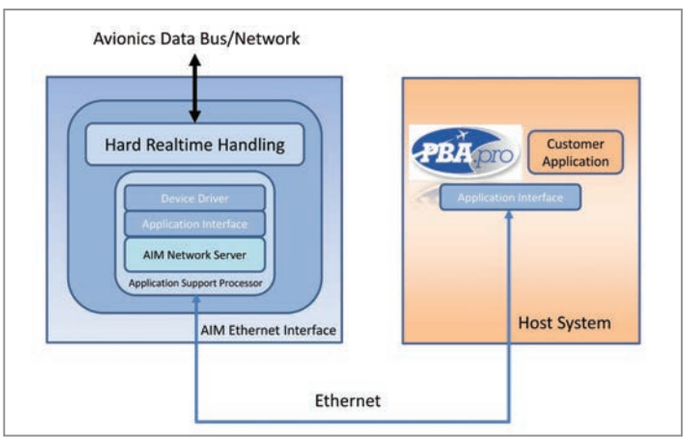
LEFT: **APE1553-x with mounted RJ-45 Ethernet connector**

ABOVE: **APE1553-x block diagram with new common core (blue elements) and ASP section (pink elements)**

BELOW (Top): **Typical application of interface boards mounted in a hosting system**

BELOW (bottom): **Ethernet-based interface with onboard network server application**





this point we can recap that the hard real-time and bus protocol tasks are clearly segregated from the additional application support processor. The real gain from such an approach is implied by the software approach, which allows an efficient development of onboard applications by using known Linux S/W development tools, instead of expensive and special OS specific tool sets.

The real strength of having such an application support processor on board is that it offers a known programming model to the onboard application programmer for an efficient migration of existing host applications, or at least parts of it. Ideally, the programming models and the application programming interfaces are almost identical.

Scalable systems

Keeping in mind that interfaces can be 'clustered' via Ethernet, such concepts offer new approaches for scalable systems with the interface hardware as well as for distributed S/W solutions. AIM's experience with the support of application support processors embedded into the hard real-time onboard designs has been field proven for more than 15 years, and implemented in various hardware form factors and software implementations.

The latest AIM design now employs a SOC component for the application support processor to run under the Linux OS and with support for standard Ethernet interface. With vast numbers of users familiar with Linux and standard Ethernet, any hurdles for the migration of tasks to employ the application support processor have now became insignificant compared with previous designs.

Since the SOC-based application support processor is part of the latest common core design of the AIM avionics databus interface boards, the functionality is inherently available for the latest PCIe-based interface boards.

The result means we have a PCIe backplane connection plus an optional Ethernet connection directly handled by the application support processor and operated under the Linux OS.

With the migration of the standard Linux device driver and application interfaces (API) to the onboard application support processor you can even use the same API by the onboard customer applications. Driving a PCI board in parallel with an Ethernet interface may seem superfluous, but the separation can be a real advantage to a later migration for fully standalone interfaces connected via Ethernet only. Now any application-specific onboard software can be executed autonomously by the application support processor with a user-definable Ethernet connection via TCP or UDP sockets.

Interface family

Soon to be available on the market will be AIM's Ethernet-based interface family with an application support processor basically executing the AIM network server (ANS), providing for a fully transparent connection via Ethernet to a host on which reside powerful applications like the PBA.pro or any other customer application based on the application interface.

In conclusion it can be seen, and becomes apparent, that the onboard software environment with a Linux OS on the application support processor offers many more software-driven variants of Ethernet-based interface devices including gateways, embedded PBA.pro boxes right up to fully customized onboard application S/W solutions.

CONTACT
AIM GmbH - Sales Office Munich
Terofalstr. 23a, 80689 Muenchen, Germany
Tel: +49 89 70 92 92 93
Web: www.aim-online.com

Go to online reader enquiry number 101

Advanced SRTD phase-tracking control

There are two popular ways to conduct resonance testing: 'fixed-frequency', and "phase-tracking". In fixed-frequency, frequencies that cause resonance are identified and then a fixed-frequency dwell is held for a period of time at each of these frequencies. The problem with the fixed-frequency method is that it is only valid up to the point that the product begins to fatigue. This is because the product's resonance frequencies drop under fatigue.

To avoid this problem, phase-tracking holds a constant phase difference at resonance. This works because the phase difference between control and response at resonance remains constant. Phase-tracking ensures that the product remains at resonance for the entirety of the test, and therefore causes the most damage to the product. Vibration Research Corp (VRC) calls this feature Sine Resonance Track and Dwell (SRTD).

One of the problems that test engineers encounter with phase tracking is picking the correct phase value. VRC has developed a method that enables the test engineer to manually track the phase value in order to determine the maximum transmissibility value at a particular resonance (transmissibility value is the value that gives the most damaging acceleration to the product). This method is advanced, user-defined, SRTD phase-tracking control.

Resonance tracking methods

There are a few options available to the test engineer for SRTD testing. To understand these options, consider a swept sine test that was conducted on a thin metal beam in which accelerations were measured on the end of the beam (Figure 3).

In this case, a resonance table was produced from the swept sine test that indicated that the fundamental mode of the long arm had a resonance at 69.7Hz; in which the measured transmissibility value was 31*g* and the measured phase was -71.6° (Figure 4).

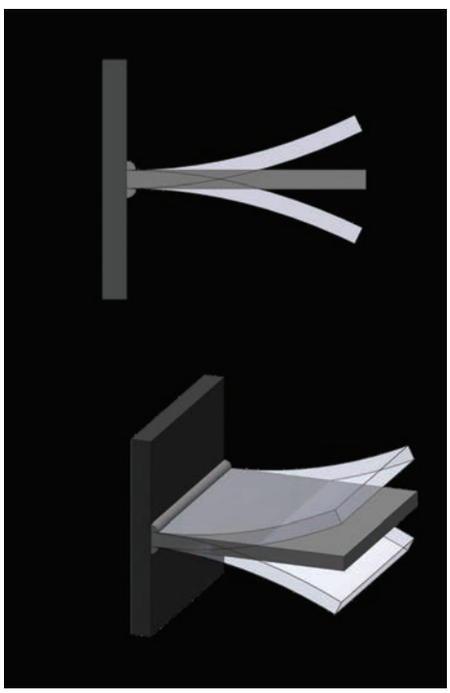
Phase-tracking: 90° default

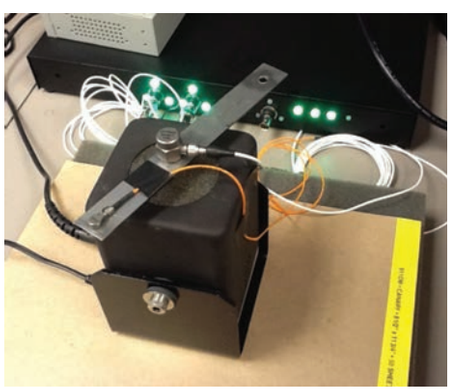
Since the theoretical phase of linear spring-mass systems is 90°, many controllers will set the phase automatically to 90°. With VRC's VibrationVIEW software, the test engineer can choose to set the phase automatically to 90° by clicking on the 'phase-tracking' check box (Figure 5). In this case, the SRTD test will lock the phase to 90° and also allow the resonance frequency to drift slightly as the test proceeds to dwell at the resonant frequency.

