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JUNE 2009

AEROSPACE TESTING INTERNATIONAL

Crossed wires

The use of cheap wiring in aircraft has been widely criticized. One expert gives his timely verdict

The X-factor

The X-51 WaveRider prepares to go to Mach 6 across the Pacific

Sun king

ANDRÉ BORSCHBERG DISCUSSES FLYING AT NIGHT – USING SOLAR POWER

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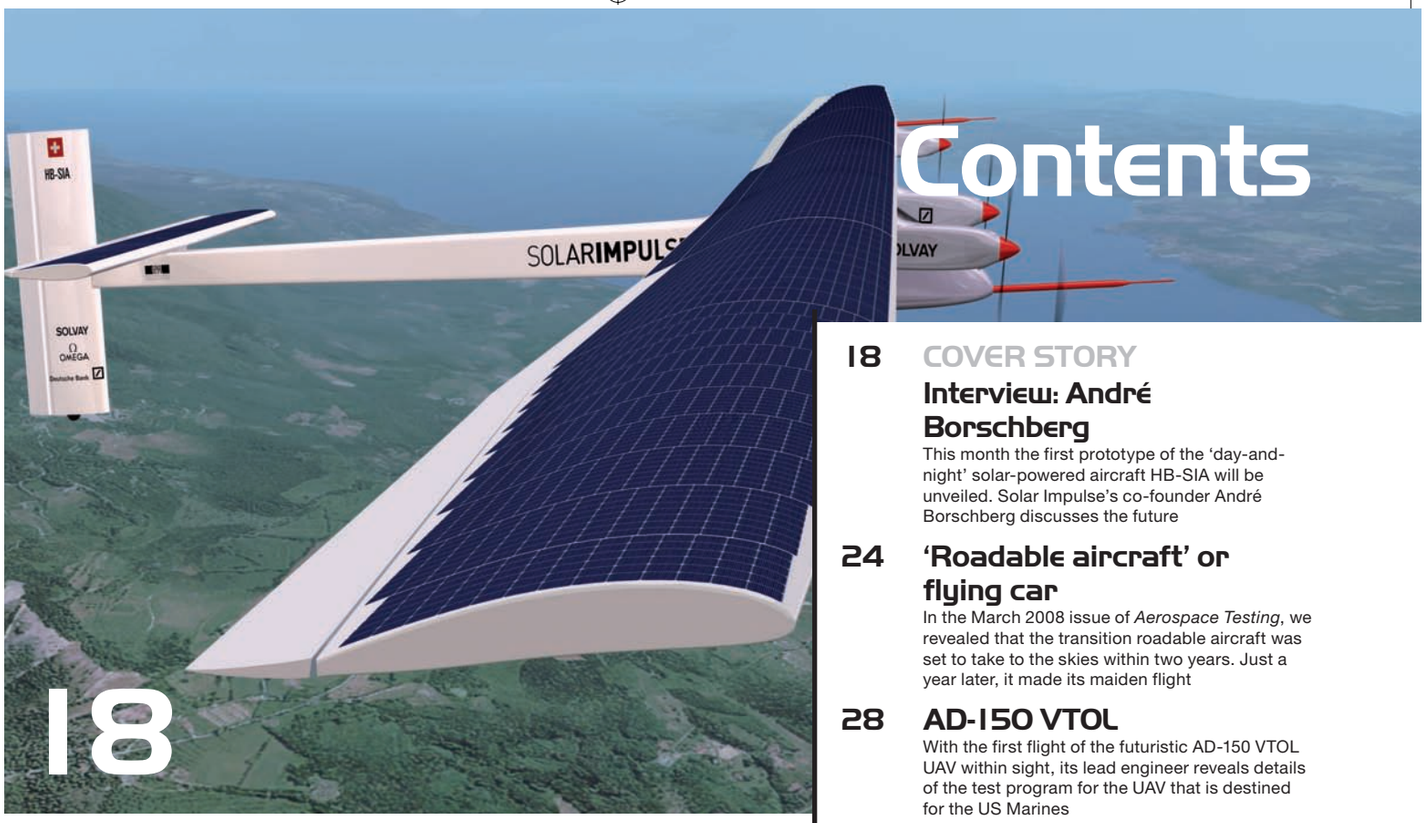

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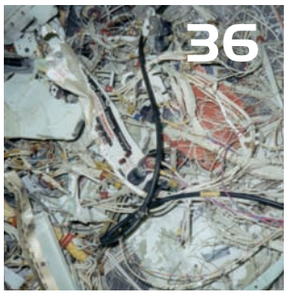

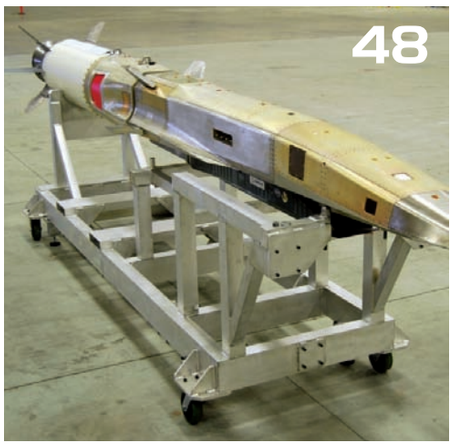

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75 YEARS

It was only in the last issue of *Aerospace Testing International* that I wrote about a recent air crash. The US Airways A320 that ditched in New York's Hudson River prompted a vitriolic response from some Boeing pilots, who ranted about whether Airbus aircraft are technically flawed. Whatever theories people have about the incident, it is a courageous tale of a captain who glided the plane to safety, ensuring that all who flew survived.

The disappearance of Air France 447, meanwhile, is shrouded in an air of mystery that sets it apart from other airplane disasters. Nearly all air crashes take place around the time of take-off or landing. But the Airbus 330 came down four hours out of Rio de Janeiro, over the Atlantic Ocean, on the edge of a tropical storm. There was no distress signal; it just disappeared off the radar.

There has been an enormous amount of press speculation about the cause of the crash, and by the time you read this, even more 'experts' will have thrown their speculation into the maelstrom. The conjuring up of theories is rife and I really don't want to buy a first-class ticket onto the bandwagon, but… In this issue there is a feature on wire failure (*p36*), the ensuing hazards, and a direct link to the crash of TWA 800 in 1995. At this point, and I am saying this very tentatively, there *could* be a correlation between the theory of lightning, stalls, weak wiring, and computer failure. (So here I am bandwagon ticket in hand…)

There has been so much debate, covering topics from terrorists to icing updrafts, that it would be stupid to list all the theories about the cause. So I got in touch with a very experienced pilot who was not keen to join me on the wagon, but did say he would forward a comment about the crash from a friend-of-a-friend, a very experienced Airbus pilot from Cathay and Virgin. This is what he said (it's interesting, and sounds realistic; I have taken out the suggestion that the captain was not even in the cockpit): "The aircraft (an A330) has five computers that handle the operation of the aircraft, with No 1 computer designated as the controlling entity for the other four. If No 1 fails, the controlling task is passed to No 2 and the aircraft remains fully functional. If Nos 1 and 2 fail, No 3 takes over and starts load shedding (by that I mean that the aircraft flight functions start to be downgraded). The aircraft can still be flown with only one computer, but the functions are greatly reduced so you have to know what you are doing. The big fear of course is that you get a cascade failure of the entire computer system – and then you have problems. The aircraft can be controlled, just, with rudders (mechanical linkage), I think possibly tail plane trim, but I am hazy now, and I have a strong feeling one needs the engines to give pitch control.

"During flight testing, in perfect conditions, the chief test pilot did an approach and landing with all five computers turned off but with a bunch of guys with fingers poised over the 'ON' buttons. During training in the simulator, captains had to display an ability to keep the aircraft in some form of flight with all computers off while the co-pilot rebooted the computers one by one. From experience I can tell you it is difficult enough in smooth conditions. In the middle of a thunderstorm or any heavy turbulence I would categorically say that it would be practically impossible. From what little I have read, if all five computers went into meltdown, the pilot would be stuffed, with basic standby flight instruments only and a marginally controllable aircraft in the worst possible flight conditions. If any pilot was faced with this scenario I genuinely think total loss of control would happen exceedingly quickly.

"My only conjecture is that the aircraft computers were working overtime controlling the aircraft in extreme conditions, one failed and they went into cascade failure mode and the pilot lost control to such an extent that it fell out of the sky and broke up. Toulouse desperately needs that flight recorder; the last thing anyone wants is an inexplicable incident."