Resonance frequency track and dwell

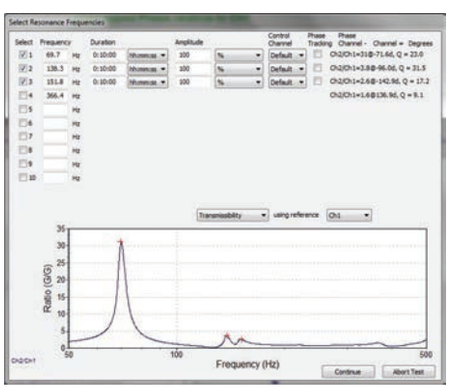
Commonly in SRTD testing, the test engineer will control the resonance frequency (resonance-track) since it is important to test the product at its resonance frequency. In this case, the controller tries to accurately measure the phase of the resonance during the swept sine test. This measured value (example: -71.6°) is recorded in the resonance table (Figure 4). This measured value, however,

BELOW (Fig 1 & 2): **Resonating cantilevered beam – profile and 3D**

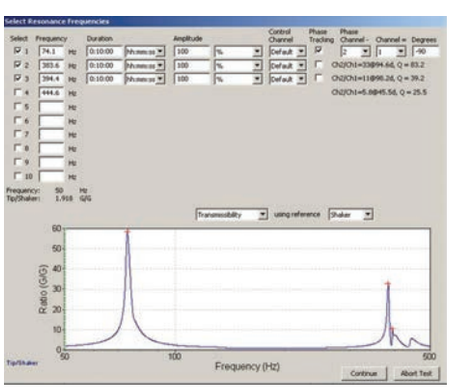




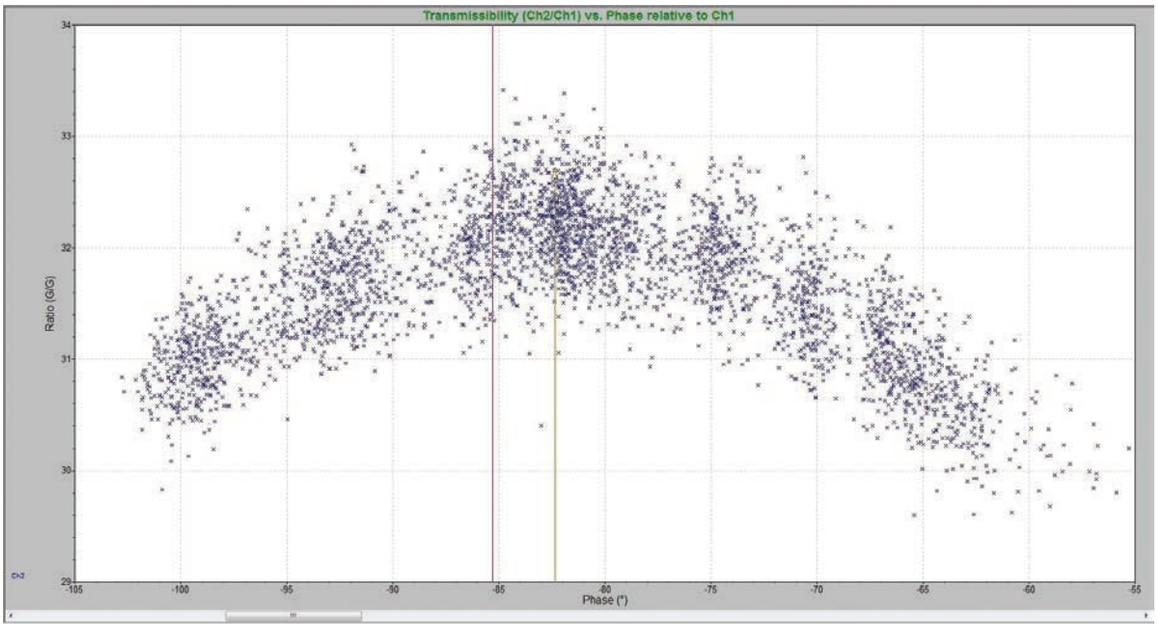
ABOVE (Fig 3): **Tear drop accelerometer attached to beam's 'short arm'**



ABOVE (Fig 4): **Resonance table for metal beam (long arm), showing fundamental resonance at 69.7Hz with a peak transmissibility of 31 G/G and a phase of -71.6°**



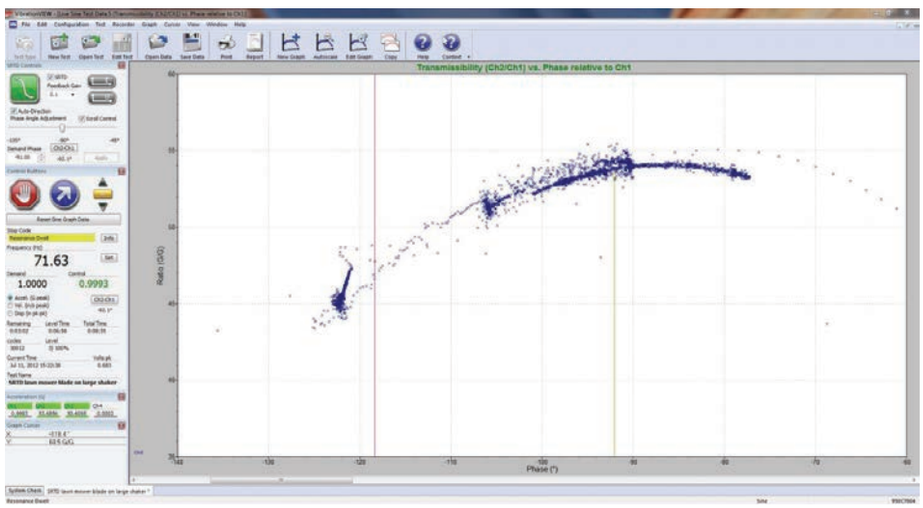
ABOVE (Fig 5): **Phase-tracking setting selected for 'lawnmower blade test' – phase is automatically set to 90°**



LEFT (Fig 6): **Transmissibility metal beam tip (long end of beam) to shaker head versus phase of resonance**

BELOW (Fig 7): **Screenshot of vibrationVIEW software, showing the use of advanced user-defined SRTD phase-tracking control to obtain a higher peak transmissibility. The peak transmissibility occurs around -90° and not the predicted -105°**

may not be entirely accurate. The inaccuracies are due mostly to the lag in reading of instrumentation. Therefore, the phase results from one swept sine may differ (sometimes significantly) from the phase results of a different swept sine. If the test engineer desires to dwell at a specific resonant frequency, then this technique is commonly used, even though the measured phase value may be off from the true phase value. In addition, this method dwells at a particular frequency with the goal of meeting the resonant frequency. However, the resonant frequency may change slightly as the product fatigues.