Several days after the crash, I got in touch with Edward B. Block, who wrote the wiring article in the issue. He said, "The scenario that brought down Air France Flight 447 fits exactly with that of faulty wiring. There have been instances lately related to Qantas aircraft, when the aircraft suddenly plunged without warning. And this is the exact scenario described on the F-14s that had picked up spurious signals from cracks in the wiring insulation. If turbulence shook the wire bundles, causing a pre-weakened spot in the insulation to break, this would lead to a 10,000°C arc-tracking event as happened three times on the Space Shuttle Columbia. If a lightning bolt with millions of amps was sent along the outside skin to be exited at the tail or wing tips, and it came upon a pre-existing crack in the wiring insulation, it would be like a hemorrhage in an artery." The speculation bandwagon rolls on…

Christopher Hounsfield, editor

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THE DREAM GOES ON

Boeing has claimed that steady progress toward the first flight of the 787 Dreamliner is being made, after the first engine runs were carried out. This is the first all-electric start of an engine on a twin-aisle commercial jetliner (they had been started electronically in test facilities earlier). The runs lasted 40 minutes. Initially, the engines were started and operated at various power settings to ensure all systems performed as expected. The test began with the auxiliary power system providing power to start the two Rolls-Royce Trent 1000 engines. The team completed a vibration check and monitored the shutdown logic to ensure it functioned as expected. "We were very pleased with the performance of the engines during this test," said Scott Fancher, vice president the 787 program.

HELICOPTER GROUNDED

The US Navy has announced that it will terminate the VH-71 System Development and Demonstration program contract. The announcement follows a Department of Defense decision to cancel the existing presidential helicopter replacement program. The VH-71 was intended to replace both the VH-3D and VH-60N aircraft currently used to conduct presidential support missions.

Government gets spending

BY TIM RIPLEY

The UK government announced in March that it is to spend some £600 million (US$992 million) on three operational test and evaluation (OT&E) Lockheed Martin F-35B Lightning aircraft. This opens the way for the UK to participate as a major partner in the next stage of the Joint Strike Fighter (JSF) test program, but will also see the Ministry of Defence (MoD) buy the most expensive aircraft ever ordered by the UK, at some £200 million (US$331 million) for each OT&E JSF.

For several months the UK's participation in the operational test and evaluation phase of the JSF project was under intense scrutiny because of the huge price tag attached to it. Last year Italy decided to forego participation in this phase of the JSF program and opt just to buy production aircraft later in the next decade to meet its needs.

"The knowledge gained from the initial operational test and evaluation program on the three JSF purchased by the UK MoD will be fundamental for us to fully understand the aircraft in areas such as operational and technical capability," said a spokesperson for the Ministry. "We will make a decision about the further purchase of the JSF when the evaluation of the OT&E has been completed. Two of the JSF OT&E aircraft will be delivered in 2011 and one in 2012."

UK Defence Secretary John Hutton added, "The Joint Strike Fighter will form an essential part of our future air combat capability. By purchasing three aircraft for testing, we will secure access to the development of the program. Working alongside their US colleagues, our pilots will gain an unrivaled understanding of this awesome aircraft and its capabilities. This is a vital program for UK defense for the military and for industry, with over 100 UK companies involved."

> **"We will make a decision about the further purchase of the JSF when the evaluation of the OT&E has been completed"**

JDAM armed Reaper

2 US Air Force plans to transform its General Atomics MQ-9 Reaper unmanned aerial vehicles (UAVs) into all-weather strike platforms by integrating GPS satellite guided weapons will come to fruition this year, according to senior USAF officers.

Colonel John Montgomery, vice commander of the USAF's 432nd Wing, told *Aerospace Testing International* that the service was "moving quickly" to add the 500 lb Boeing GBU-38 Joint Direct Attack Munition (JDAM) to weapons available for use on the Reaper. Efforts are then expected to switch to integrating the GBU-39 small diameter bomb and then the Lockheed Martin GBU-49 Dual Mode Paveway II weapon.

In March the USAF Material Command announced the successful completion of a series of JDAM test drops at the China Lake bombing range in California. According to Colonel Chris Coombs, the 703rd Aeronautical Systems' group commander, a Reaper achieved nine hits from nine JDAM drops.

"Putting the JDAM on the Reaper greatly increases its lethality on the battlefield," he said. The full certification process to clear the weapon for use by USAF and UK Reaper units is expected by July 2009, said Coombs. Currently the Reaper is only cleared to employ laser-guided GBU-12 500 lb bombs and Lockheed Martin AGM-114P Hellfire missiles.

US and British officers involved in Reaper operations over Iraq and Afghanistan say bad winter weather, particularly over Afghanistan, hinders the ability of Reapers to employ weapons using optical sensors and laser designation. With satellite-guided weapons, UAV operators say they will be able to find targets in bad weather using the Reaper's General Atomics Lynx synthetic aperture radar (SAR) and then attack them with JDAMs.

PART AND PARCEL

The US Air Force (USAF) has awarded Rolls-Royce a contract worth US$80 million to provide AE 2100D3 spare engines and parts to power Lockheed Martin C-130J military transport aircraft for the USAF, US Marine Corps, the Royal Norwegian Air Force, and the Indian Air Force.

Dennis Jarvi, president of defense, North America, for Rolls-Royce, said, "Rolls-Royce is proud of its long-standing relationship with the Air Force and Marine Corps customers, and is pleased that they continue to demonstrate their confidence in the AE 2100D3 engine. The C-130J has earned an international reputation as a valuable, multirole transport aircraft, and Rolls-Royce is committed to doing its part to ensure these aircraft are ready to carry out critical missions whenever and wherever they are needed." The AE 2100D3 engine is a lightweight, modular turboprop engine with 4,600 shaft-horsepower. The 'common core' AE engine line is produced by Rolls-Royce and manufactured in Indianapolis, Indiana.

HOSE JOB

The Airbus Military A330 MRTT (multirole tanker transport) has successfully performed a series of dry contacts using the new-generation Cobham 905E hose and drogue refueling pods, which are located under the wings. The receiver aircraft for the milestone test was a Spanish Air Force F/A-18A fighter.

According to Airbus, the system performed well in hose extension and retraction, and showed good hose response in the contact as well as stability during pre-contact and when connected. This new refueling pod is a development of the 907E already in service with the Canadian and German air forces on their A310 MRTTs.

SPECIAL DELIVERY

AEW Aircraft No 1, EI, has successfully passed tests with an MSA system and has performed its ferry flight from Israel to Mumbai, India. The aircraft was eventually delivered to the end user.

The conclusion of the tests has led the Indian customer to review the possibility of ordering additional aircraft. Beriev Aircraft Company is a prime contractor for the works performance on the aircraft, re-engining with the new PS 90 76 engines, and fitting out the equipment. The EI AEW Aircraft was produced under a contract awarded by Russia's Federal State Unitary Enterprise, Rosoboronexport. Beriev Aircraft Company is continuing to work under this contract.

UK cuts R&D funding

3 UK aerospace industry chiefs are protesting at government cuts to defense and aerospace R&D. Some 7% is to be cut from the Ministry of Defence's research and technology budget, and civilian research funding is to be frozen. The ministry's research and technology budget has decreased by 7% already in 2009. It stood at £540 million (US$888 million) in 2007/8 and £502 million (US$825 million) in 2008/9.

In April the Society of British Aerospace Companies (SBAC), the UK's aerospace, defense, and security trade association, warned the government that the decline in research and technology funding for defense will harm the armed forces' ability to carry out their roles in the future, and would be a signal to the industry of the government's declining commitment to maintaining highly skilled research in this country. Ian Godden, SBAC chief executive, said, "Chancellor Alistair Darling and the Treasury have to be made aware that the Ministry of Defence's research and technology budget should be boosted, not cut, to maintain our armed forces' capability and our industrial base. We look to this Budget to correct the recent drop in this vital area. In the context of government spending, it is a very small amount, but it delivers crucial funding with which industry can innovate and deliver for our military.

"The defense industry is ready to continue its joint commitment to invest in research and technology but needs the signal that government is not cutting its own commitment to early-stage funding, otherwise industry will have to follow suit."

Alternative fuel

4 Airlines may soon be setting up their own production facilities to make alternative green fuels after the refining industry appeared to be unable to fund the setting-up infrastructure to manufacture it.

Executives of the USA's United Airlines want to open talks with other airlines to setup a plant to make gas-to-liquid synthetic fuel. The airline plans to begin using green fuel in August 2009, if international certification is achieved. It has teamed up with synthetic fuel manufacturer Remtech to trial the fuel on a Airbus A320 later in the year.

This follows moves by Qatar Airways to test synthetic fuel on A340-600s flying between London and Doha. It is cooperating with Qatar Petroleum, Woqod, and Shell International on the project. The Middle Eastern airline wants to look at biomass-to-liquid kerosene technology.

Bizjet crashes surge

5 Poor aircrew training has been identified as a major cause for the number of accidents involving business jets. The fatal accident rate of business jets is 10 times higher than that of large passenger jets.

The statistics produced by the UK Civil Aviation Authority (CAA) paint a woeful picture of the state of safety in the business jet sector. The worst statistics are for air taxi operators, at 3.49 fatal accidents per million flight hours in the period 2000-2007. The CAA says that business jets are contributing a 'disproportionate' number of fatal air accidents. Corporate jets were much better for the same period at a rate of only 0.24, and western commercial airlines have a rate of 0.15. Owner-operated business jets had a 1.28 fatal accidents per million flight hours.

The data identified that one-third of fatal accidents occurred on ferrying and positioning flights and that 31% of accidents involved variants of the Learjet family of aircraft, from only 15% of hours flown.

Human error is identified as a major factor in these accidents, and the report recommends a raft of initiatives to improve pilot training. It says there should be more simulator training and this needs to be focused on 'whole task' training, not just flight-deck skills.

FIRE AND WATER

The MQ-8B Fire Scout VTUAV (vertical take-off and landing tactical unmanned aerial vehicle) has successfully completed its latest set of fully autonomous flight operations on board the USS McInerney (FFG-8) in support of dynamic interface testing. This was a critical step for the US Navy MQ-8B Fire Scout ahead of its operational evaluation, scheduled for later in the year.

ADVANCED COMPOSITE FIRST

Lockheed Martin and the Air Force Research Lab (AFRL) successfully conducted the initial demonstration flight of the Advanced Composite Cargo Aircraft (ACCA). The flight marked the final and most significant milestone of Phase II of AFRL's ACCA program, in which Lockheed Martin replaced the mid/aft fuselage and empennage of a Dornier 328J aircraft with an advanced composite structure.

"Yesterday was one of those perfect days where I get to be the first to fly a new aircraft and everything goes as planned. The aircraft was a real pleasure to fly and we experienced no issues," said Rob Rowe, Lockheed Martin test pilot.

ACCA took off to the east from USAF Plant, the aircraft climbed to an altitude of 10,000ft where the crew took the vehicle through a series of airspeed and stability and control tests. The tests were important to understand how the cargo aircraft performed at varying speeds, attitudes, and altitudes.

The road to this first flight started over a decade ago with industry and government laboratories collaborating in the AFRL-led Composites Affordability Initiative (CAI)

IN FROM THE COLD

The Sukhoi Superjet 100 S/N 95001 has returned from Arkhangelsk after the successful completion of natural icing tests. The aircraft was sent to the city in northern Russia in April 2009 and performed five 'ice' flights over the White Sea between Arkhangelsk and Murmansk. According to Sukhoi, natural icing tests challenge both active anti-icing protection and the passive ability of the aircraft to resist handling deterioration caused by icing. The anti-icing system heats the front edge of the wing, engine inlets, and receivers on the aircraft surface, and de-ices the windscreen. In case of failure of an anti-icing system, passive protection becomes crucial as it affects the aircraft's ability to retain good characteristics despite wing and empennage icing.

Green commercial airliner finds customer

6 Canadian aerospace company Bombardier Aerospace has at last found a launch for its CSeries 'green' airliner, defying skeptics who thought the global economic crisis would scupper the new product.

Deutsche Lufthansa AG signed a firm purchase agreement for 30 CSeries model CS100 (formerly C110) single-aisle aircraft earlier this year, becoming the first firm customer for the world's first 'green' commercial aircraft.

These aircraft will be operated by Lufthansa's subsidiary Swiss International Air Lines Ltd. The agreement also includes options on an additional 30 CSeries aircraft. Based on list price, the contract value for the 30 CS100 aircraft is approximately US$1.53 billion.

Bombardier Aerospace has also announced the launch of new model designations for its CSeries family of aircraft. The 110-seat configuration (previously known as the C110 aircraft) will be designated the CSeries model CS100 aircraft, and the 130-seat configuration (formerly the C130 aircraft) will be designated the CSeries model CS300 aircraft.

At time of entry into service in 2013, the CSeries family of aircraft will be the greenest single-aisle aircraft in its class, said the company. These aircraft will emit 20% less CO_2 and 50% less NOx, fly four times more quietly, and deliver dramatic energy savings. These include a 20% fuel-burn advantage as well as 15% improved cash operating costs versus current in-production aircraft of similar size. The CSeries aircraft will set a new benchmark in the industry, consuming as little as two liters of fuel per passenger per 100km in its more dense seating layouts.

In addition to Bombardier's fourth-generation transonic composite wing design, the company is also using its reconfigurable engineering flight simulator (REFS II) to develop customized 'fly-by-wire' control laws specific to CSeries aircraft.

Boeing tackles Chinook quality control crisis

Boeing hopes drastic action to improve quality control at its Philadelphia helicopter plant has stemmed an emerging crisis of confidence in its prime customer – the Pentagon. In 2008, the factory, which assembles CH-47F Chinook helicopters and V-22 Osprey tilt rotors, was hit by a spate of sabotages by disgruntled workers and also endured manufacturing problems.

In January this year, a worker on the Chinook line was jailed for five months for damaging one of the aircraft. Another act of sabotage remains unsolved. This disaster was followed by a run of tools being left inside helicopters and parts being fitted incorrectly.

To crack the problem, Boeing organized a Saturday morning meeting of 200 managers, who were asked to come up with new ideas. The main thrust of their responses was that the employees and managers in the factory were not following rigorous quality control processes for foreign object debris and tool control. This involved rigorous discipline among workers over the tools they use, and how they are accounted for at the end of work periods.

This resulted in the implementation of a series of improvements, which Boeing ran by its customers at the Pentagon. These seem to have done the trick – Boeing has won new orders for Chinooks worth US$4.3 billion. The whole episode shows that there is little room for complacency among aerospace manufacturers. The Chinook line at Philadelphia was one of the most well-established aircraft assembly facilities in the USA, so it was a great surprise when the problems emerged.

ALL HALE

Northrop Grumman has completed initial testing of its Multi-Platform Radar Technology Insertion Program (MP-RTIP) sensor. All dedicated mode flights have been carried out in the Radar System Level Performance Verification program, verifying system performance of the Synthetic Aperture Radar and Ground Moving Target Indicator modes.

The new sensor is slated for the RQ-4 Block 40 Global Hawk HALE UAS (high-altitude long-endurance unmanned aircraft system). Assembly of the first Block 40 aircraft, AF-18, is complete and ready for the US Air Force to begin flight testing.

"This is a major milestone for the MP-RTIP program," said

Duke Dufresne, vice president and general manager of the company's strike and surveillance systems division. "We are ready to deliver the first Global Hawk airframe for flight test, and can quickly follow up with sensor integration for operational test and evaluation. Delivering this capability to our men and women in uniform will be a game changer in the ability to detect and track adversaries on the battlefield."

TOP PRIORITY

A team at Arnold Engineering Development Center's National Full-Scale Aerodynamics Complex at Moffett Field, California, recently concluded high-power, top-priority testing on a full-scale four-bladed UH-60 Blackhawk rotor system.

The primary purpose of the testing in the facility's 40ft x 80ft wind tunnel was to evaluate an individual blade control (IBC) system for its ability to reduce noise and vibration, and to improve the performance of the rotor system.

The Black Hawk, manufactured by Sikorsky Aircraft, is the Army's twin-engine and medium-lift utility helicopter used for air assault, air cavalry, and aero medical evacuation units.

"This was the culmination of a collaborative wind tunnel test program between NASA, the US Army, Sikorsky Aircraft, and ZF Luftfahrttechnik GmbH (ZFL) to demonstrate the benefits of IBC for a UH-60 rotor," said Tom Norman, a project engineer with NASA Ames. "All major test objectives were met, allowing for the evaluation of IBC effects on power, noise, vibration, loads, and flight characteristics. In addition, the ability of the IBC technology to provide inflight tuning and reconfiguration was demonstrated."

GUIDING FLIGHT

Elbit Systems and Alliant Techsystems (ATK) have announced that they have successfully conducted flight tests of the Guided Advanced Tactical Rocket (GATR). In a recent demonstration conducted in Israel, GATR was deployed from a helicopter using a 'lock-on before launch' method to engage an off-boresight target at a range of approximately 3km.

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The US Navy established a dedicated rotary wing test unit on April 29, 1949. Frank Colucci visits its modern day descendant and looks at the range of helicopter and tilt rotor test programs underway at HX-21

Navy center HX-21

Sixty years after a Rotary Wing Section formed within the flight test division of what was then the US Naval Air Test Center, the same hangars are full of Navy and Marine Corps rotorcraft. Air Test and Evaluation Squadron Two One – HX-21 – today performs airworthiness testing and evaluates new systems on helicopters, tilt rotors, and small unmanned aircraft at Naval Air Weapons Center Patuxent River, Maryland, and elsewhere. The paying test customers are Program Management Activities (PMAs) running acquisition programs in the Naval Air Systems Command (NAVAIR). According to HX-21 commanding officer Navy Captain Steven Halpern, "By virtue of our mission, we are sometimes misrepresented as always bringing bad news to the Program Managers. Regardless of whether the test results are good or bad, I assure the Program Managers that I support that they will always get an honest, accurate, and technically sound answer from HX-21 pilots and engineers."

The busy developmental test squadron currently has 30 active military and five Wyle contractor test pilots in an organization of about 600 people. Included in the total are government civilian engineers, DynCorp contract maintainers, and a mix of military and civilian support personnel. About three quarters of the military personnel at HX-21 are Marines. Strength is augmented with pilots and support representatives from Bell, Boeing, Lockheed Martin, Sikorsky and other contractors.

As part of the Navy Test Wing Atlantic, HX-21 has 169 active test plans including new developments such as the VH-71 Presidential helicopter replacement and new systems for rotorcraft long in the fleet. The venerable Marine CH-53D, for example, is being upgraded with more powerful T64-GE-416 engines. The even more venerable CH-46E is flying with large aircraft infrared countermeasures/directed infrared countermeasures (LAIRCM/DIRCM). HX-21 technical director Joseph Carbonaro explains, "The life-cycle support testing is really where the bulk of our work is."