Advanced phase-tracking control

In the 'metal beam' test example, the actual phase of the resonance that produced the peak transmissibility was not the default value (-90°) or the predicted value by the software (-71.6°). As can be seen in Figure 6, the peak transmissibility was a completely different value (-82.5°).

Since the true phase of the resonance may not be the default value of 90°, a test engineer may not want to use the first option: phase-tracking at the default value. Since the resonance frequency of the test product may change as it fatigues, it may not be desirable to conduct SRTD testing by using the second option: resonance frequency track and dwell while using the measured phase value. With VRC's newest VibrationVIEW software, the test engineer will be able to adjust the phase value during the test to help obtain the highest peak transmissibility. This method is valuable because it enables the test engineer to dwell at a resonance using the correct phase value, while allowing the frequency value to adjust slightly for changes that occur in the product's resonance as it fatigues.

Consequently, these results indicate that the test engineer should manually control the SRTD phase-tracking in order to find the most accurate location for the peak transmissibility of a resonance. In order to obtain a phase of the resonance that will provide the highest possible transmissibility level for that resonance, the test engineer should use a manual control feature to 'tweak' the phase as necessary in order to obtain the highest possible transmissibility level for that resonance. This will serve as an improvement over the traditional phase-tracking tool or the resonant frequency-tracking method.

A new add-on feature from VRC in its VibrationVIEW Software (Version 11) is the advanced user-defined SRTD phase-tracking control that enables the test engineer to manually find the peak transmissibility at a particular resonant frequency by adjusting and controlling the phase value.

Test engineers would benefit from using VRC's VibrationVIEW software with the add-on feature, SRTD phase-tracking control, in order to conduct the most precise test – a test that maximizes the transmissibility value of the resonances, while maintaining high quality control.

CONTACT

Vibration Research Corp, 2385 Wilshere Drive Suite A, Jenison, Michigan 49428, USA

Tel: +1 616 669 3028

Email: vrsales@vibrationresearch.com

Salt-spray corrosion and chromate

REACH (Registration, Evaluation, Authorisation and Restriction of Chemical Substances) has had a major influence on the HITEA aerospace project into salt-spray corrosion testing, chromate-containing, and chrome-free primers.

A British company, Indestructible Paint, has been associated with the aerospace coatings industry for many years. It is heavily involved in ongoing discussions with many national and pan-European bodies, companies, and the EU regarding the issue of REACH, and in particular its impact on chrome-containing products for aerospace and airframe parts.

Cr6+ chemistry dominates the field of corrosion protection; however, its elimination by 2016, as currently recommended by REACH, requires new alternates to be found. Some alternatives have been proposed, but there is no wide acceptance of them, and the acceptance criteria and test regime to support new developments, other than salt fog testing (which is widely seen as inadequate), do not exist. This is of particular concern to the aerospace industry, because critical aerospace applications require the use of 'paint finishes to protect the base metal from corrosion for up to 40 years to ensure the safety of passengers' (ASD position paper to ECHA, dated September 13, 2011). The development of valid, industry-wide test methodologies, and the application of these to the development of REACH-compliant replacements suitable for rapid deployment before 2016, is therefore required.

Consortium

A consortium comprising full supply chain and academia has been brought together to address this issue over a two-year period at a cost of US$3.5 million (£2.2 million).

The core outputs will be common test methodologies and understanding; demonstration of new Cr6+ free products (or gap analysis if an alternative is not identified together with an understanding of the causes); and underpinning understanding of surface structure and chemistry. The project therefore represents an opportunity for the UK aerospace industry to become a leader in the area of Cr6+ replacement through the development and demonstration of innovative materials underpinned by a common testing program, an improved science-based understanding, and a centralised materials data management architecture. A successful project will result in the removal of Cr6+ surface protection coatings from the operating environment. This will address the environmental concerns and reduce operating costs by removing the need for specialized protective equipment. The materials testing protocols and information architecture will lead to reductions in materials testing costs and time to market by avoiding duplication of effort and insuring sharing of knowledge.

The crew

The consortium led by Rolls-Royce includes many UK-based Tier 1 aerospace specifiers including: Meggitt, Aero Engine Controls, Goodrich (now UTC), GE, and Messier Dowty. Other members include Indestructible as a paint developer and maker; Ashton & Moore and Poeton as applicators; Granta as a knowledge coordinator; and three universities to look at new methods of testing.

The project should show new, common test methodologies for surface protective coatings; identification and demonstration of new Cr6+ free surface protection systems (or gap identification if an alternative is not identified); improved science-based understanding of the coatings, surfaces and how to optimize them; and finally a knowledge management and dissemination system.

These will be disseminated through publications, the Materials and Aerospace & Defence KTNs (Knowledge Transfer Networks) and other outlets. In addition, the consortium will form a consultation group open to all parties in this area to explain the approach and progress, and to ensure dissemination in other sectors. The consortium will also look to get the outputs adopted in standards though their memberships of standards committees. The consortium OEMs and Tier 1 companies will specify the new coatings for use on their products.

The specialist processing companies will be able to set up facilities to provide these coatings to a wide range of end users, and the SME coating suppliers will be able to supply the materials these processes will require. Additionally, new areas of academic research will be opened up, thus strengthening the science base. New coatings need to be ready when the current processes require authorization, expected to be early 2016.

Corrosion in aerospace parts is prevented by aerospace-approved chromate-containing system

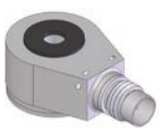
CONTACT

Indestructible Paint Ltd, 19-25 Pentos Drive,
Sparkhill, Birmingham B11 3TA;
Tel: +44 121 702 2485,
Fax: 0121 778 4338
Email: sales@indestructible.co.uk;
Web: www.indestructible.co.uk

Accelerometers for Aerospace Testing

Dytran Instruments, Inc. offers a full range of the industry's most reliable accelerometers for:

- » FLIGHT AND FLUTTER TESTING
- » HEALTH & USAGE MONITORING SYSTEMS (HUMS)
- » SATELLITE TESTING
- » ROTOR AND FIXED WING AIRCRAFT MONITORING
- » MODAL AND STRUCTURAL ANALYSIS
- » HIGH TEMPERATURE ENGINE MONITORING



On-board flight testing

3326A Series

- Utilize standard aircraft power supply (+20 to +32 VDC)
- Lightweight, case isolated design
- 360° cable orientation

Jet engine testing

Model 5334

- +482°C operation
- Integrated differential amplifier and hardline cable
- IEPE

Engine analysis

Model 3316C

- +482°C operation
- Miniature cubic design weighing 6 grams
- Dytran patented technology

Flight & flutter testing

7500A Series

- Differential output
- Ultra low noise operation
- Hermetically sealed
- MEMS technology

Modal analysis

3333A Series

- Lightweight triaxial design weighing 2.3 grams
- Miniature 4-pin connector
- Low noise operation

HUMS

Model 3077A

- Integrated mounting bracket
- Multiple sense directions available
- 10 mV/g, IEPE

DYTRAN INSTRUMENTS, INC.