Current year plans budget 1,920 billable project flying hours for PMAs, plus maintenance and other flying. Much of the work is driven by the former 'global war on terror'. "Many of these projects are short-fused with varying levels of aircraft integration," notes Halpern. "Typically, we are able to execute associated testing quickly." LAIRCM/DIRCM, for example, was tested and fielded on the Marine CH-53E just three months after a formal requirement.

Other projects integrate new capabilities on evolving aircraft. The MH-60R only recently deployed with its first carrier battle group, and HX-21 is now testing periscope detection radar on the newest Seahawk. "It's probably the most complicated helicopter weapons system on the planet," observes Carbonaro. He adds, "These are flying avionics busses. A big part of our job is systems testing, and that means software testing."

The Navy MH-60R packs advanced anti-submarine warfare, anti-surface warfare, and surface strike capability in a single helicopter. HX-21 is currently testing periscope-locating modes for the MH-60R radar

HX-21 also oversees Integrated Test Teams (ITTs) that pool developmental, operational, and contractor testers on new programs such as the Marine CH-53K Heavy Lift Replacement helicopter due to fly in 2012. "Over the past years, integrated test was little more than a buzz word with various definitions depending on the program," observes Halpern. "As both industry and government begin to define and realize the benefits, the expectation is that Integrated Test will be the standard."

HX-21 is now developing processes and procedures for a self-sufficient CH-53K ITT including HX-21 pilots and engineers. ITTs report to their NAVAIR Program Managers, but according to Carbonaro, "We help manage the risk and conduct the test program safely without breaking things."

Unlike operational testers, HX-21 flies developmental testing with only trained, board-selected test pilots and engineers. Graduates from the Naval Test Pilot School at Patuxent River are taught both how to collect data repeatedly and how to relate test data to real-world missions. Halpern observes, "A major contribution to the development and the acquisition process as a whole is a test pilot/engineer's ability to make the leap from flight test data to mission-relation."

Insights from HX-21 test pilots and engineers help classify deficiencies and

“Many of these projects are short-fused with varying levels of aircraft integration”

Operational testing of the Marine MV-22 Osprey was performed by squadron VMX-22, but HX-21 continues developmental work on tilt rotor systems and flying characteristics

show program managers the maturity of their systems and how they comply with specifications. Carbonaro says, "We provide information to the PMAs . . . to make sure the systems they're paying for perform as expected."

If it's in the fleet...

The HX-21 test fleet includes nearly all the helicopter and tilt rotor sub-types in the Navy and Marine Corps inventory, four MH-60R and four MH-60S Navy Seahawks; two AH-1Z and two AH-1W Marine Cobras; a new UH-1Y Marine Huey; four MV-22 Marine Ospreys; one CH-53E Marine Super Stallion, one CH-53D Sea Stallion, and a Navy MH-53E Sea Dragon. A CH-46E put HX-21 back in the Marine Phrog business for LAIRCM/DIRCM tests and will receive infrared engine exhaust suppressors and the Blue Force Tracker in upcoming tests. Navy SH-60Bs, -60Fs, and -60Hs are borrowed from fleet squadrons as needed for tests on legacy Seahawks.

HX-21 test work is as varied as the test fleet. The multi-mission MH-60R and MH-60S Seahawks, for example are testing the integrated mechanical diagnostic system, joint mission planning system, LINK 16 datalink, and single channel ground and airborne radio system. The MH-60S will fly with Airborne Mine Neutralization System (AMNS), Airborne Laser Mine Detection System (ALMDS), Downed Aircrew Locator System (DALS), and rockets for armed helo missions. According to Carbonaro, "It's the Swiss Army knife of helicopters. It does everything and does it well, too." HX-21 testers flew H-60 Airborne Mine Countermeasures tests at Panama City, Florida and made Hellfire missile shots were made at Eglin Air Force Base. "Our teams go all over the place."

New AH-1Z attack and UH-1Y utility helicopters will revitalize Marine Corps light attack helicopter squadrons. The UH-1Y achieved initial operational capability last year and is now deployed for the first time with a Marine expeditionary unit. The AH-1Z is due to achieve initial operational capability in 2011 and should go to sea shortly thereafter. HX-21 crews solved rocket gas ingestion problems with the AH-1Z. They are currently evaluated a mast-mounted satellite communications antenna on the UH-1Y.

> **"It's the Swiss Army knife of helicopters. It does everything and does it well too"**

With the VH-71 program marked for cancellation by the Secretary of Defense, today's Presidential helicopter fleet is marked for improvements. HX-21 has an NSH-60F Seahawk and a Nixon-era NVH-3A Sea King test software and hardware to test VH-60N and VH-3D Presidential helicopter cockpit upgrades. The cabled and shielded testbeds can fly without the security and scheduling complications surrounding actual Presidential aircraft (The VH-71 ITT keeps its test aircraft in a separate, secure Presidential Helicopter Support Facility). The Presidential lift improvement program also includes new composite main rotor blades for the VH-3D to be test-flown by Sikorsky, and more powerful T700-GE-401C engines for the VH-60N.

HX-21 also flies two TH-57Cs for night vision goggle proficiency and other training, and it hosts the last UH-3H res-

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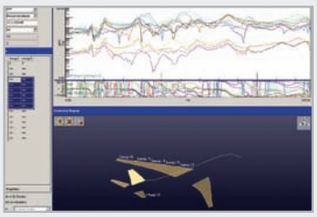

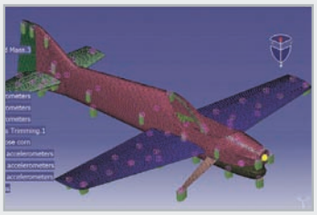

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cue Sea Kings in the Navy. "We're kind of busting at the seams here," acknowledges Carbonaro. CH-53K work will be housed in another hangar, and Fire Scout Unmanned Air Vehicles fly at the Webster Field Annex southwest of Patuxent River Naval Air Station. HX-21 plans call for modernized facilities. "Our goal is to get all the helicopters closer together," notes Carbonaro.

Test on the ranges

Elsewhere, HX-21 has four of the five flyable V-22 tilt rotors at Patuxent River, including a fully instrumented engineering and manufacturing development aircraft. Tilt rotor lift improvement test plans look to evaluate opposed lateral cyclic and new flap settings for high altitude operations in Afghanistan. The Navy rotary-wing test squadron also supports development of the Air Force CV-22 Special Operations tilt rotor and visiting helicopter programs.

Instrumented V-22 tests over the Atlantic Test Range will telemeter critical parameters to the ground. HX-21 is organized like most Navy squadrons, but it includes a project liaison team to install test equipment and instrumentation. A separate NAVAIR Air Vehicle Modification and Instrumentation group designs, integrates, and maintains flight-test instrumentation and data acquisition equipment. "We try to keep it standardized," explains Carbonaro. HX-21 uses a portable airborne instrumentation station to tap into MIL-STD 1553 aircraft busses, and telemetry adheres to Inter-Range Instrumentation Group (IRIG) standards. "You can take a telemetry system off a Navy aircraft and fly it at Edwards Air Force Base," notes Carbonaro.

HX-21 has responsibility for the Fire Scout unmanned helicopter planned to go aboard Littoral Combat Ships and conducted landing tests with the UAV Common Autonomous Recovery System (UCARS) on the frigate USS McInerney. Carbonaro admits, "A rotorcraft landing on deck is one heck of an engineering challenge." The demonstration ship sailed into Chesapeake Bay in March for a new test series cut short by software issues. Future launch and recovery trials will be conducted off Mayport, Florida where the UAV can divert to shore readily. The Fire Scout Integrated Test Team includes three engineers from HX-21 and is currently integrating payloads on the improved MQ-8B Fire Scout. Three MQ-8B and two RQ-8A Navy Fire Scout Unmanned Air Vehicles (UAVs) are kept by the maritime UAV office at the Webster Field Annex to the North of Patuxent River Naval Air Station.

> **"HX-21 has four of the five flyable V-22 tilt rotors at Patuxent River"**

HX-21 also has responsibility for the fixed-wing RQ-7 Shadow UAS bought by the Marines, and other small unmanned aircraft. (The big Global Hawk, part of the Broad Area Maritime Surveillance system, is tested by fixed-wing squadron VX-23.)

The Naval Air Systems Command last year established a Naval Aviation Center for Rotorcraft Advancement to focus the naval helicopter/tilt rotor vision and access more Research Development Test and Evaluation (RDT&E) funding. The process is beginning with an inventory of US rotary wing resources including laboratories, test facilities, and other infrastructure. HX-21 is a key test asset available to a naval aviation community of growing capability and importance. ▮

HX-21 Armed Helo tests combined with other MH-60S and Hellfire mission packages

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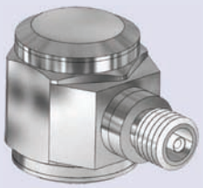

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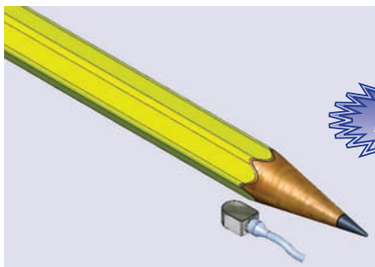

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Fly-by-night idea?