21592 Marilla Street
Chatsworth, California 91311
USA
Phone: (818) 700-7818
info@dytran.com
www.dytran.com

Active mains filter

There is an easy way to reduce the weight of aircraft and thereby lower fuel consumption: use more lightweight electrical components instead of heavy hydraulic and pneumatic systems. However, this also pushes up the requirements regarding the quality of the power supply from the aircraft's electrical system. German company Liebherr-Elektronik GmbH has developed an active mains filter prototype that guarantees powerful interference suppression in the electrical system.

Filters suppress interference

In aircraft, electrical energy is generated by three-phase generators driven by the turbines. Each electrical consumer must first generate direct current from the three-phase variable-frequency network (360 to 800Hz). Up to now, this was done by 12-pulse rectifiers (special rectifiers with a 12-pulse transformer) and active power factor correction (PFC). An active mains filter is a superior alternative to PFC because it can compensate for single harmonics, reactive power, asymmetrical voltages or even overvoltages, depending on how it is designed.

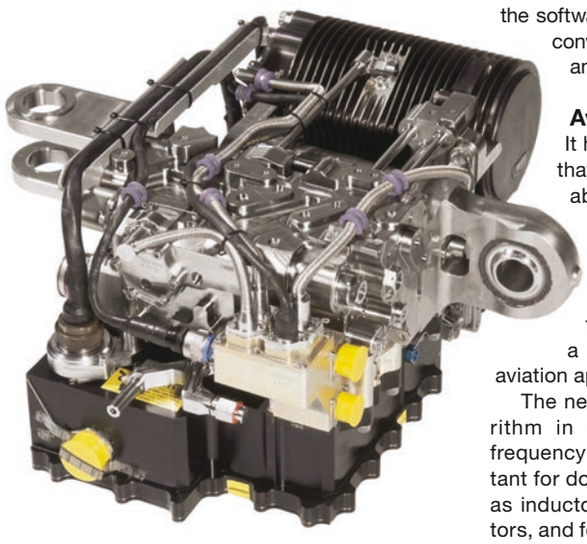
Active mains filters are not used in aircraft yet because of the extremely fast control necessitated by the high frequency of the aircraft electrical system (800Hz, relevant harmonics up to 10kHz). But now new, fast-switching semiconductors are making active mains filters a viable proposition. The ability to suppress interference in several devices simultaneously by means of one active mains filter is particularly attractive.

This is far more economical than installing a separate filter for each device. Moreover, the active mains filter has to be designed only for the currents that need correcting, so its dimensions and weight are much lower than in an active PFC, which is designed for the entire current. In addition, the high switching frequencies make it possible to use compact inductors.

Prototype development

The primary requirement for implementing an active mains filter is powerful hardware, needed to achieve high switching frequencies of up to 100kHz and compute the complex control algorithms in real time. The switching frequency currently achieved with a dSPACE prototyping system is 50kHz, so the entire control algorithm must be computed in less than 20µs. Due to multitasking, the computing power can be distributed flexibly, meaning that less important digital I/Os and temperature signals can be evaluated at considerably lower speeds, thus allowing additional resources to be assigned to more important tasks.

After the controller design is completed in MATLAB, all the sensor signals and any virtual variables can be observed at runtime by means of the software, dSPACE ControlDesk, which is a convenient way to perform error detection and parameter optimization.



Aviation approval

It has been successfully demonstrated that an active mains filter operates reliably despite the aircraft's variable power frequency. The harmonics are successfully compensated for. Measurements confirm that a device with an active mains filter fulfills the relevant standards. This is a major step along the long road to aviation approval.

The next task will be to optimize the algorithm in order to increase the switching frequency to more than 50kHz. This is important for downsizing passive components such as inductors and intermediate circuit capacitors, and for enhancing operational safety. The more frequently the model is computed, the better unexpected events such as voltage transients or phase failures can be detected and compensated for. The high safety levels required in aviation make such robustness an absolute necessity.

The active filter algorithm in the target application is implemented in a digital signal processor (DSP) from Texas Instruments. The developed algorithms are converted into production code for this DSP through dSPACE TargetLink.

LEFT: The increased use of electrical components in aircraft requires high-quality electrical interference suppression

ABOVE: The Airbus A380 Electrical Backup Hydraulic Actuator (EBHA) – a typical example of an application of an active mains filter

CONTACT

dSPACE GmbH, Rathenaustr. 26, 33102 Paderborn, Germany

www.dspace.com

Microphones for resonant acoustics

Shipping a defective aerospace gas turbine blade is potentially catastrophic for a company, a customer, and an airline passenger. Resonant inspection through the non-destructive test resonant acoustic method (NDT-RAM) is designed to help deliver fully inspected parts, economically and on time, providing confidence in the quality of manufactured parts. PCB Piezotronics Inc acoustic microphones are used to measure the sounds of good and bad parts to establish pass/fail criteria for this inspection method.

The resonant acoustic method is a unique form of resonant ultrasound spectroscopy, also known as resonant inspection. The ASTM E-2001-08 standard addresses resonant inspection. The NDT-RAM provides a whole body component inspection sensitive to both internal and external flaws. NDT-RAM can detect imperfections such as variances in overall shape, weight, and density of parts. It can also identify where processes such as machining or heat treating have been missed.

Unique signature

Every part has a unique vibration signature (its resonant frequency). This resonance is almost exactly the same from 'good part to good part'. The resonance will shift when there is an internal or external change or imperfection. For example, when a bell has a crack, it does not have a clear ring and loses its ability to hold its tone. The same is true of a part that has a flaw.

With the time and frequency domain using the 'fast Fourier transform' process, the response signal is separated into discrete frequencies. This allows for easy interpretation of data in the frequency domain. Peaks represent a specific component's resonant frequency.

The result is a 'response frequency spectrum' that is unique to a specific part. The principal mechanical properties of an object are mass, stiffness, and damping. If mass, stiffness, or damping of a component is varied, then the dynamic response characteristics of an impact on the component will also vary. Using this spectrum, it is possible to look for changes in parts. A good example of the resonant signature for both a good and defective part includes: good signature, defective signature, and analyzing data.

Focusing on a specific peak

By examining peaks at a closer range, variances in the frequency response are easier to see. Below left is an example of a typical frequency shift. This shift is typical from 50-500Hz. The green block represents the 'pass/fail' criteria (or limit). If the peak is inside the block, the part passes and is ready for the next process.

This is an example of the absence of, or the significant difference in the amplitude of, a peak. The defect caused the part to dampen faster and not hold its tone.

Once the pass/fail criteria has been set for a given part, the NDT-RAM application can be brought online. Testing can occur as quickly as one-part-per-second and the system can be entirely automated, allowing for 100% inspection of your high-volume production-line parts.

A record of every tested part is automatically stored in report form. This enables statistical analysis on lots, shifts, percentages, and types of defects.

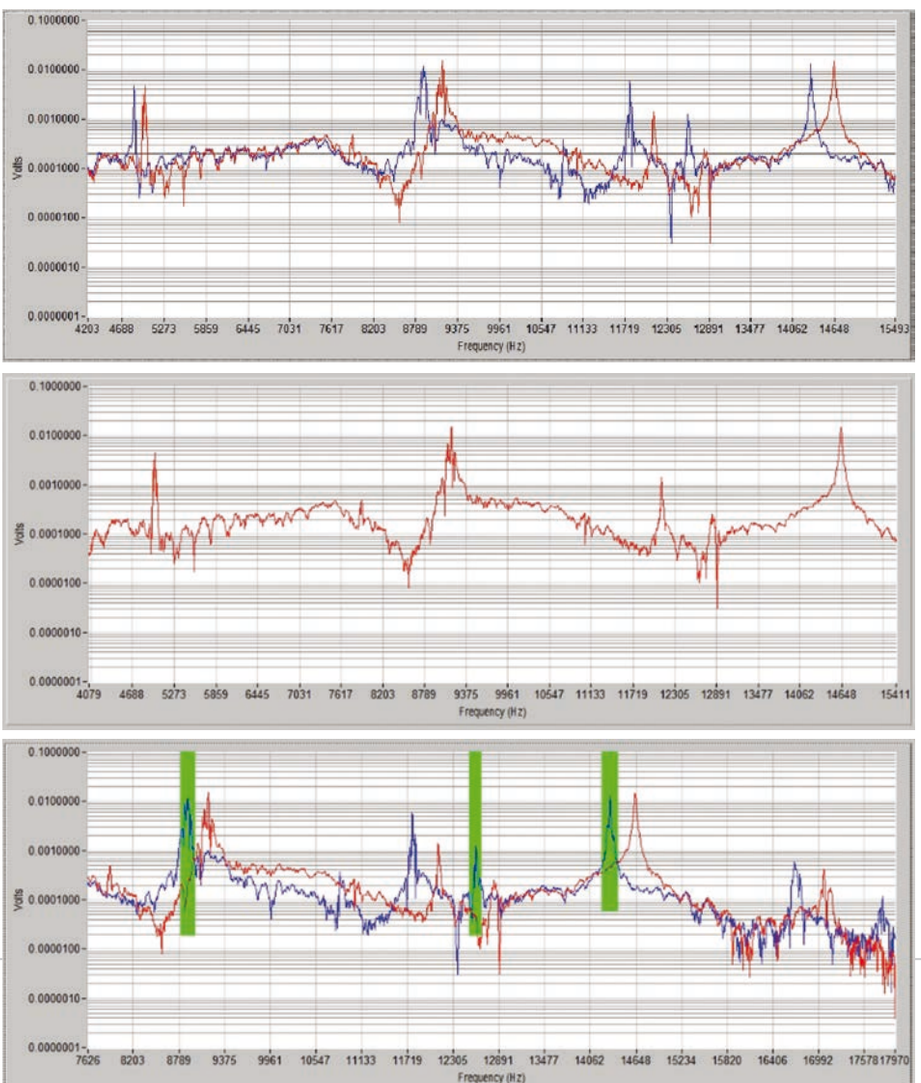
Sample test

Sometimes it is necessary to have more than one pass/fail criterion. There are examples of parts that require four points to be checked to determine a good part from a defective part. In this test, all four points must be good for the part to pass.

PCB microphones

PCB Piezotronics offers a variety of acoustic measurement products, including condenser, modern prepolarized, traditional externally polarized, array, probe, low-profile surface, and also special purpose microphones. Microphone products are complemented by an assortment of preamplifiers, signal conditioners, A-weighting filters, handheld calibrators, and accessories.

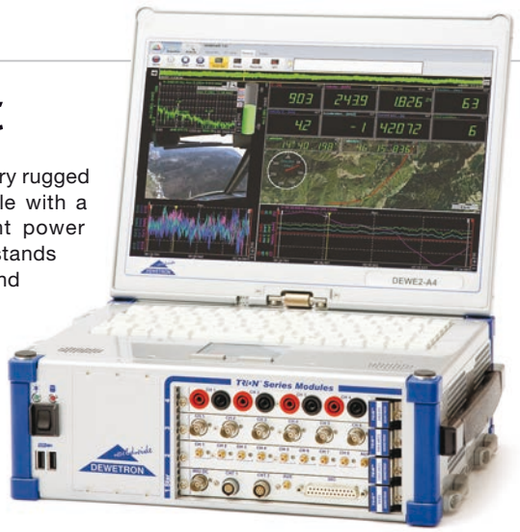
As a global supplier, PCB has sold microphones, preamplifiers, and acoustic accessories for test and measurement applications to the most respected company names throughout the world.



LEFT FROM TOP: overlaid good (blue) and bad (red) resonance data showing shift of response peaks; defective resonance signature; overlaid good (blue) and bad (red) resonance data with criteria

CONTACT
Bob Metz, product manager, PCB
Tel: +1 866 816 8892
Email: bmetz@pcb.com

Precision with flexible measurement



Dewetron's new DEWE2 with TRION modules offer high flexibility, high channel density, and even more precise measurement results. The innovative DEWE2 series has already been awarded the NASA Tech Briefs product of the month in August, and is a 'Product of the Year' finalist for 2012.

Maximum flexibility is guaranteed with the TRION modules: each one can be combined and exchanged directly by the user within seconds, enabling rapid adaptation of the DEWE2 instruments for every sensor and every application. The modules offer a precision of 0.02%. The function of every single measurement channel, as well of the connected sensors, can be proofed easily via system check. This results in a reduction of user errors, which saves valuable time for flight test engineers.

The DEWE2 system series is very rugged and different chassis are available with a battery pack for an independent power supply. The product particularly stands out because of its high precision and high channel density.

All the different signals from the numerous flight test applications such as analog, digital, CANbus, GPS, counter, and even video signals, are already hardware-synchronized during the measurement process. This is guaranteed by the specialist Sync-Clock technology, which ensures the highest quality measurement data and maximum total efficiency for viewing, assimilating, and evaluating results.