IN JUNE 2009 THE FIRST PROTOTYPE OF THE 'DAY-AND-NIGHT' SOLAR-POWERED AIRCRAFT HB-SIA WILL BE UNVEILED. COULD IT MARK THE BEGINNING OF A NEW AGE IN FLYING WITHOUT FUEL? CO-FOUNDER ANDRÉ BORSCHBERG EXPLAINS THE TECHNICALITIES

BY CHRISTOPHER HOUNSFIELD

It will be on 26 June 2009 at Dübendorg Airfield near Zurich in Switzerland that the official unveiling ceremony of the Solar Impulse HB-SIA will take place. The machine will have a wingspan of 64m, wider than an A340, but will weigh just 1,500kg, lighter than a small glider. Its aim: to verify the working hypotheses of solar-powered flying and to validate the selected construction technologies and procedures. If the results are conclusive, it will make a 36-hour flight, the equivalent of a complete day-night-day cycle, in 2009 without any fuel.

The concept was raised exactly 10 years ago, when Piccard completed the first non-stop circumnavigation of the earth in a balloon, Orbiter 3, and he realized he had burnt and released four tons of propane fuel into the atmosphere. He wanted to do the same again in a craft that was powered by renewable energy.

That was a decade ago, and in those years a team of more than 50 specialists from six countries, based in Switzerland, assisted by a further 100 outside advisers have finally completed construction of the first prototype. Heading up these experts are a duo. Bertrand Piccard and André Borschberg. Piccard is the more famous visionary who conceived the project, but it is Borschberg who is the man pulling the strings, running the operation and managing the project.

A graduate of the EPFL (Ecole Polytechnique Fédérale de Lausanne) in mechanical engineering and of the MIT (Massachusetts Institute of Technology) in management sciences, Borschberg has an impressive entrepreneurial background of founding companies, and is now CEO and pilot of Solar Impulse. *Aerospace Testing International* caught up with him at the airfield to discuss the June launch. "It's going to be special because of the unveiling of our first prototype airplane with 64m wing span. We have found a solution on how to build, design and construct an airplane within our weight budget which is of 1.6 tonnes or about 1,600kg and so it was that trend forward that we could find a structure and the design which meets these aerodynamic requirements. This is why it has taken five years to develop.

"The big difference now is with it's performance. Performance can be measured simply

with a very low sink rate. If you have a low sink rate and a light airplane, the energy consumption becomes very low and this energy consumption, in relation to the amount of batteries we have on board, allow us to fly through the night. A longer wingspan allows the improvement of its aerodynamic efficiency by reducing the induced drag. This produces a weaker airplane sink-rate and thus reduces the power of the motors required to maintain it in a horizontal position. The second advantage of a large wingspan is the benefit from a greater surface on which to place the solar cells. So that's this equation, which makes it new, and to have the performance we understood that we needed the big wing span of 60m minimum and now we will have 64m," explains Borschberg.

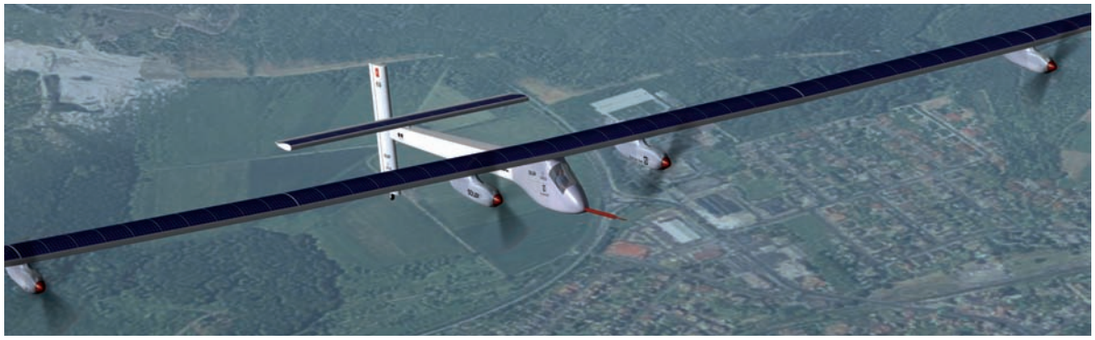
"A longer wingspan allows the improvement of its aerodynamic efficiency by reducing the induced drag"

The project recently passed through two important test phases. Back in December 2008 the Göttingen Aeroelasticity Institute (DLR) spent a week carrying out vibration testing. The tests were aimed at assessing the risk of resonance, by defining the aircraft's specific frequencies and verifying by physical experimentation the correspondence between the model calculated by the engineers and the aircraft's real technical characteristics.

For this, the fuselage, the wingspar and the front and side stabilizers of aircraft were assembled for the first time. Using electrodynamic 'excentrics' fixed at different points, the DLR's experts set the aircraft vibrating and measured the repercussions with 71 sensors placed along the spar, the fuselage, the tailboom and the

Solar power

- Shell Oil predicts that 50% of the world's energy will come from renewable sources by 2040
- Sunlight travels to the earth in approximately eight minutes from 93,000,000 miles away, at 186,282 miles per second
- Sunlight is composed of photons, or particles of solar energy. These photons contain various amounts of energy corresponding to the different wavelengths of the solar spectrum. When photons strike a photovoltaic cell, they may be reflected, pass right through, or be absorbed. Only the absorbed photons provide energy to generate electricity
- The Earth is about 13,000km (8,000 miles) wide, whereas the Sun is roughly 1.4 million kilometers (900,000 miles) across
- The middle of the Sun is at least 14 million °C.
- The Sun contains approximately 98% of the total solar system mass. Its interior could hold over 1.3 million Earths
- The Sun has been active for 4.6 billion years and has enough fuel to go on for another five billion years. At the end of its life, the Sun will start to fuse helium into heavier elements and begin to swell up, ultimately growing so large that it will swallow the Earth.



André Borschberg is a member of such notable associations as the prestigious Young Presidents' Organization and the Organisation of Chief Executives

engine and battery supports. In all they tested around a hundred vibration modes at frequencies varying from 8 to 20Hz.

At the time the test results revealed a few, but minimal differences, with the computer model the engineers had developed. The elasticity modulus turned out to be slightly less high than planned for the structure of the whole.

In mid-February a series of more robust tests put the wingspar through its paces. These directly tested its resistance to high charges, simulating situations like a combination of turbulence and extreme piloting maneuvers.

For these charge, flexion and torsion tests, the wingspar was fixed at its center, the only fixed point. On thirty or so platforms suspended from cables or winches and distributed along its entire length, lead weights were gradually added in order to define four standard conditions: 25% charge, 50%, 75% and finally 100% - equivalent to 3.5g, a charge factor analogous with that of civil aviation aircraft. In this final case, the deflection measured at the wing tips was 1.20m. 5.5 tonnes of lead in all were used.

What have been the most recent tests? "Each element, everything which is in this airplane is custom made, it has been optimized by itself, but also it has been optimized looking at the entire propulsion chain, so water, battery, solar cells, electronics together and so on and so we had some tough test bench so that we can test all that together to optimize it. Now we are testing all four engines together with all the equipment which goes into the airplane, so that's the final big check just before the integration into the aircraft.

This is tested also and you know temperatures in which this airplane will fly in, which is you know, up to -40°C and we tested also at low pressure because electrics also had to work in high altitude is much more pressure than the one bar we have here. So all these final tests have to be performed as well," Borschberg expands.

The pilots

Although, flight testing will be contracted to a professional test pilot, Borschberg and Piccard will be the pilots who share the day and night flying, and the arduous and eventual global circumnavigation. Borschberg trained as a pilot at the Swiss Air Force School, first of all on Venoms, then Hunters and Tigers, airplanes that he has piloted for more than 20 years.

The flying will be gruelling, for a start everything is at a minimum to save weight, so the instrument panel will be reduced to the essentials, and with a non-pressurized cockpit it will be unable to fly above 8,500m. It will be a first approach at optimizing the balance between energy consumption, weight, performance and controllability. "We have set up 8,500m as the maximum altitude at which it would climb, corresponding to this -40°C, which is always the standard temperature for components and so we use oxygen masks. We just have been testing all these different systems in the decompression chamber and so to see how we as pilots perform. Already I have been in this chamber. It is always good to remember how it is like when you are running out of oxygen because you don't have that much time to react and we wanted to see how our oxygen systems functioned also."

Casually Borschberg outlines the task ahead: "For the first airplane, the flight duration is not long, it will be flying 36 hours, it is still manageable for a pilot in one go. With the second airplane, we expect to fly with one pilot for each leg up to five days and five nights. We will go for what we call specialist sleep techniques, when you sleep for a very short period of time.