Further information
Dewetron GmbH
Parkring 4, A-8074 Grambach bei Graz, Austria
Tel: +43 316 3070 141
www.dewetron.com

or go to online enquiry card 106

Engine vibration kit

Aero engine challenges grow as requirements for noise, efficiency, weight, and safety are becoming more stringent. New engines must be quieter, safer, lighter, and more efficient – all while remaining within the development budget. Brüel & Kjær's 3656-A engine vibration test kit has been developed in close collaboration with Turbomeca to perform vibration test measurements for field inspection on all Turbomeca helicopter engine families, according to their respective maintenance manuals. The system provides an immediate and unambiguous pass/fail engine health result using vibration diagnostics.

As a leading helicopter engine manufacturer, Turbomeca requires that engine vibrations are regularly measured and compared with their manufacturer-stated field limits. These tests lead to the operational decisions governing whether aircraft are allowed to fly or not, and whether maintenance needs to be performed on their engines.

The vibration test kit includes all the hardware and software needed to perform on-ground vibration test procedures. An industrial accelerometer that is specially adapted for use on gas turbines ensures reliable vibration measurements. The heart of the system, the 2250-H-100 handheld vibration analyzer, is equipped with Turbomeca engine templates for the Arriel, Arrius, Artouste, Astazou, Makila, Turmo, Ardiden, and TM-333 engine families. The templates combine with a simple user-interface to match the prescribed checking procedure, and lead users through the whole process. Test complexity is further minimized with a simple display containing all of the necessary test information.

The raw measured data can be sent to Turbomeca for further analysis by simply downloading all data to a PC and emailing it directly to the company, following the recommendations in its engine maintenance manuals.

The noise and vibration data acquired from engine test cell and ground test measurements are used extensively to predict noise while engine ground test measurements are used for family plan certification of aircraft derivatives and for evaluation of new noise-reducing devices.

Further information
Brüel & Kjær Sound & Vibration Measurement A/S
Tel: +45 77 41 20 00
www.bksv.com

or go to online enquiry card 107

Full-service supplier to the aerospace industry

Jacobs provides technical, professional, and construction services globally, ranging from on-site support, to the delivery of advanced technical facilities and specialty systems. The company maintains offices with full-spectrum project capabilities including management, design, procurement, construction, integration, and commissioning. Its resumé includes advanced technical facilities in the aerospace sector, with services ranging from technology consulting to turnkey design/build. Jacobs' consulting services range from facility planning/utilization studies, to the latest modeling and simulation techniques including aero-acoustic predictions, while its design services range from specialty subsystems, to the delivery of facility drawings and specifications. For NASA, Jacobs assessed critical aeronautics test program and strategic capabilities asset program test facilities – recommending modifications for sustainment of facility capabilities.

Jacobs provides engineering and management support and assumes turnkey responsibility for the design/build of technical facilities and specialty systems. To support the development of next-generation space vehicles, it has designed and is managing the construction of a US$350 million rocket engine altitude test stand at NASA's Stennis Space Center. Jacobs is also helping NASA plan for future space launch operations through studies to transition Kennedy Space Center launch pad infrastructure to new space launch systems. In addition, Jacobs recently designed and constructed modifications to the Icing Research Tunnel at NASA's Glenn Research Center – providing enhanced capabilities for aircraft testing.

The automated test and measurement software, Test SLATE, is a test control/data software and a proven solution for integrating diverse hardware, managing test configurations, and transforming data into meaningful results. Test SLATE was installed as the software platform for new high-speed systems designed to enable the US Department of Defense to perform rotorcraft testing at the National Full-Scale Aerodynamics Complex at NASA's Ames Research Center.

Further information
www.jacobstechnology.com
www.testslate.com
or go to online enquiry card 108

Super-compact high-speed camera launch

AOS high-speed cameras are renowned for their robustness and reliability in extreme applications such as airborne store separation tests. Their modular design allows for simple integration into existing camera and measurement systems.

The newest addition to the product line of MIL-tested and certified high-speed cameras is the ultra-compact Q-MIZE EM. State-of-the-art electronics in combination with high-quality components, such as a non-flammable NiMH battery, have made it possible to reduce the camera's size by almost 40% compared with previous models. Integration into limited spaces inside camera and measurement pods and compartments is now easier than before.

The key specifications of 3MP image resolution, 100,000fps maximum frame rate, IRIG-B time stamping, and programmable status lines, represent the leading edge in high-speed cameras for airborne applications.

With a footprint of just 74 x 80mm, the Q-MIZE EM will fit into the tight spaces that other cameras will not fit; for special camera positions, the Q-MIZE EM is available with the connectors positioned on the sides, thus minimizing the depth.

A range of extensions, such as video-out and CF interfaces, expand the camera's versatility even further, and customers can also request specific camera connectors. Like all AOS MIL cameras, the new Q-MIZE EM is tested and certified according to MIL-STD-810 and 461.

Further information
AOS Technologies AG, Taefernstrasse 20,
CH-5405 Baden-Daettwil, Switzerland
Tel: +41 56 483 34 88
info@aostechnologies.com
www.aostechnologies.com

or go to online enquiry card 109

Conducive to bond trials

Aircraft systems are exposed to a large number of environmental challenges: lightning strikes, electromagnetic fields, rapid extreme pressure, and temperature changes, all of which have an adverse effect on aircraft life and performance. Therefore it is essential to perform regular non-destructive testing (NDT) conductivity tests to ensure structural and electrical integrity.

Good quality electricity conductivity for the aircraft structure, especially of the outer skin, protects it from damage by lightning strikes or electrostatic discharges. Structures made of fiber composites, together with associated equipment and wires, are especially prone to damage.

It is very important that junctions, screw connections, connectors, grounding cables, and cable ducts are tested for conductivity, even if they are difficult to access. By testing the resistance of screens, equipment, structural components, etc, it is possible to detect compliance to regulations during manufacturing processes, or if the connections, despite aging, meet the requirements. The performance of these measurements is naturally subject to stringent quality control.

Test-Fuchs, taking advantage of its long-time experience in testing, has developed and successfully launched convenient test equipment to meet stringent safety critical requirements for bonding tests. The tests can be carried out easily by a single operator and it is not required to remove parts or to re-open screw connections. All equipment is battery operated, easy to use, and has a compact design to ensure easy use in points that are hard to access. Test-Fuchs offers three different types of equipment for testing: bonding tester, loop resistance tester, and anti-static paint tester.

Many airlines already rely on Test-Fuchs' quality in its NDT conductivity testing.

Further information
www.test-fuchs.com.

or go to online enquiry card 110

Index to advertisers

Eye on the tiger

ROBOT CAMERAS HAVE BEEN EXTENSIVELY USED TO FILM UP CLOSE TO SHY WILDLIFE. NOW A NEW REMOTE AIRCRAFT CAN FILM FROM THE SKY AND IT FITS IN A BACKPACK

BY JARNO PUFF

We all enjoy lying on the couch and watching spectacular natural, social, and wildlife documentaries presented on the TV. The quality has increased greatly in the past decade, much of which is thanks to new affordable technologies available to camera operators and producers.

I am a big documentary watcher and fan. This was the first reason my team and I decided to develop a remotely piloted aircraft systems (RPAS) family specifically for the wildlife and documentary film-making industry. We took all our previous experience and expertise in developing RPAS for civil defense applications and worked with video operators and producers.

Advanced Aviation Technology (A2Tech) is a small R&D company focused on the development of small rotary wing RPAS for the civil market. Our goal was to develop something robust and highly transportable that could fit in the backpack of a small film crew.

Development process

The quadrotor-equipped, small remotely piloted aircraft system, RV-VTOLx4, was designed for commercial aerial work, such as industrial inspection, aerial photography, and first responders support, where manned helicopters can't be used, such as in very low altitude, obstacle populated, and cost-sensitive scenarios. The 11 lb multi-rotor helicopter, with four 350W electric engines carries payloads up to 5.5 lb at sea level. This payload may not seem a lot, but is enough to keep a reasonable weight/performance ratio in the weight class of electric-driven 16 lb MTOW multi-rotor systems. More payload could be carried, but flight endurance would be worse. The target payloads range from light electro optical daylight and thermal inspection cameras weighing only a couple of hundred grams, up to DSLR camcorders of 2kg. A 500g, lightweight, dedicated, 3-axis gyrostabilized camera mount was developed to carry up to 5kg of payload. This will bring the total useful payload of the RV-VTOLx4 to the yet qualified 5.5 lb.

For the proof of concept, the airframe was made of wooden rods instead of 18mm carbon tubes, connected together by industrial grade glass-reinforced plastic clamps. Also, the avionic bay was made from plywood, which is much more easy to drill, shape, and cut than 4mm carbon fiber sheet.

Wooden rods were substituted by machine cut 18mm carbon tubes. New prototype engine mounts were made later after the first test flight, and were shown not to be reliable or rugged enough. The plywood avionic bay floor was remade using the RV-VTOL25 sandwich technology made by the airex core material covered by 0.3 mm carbon sheets. At the end, the final configuration was set up by a carbon tube main structure airframe with foldable rotor arms.

TOP RIGHT & BELOW: **Payload tests were performed, adding 0.5kg payload weight at a time, using an underslung loaded bottle of water**

Flight-test program

The first flights were dedicated to the identification of the propulsion performance. Using a 'wattmeter' mounted under the payload mount support and holding the aircraft over the head, throttle was increased in 25% steps and current consumption was read and recorded.

Later, payload flight tests were performed, adding 0.5kg payload weight at a time, using an underslung loaded bottle of water with weight markers. During each hovering flight, current consumption was read and recorded in a table. The system was able to keep 2kg of underslung load without any problem, as previously calculated on the drawing board. The third stage was testing the aircraft's handling and flying capabilities. A sortie of eight circles, climbing and descending, high-speed fore and aft, and yawing, was performed in accordance with our chief test pilot Lele Grezzani, who was excited about its smooth, easy handling characteristics.

For the next aircraft tests, the final target of 2.5kg of payload and new battery chemistries in different temperatures and altitudes will be tested.

Engine and prop problems

Electric engines use usually neodym magnets, which are sensitive to corrosion in humid environments. Unfortunately, we encountered this issue and had to substitute all magnets on all four engines and risked grounding the aircraft. Fortunately, during a pre-flight check in the lab, one engine stopped working on the bench. To resolve this issue, tropicalized magnets were used so operations in high-humid environments are no longer a problem.

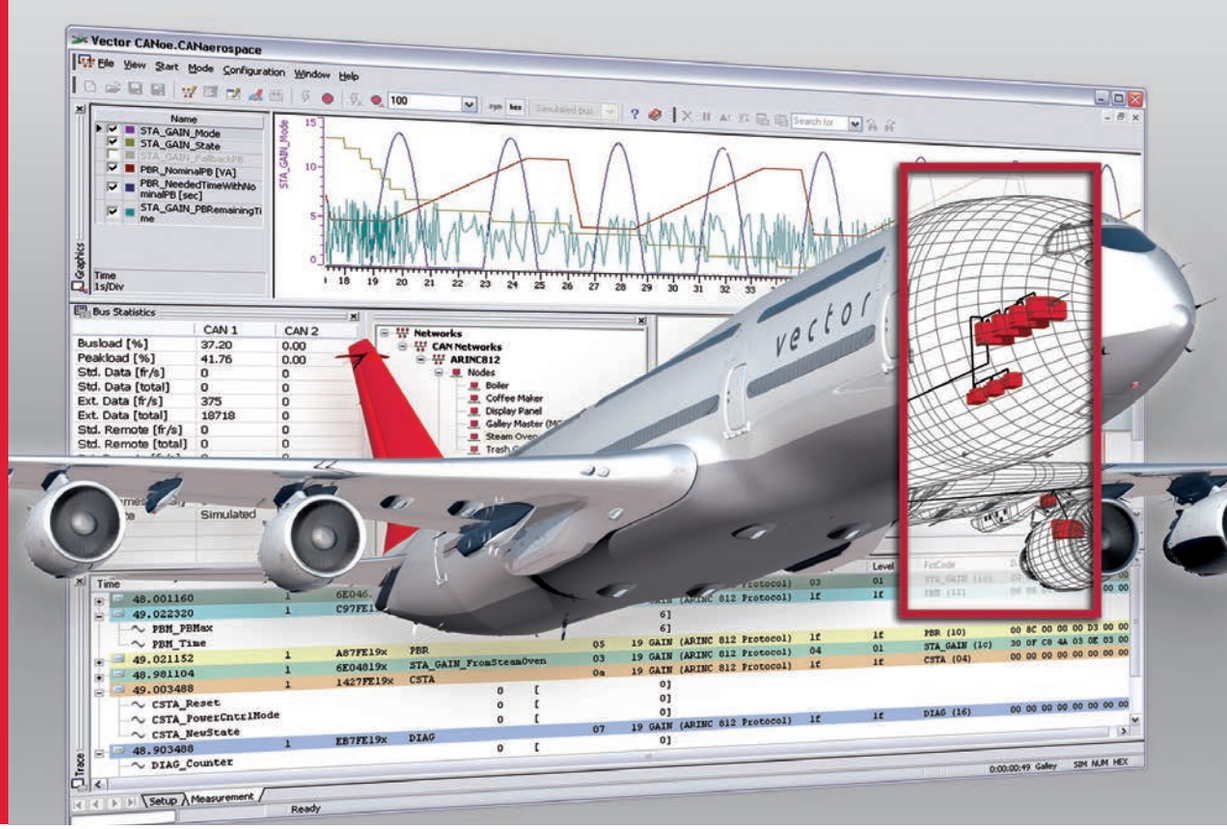
A second issue finally grounded the aircraft, but damage was very limited due its robust airframe design. Prop adapter number 4 slipped on the engine shaft during a strong climb and the aircraft airlift and ground on field. This was due a wrong prop adapter design. It was redesigned, machined, and one week later, it flew again, better than ever.