"We will also develop relaxation methods to improve alertness and reduce the amount of sleep we need, as well the way we are going to feed ourselves. It's not decided yet if we go for pressurised or non-pressurised cabin for the

> **"It is a technical adventure, and a personal adventure as a pilot. It will be amazing to fly for five days and five nights"**

second airplane. We have worked on the system so we have technologies available, but we will see which one is more suited. The pressurised cabin is heavier so it needs the performance of the airplane to be a bit bigger, therefore more difficult to handle and also the non-pressurised is lighter, needs a smaller airplane, and is easier to handle."

The dark hours

Every square metre of photovoltaic cells which cover the wing can only supply 28W, the equivalent of an electric light bulb, to the propeller continuously over a 24-hour period? As the company says: 'How can an airplane fly on the energy consumed by a supermarket window?' It is impossible without a complete optimization of the airplane and without a drastic reduction in its energy consumption.

The biggest problem has been the weight ratio, with the batteries taking up over a quarter of the entire weight, as Borschberg details: "The achievement of the weight has been difficult. We have created a structure which is quite complex to fly in the envelope that we have defined, and to achieve this weight budget has been hard. The wing loading is 8kg per square meter, which is extremely low when you have more than 400kg of batteries aboard this airplane as well. So this was a very, very big challenge, the second challenge I suppose is how to control such an airplane? When you have a low speed craft, you have low power flight controls available. A big wing span, a short fuselage, so how to control this? The flight controls of course, all these will be tested in the first flight so that we are told it will interfere."

At some point during the evening, while airborne, the sun will eventually dip below the western horizon and the valuable rays that power HB-SIA (it's registration mark) will disappear. How will the craft stay in the sky for hour after hour? "In two different ways. First of all, we 'store' it in altitude, which means we climb during the day using some power, I mean we climb higher and when we reach sunset, the first thing that we will do is very slowly fly down to a low altitude, with this airplane, it can be 1,500m or 2000m. So this is the time when we don't have to use the energy stored in the batteries and then when we reach this low altitude, then we start to use the energy in the batteries and hopefully, the batteries will be charged enough so that one can fly through the entire night," predicts Borschberg.

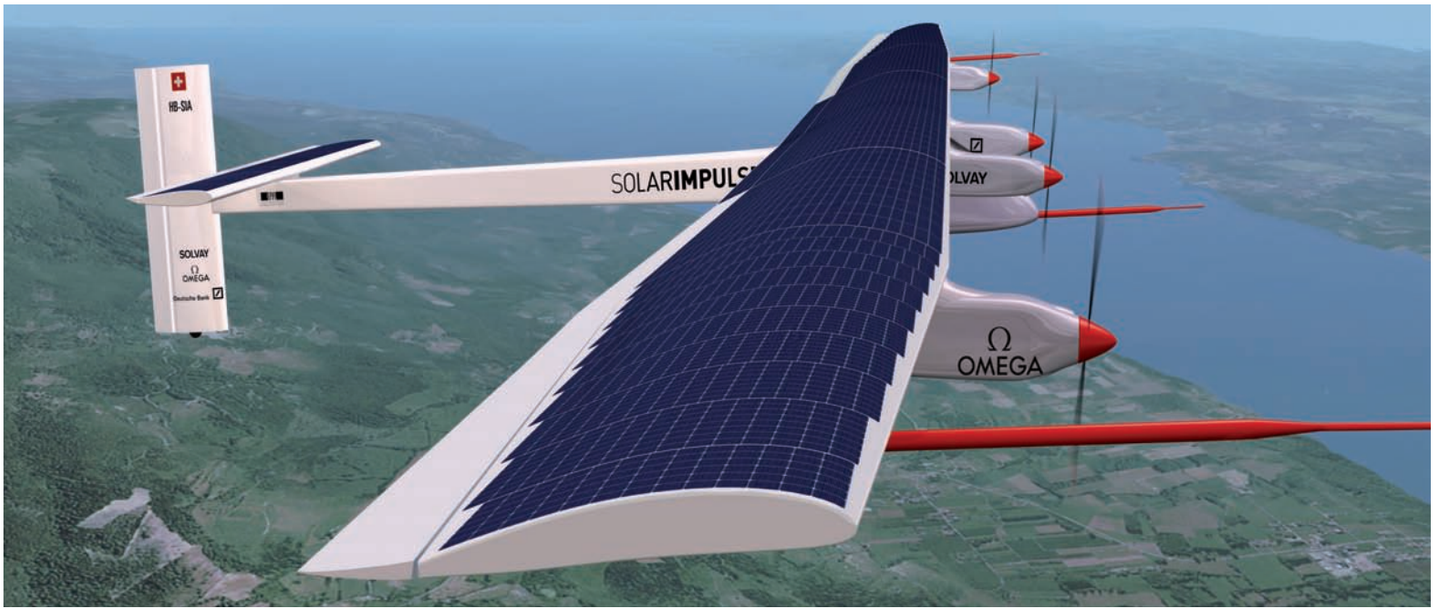
The next phase

Unveiled in June 2009, first flight by the end of the year? "The first flight will be taxi flights, one-way flights, these should happen about the end of September. You know, you go at one or two metres above the runway. You stand in the middle, you measure, you evaluate, you understand how this aircraft functions, then we go to five metres and so on and so on, slowly we'll build up confidence until we can really leave the airport environment and do the first big flight and this should happen before the year end.

"I love to work with new projects and new ideas, new innovations. For me that is extremely important. Second, I am getting concerned about climate change and our role within this, our environment and am very happy in reducing our impact on the environment. It is also a technical adventure, and a personal adventure as a pilot. It will be amazing to fly for five days and five nights," Borschberg reveals.

It is easy to forget what the aim of project Solar Impulse is trying to achieve, and many parties will dismiss the idea as nothing more than a quirky concept, a fly-by-night idea. But it is a beginning, and it could be huge. For the first time, within just a few years, a human will be propelled around the world using no fuel whatsoever, only renewable energy, and that goal is incredible and has to be applauded. As the environmentalist and ecologist Nicholas Hulat said "...In your project of flying round the world in a solar-propelled airplane, there is as much genius as naivety, poetry as reason, audacity as precaution..." ▮

After five years of engineering, simulations and construction, the prototype solar aircraft HB-SIA will be presented to the media on June 26 next at Dübendorf airfield close to Zurich



Traffic buster

IN THE MARCH 2008 ISSUE OF *AEROSPACE TESTING*, WE REVEALED THAT THE TRANSITION ROADABLE AIRCRAFT WAS SET TO TAKE TO THE SKIES WITHIN TWO YEARS. JUST A YEAR LATER, IT MADE ITS MAIDEN FLIGHT

BY CHRISTOPHER HOUNSFIELD

In March 2009 the first Transition Roadable Aircraft, or 'flying car', left the road and rose into the air for its inaugural flight. The Transition is a two-seater aircraft designed to take off and land at local airports, and drive on any road. Transforming from airplane to car takes the pilot less than 30 seconds.

A historic milestone for aviation, the flight comes after six months of static, road, and taxi testing. In flight, the Transition cruises up to 450 miles at more than 115mph, it can drive at highway speeds on the road, and it fits into a standard household garage. The vehicle has front-wheel drive on the road and a propeller for flight. Both modes are powered by unleaded gasoline from a regular roadside fuel station.

"This breakthrough changes the world of personal mobility," says Carl Dietrich, CEO of Terrafugia, the company behind the craft. Travel now becomes a hassle-free, integrated,

"The first flight was actually quite routine – but that doesn't mean we weren't excited when everyone was safely back at the hangar"

The Transition Roadable light sport aircraft runs on premium unleaded auto gas. Carl Dietrich, Terrafugia's CEO re-fuels. Anna Mracek Dietrich below with the Transition

land-air experience. It's what aviation enthusiasts have been striving for since 1918."

For its first flight, the Transition was flown by USAF Colonel Phil Meteer (now retired) at Plattsburgh International Airport in Plattsburgh, New York.

Categorized as a light sport aircraft, the Transition requires a sport pilot license to fly. The proof-of-concept will undergo additional advanced flight and drive testing, and a pre-production prototype will be built and certified before first delivery.

Terrafugia comprises a team of award-winning engineers who have been developing personal aircraft since 2006. Founded by five pilots who are graduates of the Massachusetts Institute of Technology (MIT) and supported by a network of advisors and private investors, Terrafugia's mission is the innovative expansion of personal mobility. Indeed, 'Terrafugia' is Latin for 'escape from land'.

Anna Mracek Dietrich is Terrafugia's chief operating officer and co-founder, and received her Bachelors and Masters degrees from the Department of Aeronautics and Astronautics at MIT. She has experience at both GE Aviation and Boeing Phantom Works. She spoke to *Aerospace Testing International* about the Transition's progress.

When we spoke just over a year ago, you were building your first prototype. A lot has happened since. How did you work out your test program up until first flight?

We've maintained, and kept to, a detailed development and testing program since the company was founded in 2006. Safety is of course the primary driver for our testing program. The goal of the proof-of-concept vehicle was to demonstrate the capability of driving, flying, and transitioning smoothly between the two in the same airplane. After the successful completion of our first phases of drive and flight testing, that goal has been met. We are now looking at what additional testing should be done to further inform the optimization and refinement of the design for the next prototype.

What happened on the day of the first test flight?

We began testing before dawn, pushing out of the hangar at twilight. We have several stations manned during taxi and flight testing: a chase aircraft, a chase truck, a weather station, data collection, a control tower, videography and photography, and of course, our test pilot in the aircraft. The first flight was actually quite routine and went according to our testing plan – but that doesn't mean we weren't excited when everyone was safely back at the hangar after the flight. That afternoon we did a precautionary full-vehicle inspection, and did not conduct additional flights until 48 hours later (we had a weather delay the next day).

What was the biggest reward, satisfaction, and surprise?
Seeing something that you have helped to build take flight is a very satisfying experience. Seeing that satisfaction echoed in the rest of our team was my biggest reward. There were no surprises, thankfully.

A year ago you said the biggest challenge you faced was the wing hinge and locking system. How was this overcome?
We prototyped the wing mechanism individually before building the complete proof-of-concept vehicle. That wing prototype performed very well, and the next-generation wings that are on the proof-of-concept have met or exceeded all of their requirements, including 4g load testing.

What new construction and test problems have you had to face since then?
Again, I have to say, no problems. We structure our design and testing program so as to incrementally meet each challenge associated with bringing a new type of aircraft to the general aviation marketplace.

> **"The Transition is not a 'flying car'. It is a roadable aircraft, designed to be used by trained pilots"**

Where does this place you in the 'flying car' race stakes and government legislation?
To reiterate, the Transition is not a 'flying car'. It is a roadable aircraft, designed to be used by trained pilots in and out of the existing airport infrastructure. We're building solid and productive relationships with the necessary regulators, and look forward to continuing to work with them to bring a new level of safety and innovation to general aviation.

How did the engine perform?
We're quite happy with the Austrian Rotax engine that we're using, which is a specialist engine for light aircraft. It's in about 70% of the light sport aircraft fleet.

What's happening next? Will there be a design change?
We plan to build at least one more prototype, and actually, most likely two, and conduct the appropriate level of testing on each of them. The next prototype design is already well underway and will include optimization and refinements based on what we have learned over the course of the proof-of-concept development and testing, but it looks like it will be largely the same design.

Will we ever have roadable buses?
Aren't they called 737s? ▮

Specifications

Cruise:	100kts (115mph)
Rotate:	70kts (80mph)
Stall:	45kts (51mph)
Range:	400 nautical miles (460 miles)
Fuel burn:	5gph
Fuel tank:	20 gallons
Useful load:	430 lb
On road:	30mpg at 65mph

OTHER INFO:
- Automotive-style entry and exit.
- Automated electromechanical folding wing.
- No trailer or hangar needed.
- 100bhp Rotax 912S engine.
- Full vehicle parachute available.
- Modern glass avionics.
- Safety cage and crumple zone.
- Side impact protection.
- Cargo area is large enough to hold skis, fishing poles, or golf clubs.

The Terrafugia Transition taking off from runway 17 at Plattsburgh International Airport, New York

A most unusual aircraft

WITH THE FIRST FLIGHT OF THE FUTURISTIC AD-150 VTOL UAV WITHIN SIGHT, ITS LEAD ENGINEER REVEALS DETAILS OF THE TEST PROGRAM FOR THE UAV THAT IS DESTINED FOR THE US MARINES

BY PAUL VASILESCU

The American Dynamics Flight Systems (ADFS) AD-150 is a tilt-duct vertical take-off and landing (VTOL) unmanned aerial vehicle (UAV) capable of achieving high forward airspeeds. The aircraft uses a pair of rotating wing tip-mounted ducted fans to provide the vertical lift and forward thrust needed to approach 300kts. The AD-150 has been developed around upcoming US Marine Corps requirements for a high-speed VTOL UAV capable of operating in a shipboard maritime environment.

The aircraft weighs approximately 2,300 lb, can transport a 500 lb payload, and has a maximum range of approximately 700 nautical miles. The projected flight envelope ranges from VTOL/hover to cruise at 240kts. Potential missions include intelligence, surveillance, reconnaissance, and targeting (ISR&T), electronic attack (EA), logistical resupply, and weapons delivery.

The development path for the aircraft includes a combination of computational modeling and physical testing. The aircraft's ability to transition mid-flight between vertical and horizontal flight modes presents a considerable control challenge. Before any test flights can take place, an accurate computational model must be created. The accuracy of the model, however, can only be validated through physical testing. Therefore, the road map includes the creation of computational fluid dynamics (CFD) models of the airframe and propulsion system, wind-tunnel testing, static lift and propulsion system testing, aircraft ground testing, and flight testing. Each testing milestone provides a comprehensive data set used to refine the aircraft's flight dynamics and six-degrees-of-freedom (6DOF) simulation models, both of which are critical to development of the aircraft.

American Dynamics has teamed with the Department of Aerospace Engineering at the University of Maryland for the wind tunnel testing segment and for the development of the flight dynamics model of the AD-150. Dr J. Sean Humbert is the principle investigator for the effort, which will yield an accurate flight-dynamics model for the AD-150's projected flight envelope.

Humbert is the director of the university's Autonomous Vehicle Laboratory, and specializes in flight dynamics, avionics, and control theory. He currently has programs in place with the Air Force Office of Scientific Research (AFOSR), Air Force Research Laboratory (AFRL), Defense Advanced Research Project Agency (DARPA), the Naval Research Laboratory (NRL), the Office of Naval Research (ONR), and the Army Research Laboratory (ARL).

Computational models

CFD models were created for the AD-150 airframe and propulsion system using SolidWorks and CD-Adapco's Star-CCM+ software. The models were created with the flexibility to simulate flows for the airframe and the

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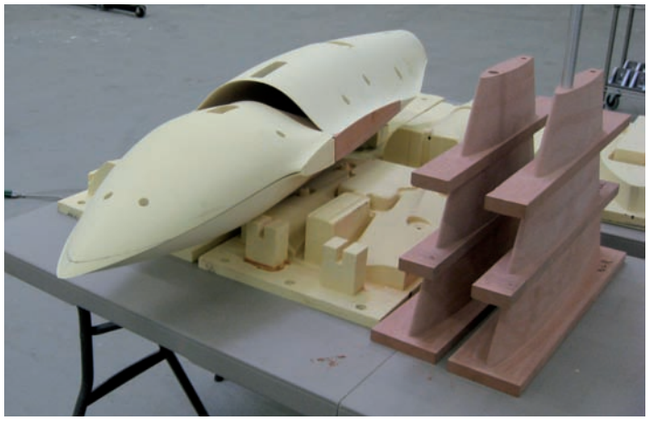
propulsion system in static and dynamic cases, both in and out of ground effect. The models are also capable of simulating operations under virtually any type of atmospheric conditions.

The airframe models were created based on the geometry of the full-sized aircraft, and then scaled down to the size of the wind-tunnel model to enable a direct comparison of the results. Star-CCM+ solved the models using various flow conditions corresponding to the combinations of angles of attack, sideslip angles, and airspeeds tested in the wind tunnel. Once solved, each simulation provided data on aerodynamic forces, aerodynamic moments, and pressures. Each simulation also provided plots illustrating pressure distributions and flow visualizations.

The propulsion system models were created based on the full-sized geometry of the shaft-driven propulsion systems. These models are significantly more complex than the airframe models because they involve rotating geometry, which requires modeling with multiple regions. The stationary region includes the outer wall of the nacelle, transmission cowling, supporting frame, and most of the inner wall of the nacelle. The rotating region includes the fan disk, spinner cone, and a small portion of the inner wall of the nacelle. Two separate models enable simulations to be run for operations in ground effect and out of ground effect, both with and without airflow or airspeed. The propulsion-system models are able to provide performance- and power-requirement data for cases at any stage in the AD-150's flight envelope.



The AD-150 wind tunnel model with high control surface deflection, and during construction

> **"The wind tunnel test program was an important milestone in the development path of the AD-150"**

Wind tunnel

Wind tunnel testing was conducted at the Glenn L. Martin Wind Tunnel in the winter of 2009 on a 3/10 scale model of the AD-150 aircraft. The tests included static and dynamic tests both with neutral-control surface positions and with control-surface deflections. Measurements included aerodynamic forces, aerodynamic moments, pressures for the static tests, three-axis attitude, acceleration, and rates for the dynamic tests.

The model itself was computer numerical control (CNC) machined to ensure the highest level of accuracy and closest correlation to the full-sized aircraft. The scaling was based on the optimal Reynolds number for the Glenn L. Martin wind tunnel. The model was constructed without the wingtip-mounted propulsion systems as they do not scale well. Aerodynamic data for the propulsion systems will be added to the flight dynamics model separately, after the static-lift and propulsion-system test.