What next?

The complete system is based on an aircraft, one backpack GCS (ground control station) for the pilot, and one backpack camera operator RVT (remote video terminal). As soon as the backpacks are finished, extensive on-field testing is planned. These tests will become difficult as they will be under real wildlife filming conditions.

Tests will include transportability of the system, backpack ergonomics, video link and control datalink performance using license-free frequencies, three-axis camera mount reliability, and stability employing remotely controlled HD camcorders and DSLRs. Most of the initial wildlife filming tests will be done at the Parco Natura Viva Garda Zoological Park. Flight tests with lions, tigers, rhinoceros, giraffes, and monkeys will be performed to understand the levels of noise the aircraft are generating, and at what distance the animals will recognize them. ▮

Jarno Puff, is the R&D director, Advanced Aviation Technology - A2TECH based in Italy



Test your avionics network efficiently and reliably

With focused support, development processes in electronic networking can be implemented in a more time-saving and cost-effective way:

- Use protocol-specific tools to systematically and reliably develop your network design.
- Find and avoid errors early in development conveniently and cost-effectively.
- Validate changes made to the software and the communication system – quickly and easily – with regression tests.
- Exchange data with colleagues and development partners – easily, securely and without overhead – whether from databases, models or test scripts.
- Benefit from a multi-bus tool approach to developing, testing and implementing gateways.

Improve the efficiency of your overall development process – from design to testing and analysis – with the practice-proven tools CANoe and CANalyzer and our comprehensive services.

More information and a demo version of CANoe with AFDX® / ARINC 664 support: www.avionics-networking.com

Supported bus systems and protocols:
AFDX®, CAN, IP, Ethernet, ARINC 429 / 812 / 825 / 826, CANaerospace, CANopen

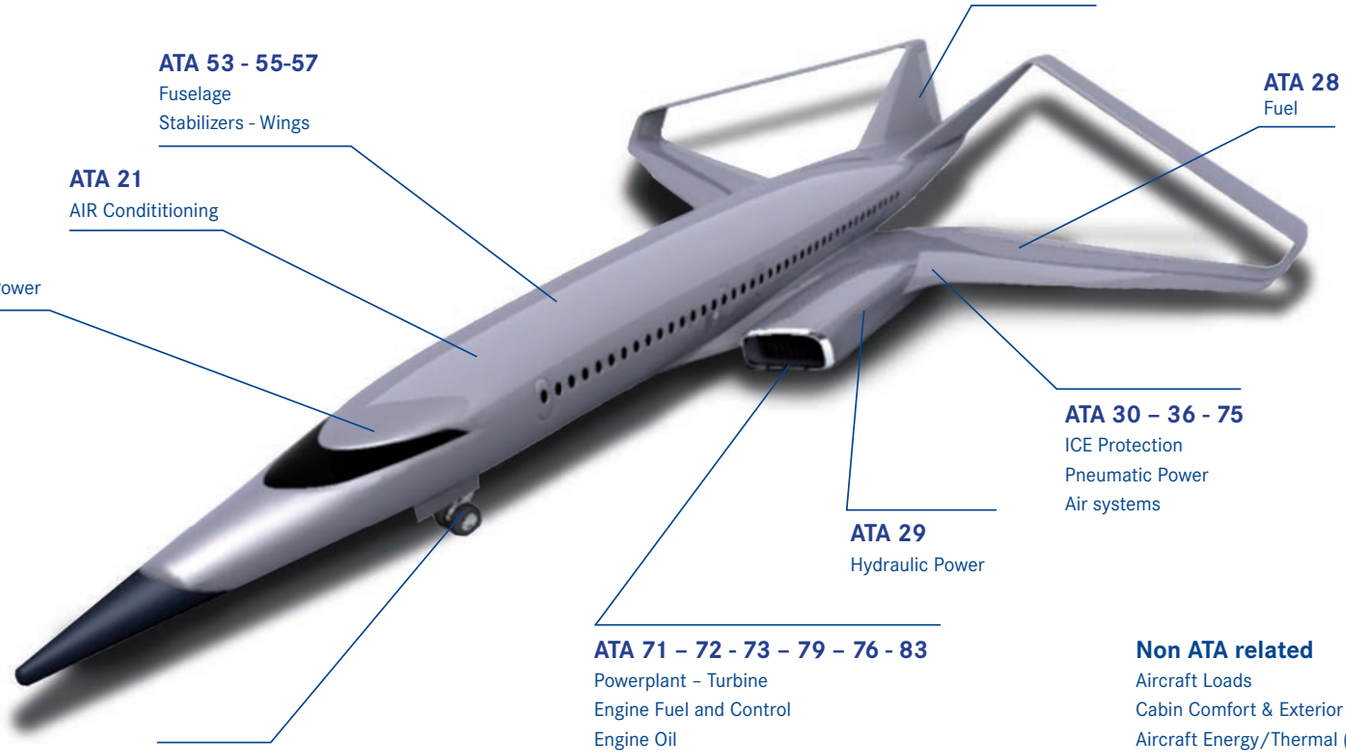
AFDX® is an Airbus' registered trademark

Vector Informatik GmbH
Stuttgart, GERMANY
www.avionics-networking.com

vector

Leading partner in
Test & **Mechatronic Simulation**

An unrivaled portfolio of Structural and Mechatronic System Simulation and Testing Solutions



ATA 27
Flight Controls

ATA 53 - 55-57
Fuselage
Stabilizers - Wings

ATA 28
Fuel

ATA 21
AIR Condititioning

ATA 24
Electrical Power

ATA 30 – 36 - 75
ICE Protection
Pneumatic Power
Air systems

ATA 29
Hydraulic Power

ATA 71 – 72 - 73 – 79 – 76 - 83
Powerplant – Turbine
Engine Fuel and Control
Engine Oil
Engine Controls
Engine Accessory Gearbox

ATA 32
Landing Gear

Non ATA related
Aircraft Loads
Cabin Comfort & Exterior Noise
Aircraft Energy/Thermal (VIA)
Aircraft Integration Testing (VIB)
Structural Dynamics

LMS solutions for the next-generation aircraft

- structural pre-sizing & certification
- noise & vibration
- structural dynamics
- acoustics
- virtual testing
- system design & optimization
- structural & failure analysis
- composites optimization
- kinematics, dynamics & loads
- power management
- engine modeling
- rotor dynamics
- thermal & mechanisms analysis
- virtual integrated aircraft
- virtual iron bird
- ground vibration testing

Join us at the **2012 LMS Aerospace conference**
October 4-5 - Toulouse, France

LMS®
ENGINEERING INNOVATION

More information on **www.lmsintl.com**