Tare and interference

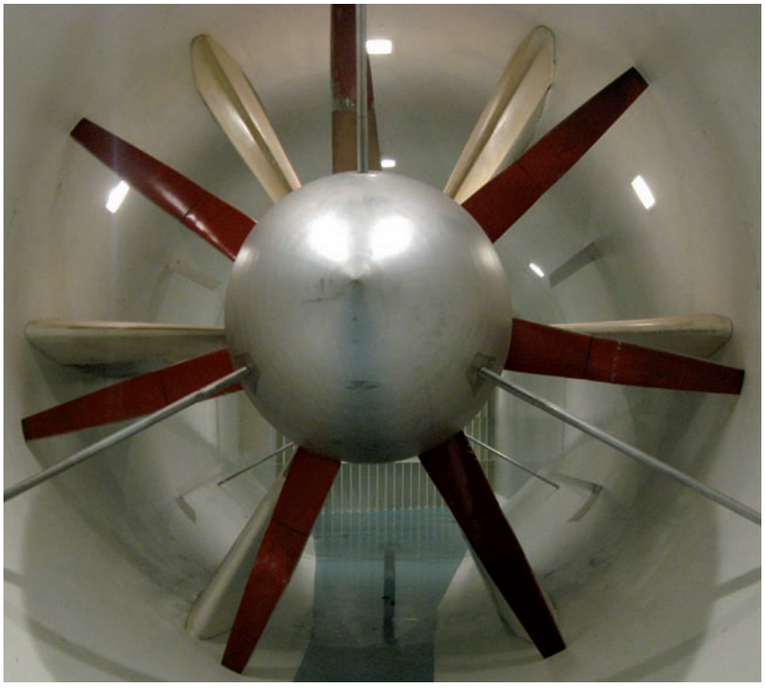
The AD-150 scaled model was mounted to a rotating balance with a pitch link capable of accurately measuring the forces and moments acting upon the model. The balance also changed the model's angle of attack and sideslip angle. During the first test, the tare test, the model was run through full sweeps of angles of attack and sideslip angles from the test matrix without any wind running over the model. Forces and moments were measured and recorded.

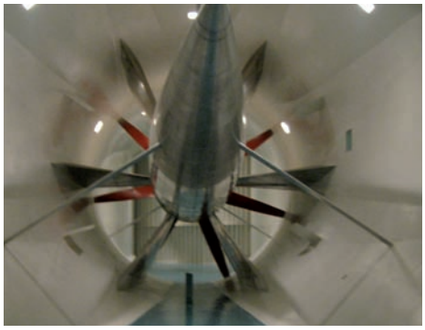
During the second test, the interference test, the model was inverted and run through full sweeps of angles of attack and sideslip from the test matrix with wind running over the model. The interference test was run twice, once with a mirror image of the hammer, pitch link, and fairing that supports the model, and once without. Forces and moments were measured for both configurations. The differences between the two configurations were recorded because of the aerodynamic effects due to the wind tunnel interfacing components. The forces and moments from the tare and interference tests were deducted from all subsequent runs in order to provide an accurate aerodynamic representation of the aircraft.

Static tests

A test matrix was created as a representation of all relevant combinations of angles of attack, sideslip angles, and forward airspeeds for the AD-150. The angle-of-attack sweep included test points from -5° to +16°, and this included a few test points beyond the AD-150's stall angle. The sideslip-angle sweep included test points from -13° to +13°. The airspeed sweep included runs at 50mph, 80mph, 110mph, 160mph, and 200mph. Runs at the higher speeds were not necessary as the measured force and moment coefficients did not change much above 110mph. The model was then run through all data points in the test matrix with neutral control surface positions. Measurements were taken in both the wind-frame and the body-frame coordinate systems.

Upon completion of the neutral cases, the model was reconfigured to support multiple control surface deflection angles of both the ruddervators and the flaperons in fixed increments running from -45° to +45°. A subset of the original test matrix was then run for each control surface deflection case to measure change in pitching, rolling, and yawing moment versus control surface deflection angle. All static forces and moments were measured and





The Glenn L. Martin Wind Tunnel is a low speed tunnel that has been actively involved in aerodynamic research and development since 1949

HIGH TORQUE LIFT

American Dynamics Flight Systems's High Torque Aerial Lift (HTAL) implementation in the AD-150 maximizes the vehicle's control authority during hover and transition to forward flight. The two HTAL systems are driven by a single Pratt & Whitney Canada PW200 Turboshaft engine.

The AD-150 features a modular-mission payload design, with internal bays and external stores located in the vehicle's center of gravity. The AD-150's versatile payload-bay configuration enables the AD-150 to support the most demanding payload systems and missions.

recorded as well, in both the wind frame and body frame coordinate systems.

The dynamic test segment involved altering the model to remove the pitch link, add an inertial measurement unit, and replace the static interface between the model and the wind tunnel with a set of bearings that enable the model to pivot freely about one axis at a time. The purpose of the dynamic tests was to measure the oscillations of the aircraft and to determine aerodynamic damping. The AD-150 is aerodynamically stable in the yaw axis, but unstable in the pitch axis.

The initial set of dynamic runs measured yaw so the model was configured to pivot about the aircraft's vertical axis. A string was attached to the empennage of the model and run out of the test area. During the first set of runs, the ruddervators were set to neutral positions. During the second set of runs, the ruddervators were repositioned to induce a yawing moment. Once the tunnel was turned on, the model was disturbed by pulling the string attached to the empennage. The model then oscillated left to right until it stabilized pointing into the wind.

The second set of dynamic runs measured pitch so the model was reconfigured to pivot about the aircraft's lateral axis. All dynamic pitch cases were run with neutral control surface positions. Because the AD-150 is aerodynamically unstable in the pitch axis, a spring was added to the model to dampen the oscillations and to prevent the model from pivoting beyond its mechanical limits. Once the tunnel was switched on, the model was disturbed by a pole running out of the ceiling of the test area. The test included both pitch up and pitch down cases. Once disturbed, the model would oscillate in the pitch axis until it reached a neutral attitude.

Comparison to CFD models

Upon completion of the tests, the wind tunnel data was compiled and compared to the data set from the CFD models. In most cases, the data from the CFD models matched the data from the physical experiments almost identically.

"The American Dynamics team came to the wind tunnel test with a more complete set of CFD results directly comparable to the tunnel conditions than any other group we have worked with up to now," says Dr Jewel Barlow, director of the Glenn L. Martin Wind Tunnel. "It was possible in the cases of many configurations to plot direct comparisons of the computed and measured results. The most important longitudinal results typically showed curves with the same shapes for the computed and measured results and with modest offsets. "I consider the comparisons to be outstanding and to clearly indicate the potential of using the CFD methods as implemented by American Dynamics for extensive design studies."

Static lift and propulsion

The next critical test in the AD-150's development path is the static lift and propulsion system test. This test calls for the creation of an instrumented test rig on which the full AD-150 lift and propulsion system could be mounted and tested to full design power. The purpose of the test is to mechanically validate the aircraft's drive and propulsion systems and to physically validate the performance and power requirement data generated through the CFD models. American Dynamics currently has an agreement in place with the US Army's Aberdeen Proving Ground to perform this test in the coming months.

The AD-150's ground and flight testing will be conducted at the Proving Ground, after successful completion of the static lift and propulsion system test. American Dynamics' agreement with Aberdeen enables AD-150 flight tests to include hover in ground effect, hover out of ground effect, transition between hover and forward flight, and conventional forward flight.

The wind tunnel test program was an important milestone in the development path of the AD-150. In the coming months, ADFS will conduct propulsion testing and computational modeling and analysis, continuing a partnership between the company and the University of Maryland. After the completion of the tests, the ADFS team expects to demonstrate the capabilities of the AD-150 in flight. ▮

AD-150 airframe on display at American Dynamics Flight Systems's Jessup, Maryland facility

Paul Vasilescu is the technology development director at American Dynamics Flight Systems and is lead engineer on the AD-150 aircraft program

"On the ground, noise sources in the entire audio spectrum can be detected, including snipers and mortars"

Dr Hans-Elias de Bree

Founder, Microflown Technologies

In 1994, Hans-Elias de Bree discovered by chance that the MEMS-based DC flow sensor he was developing for his Masters thesis was able to measure AC flow or acoustic particle velocity. In 1998, after obtaining his PhD on the further exploration of his Microflown sensor, he co-founded Microflown Technologies.

Now, 10 years later and much research, the company has an extensive portfolio of acoustic near-field applications, for areas such as inflight panel noise contribution analysis and in-situ acoustic absorption measurement.

Microflown Technologies entered the defense industry only very recently, offering the merits of broadbanded far-field acoustic vector sensors to improve situational awareness.

What makes the Microflown sensor different?

For the sake of simplicity, compare it to the electric domain. If sound pressure were the equivalent of voltage, acoustic particle velocity is the equivalent of amperes. The Microflown sensor is the only commercially available acoustic ampere meter.

I think engineers would find it very strange if they could measure only voltage to determine electrical power and resistance.

Is it important that acoustic particle velocity is a measurable quantity?

Yes. Of course, one can calculate acoustic particle velocity by taking a pressure gradient, but there are many limitations in practice that no manufacturer likes to explain and no user likes to hear.

Take for example sound intensity measurements that were usually based upon two phase-matched sound pressure transducers. Such measurements cannot be used in reverberant conditions, as the measurement is hampered by the pressure/intensity index.

Of course, you may overcome the problem by using an anechoic room, but such a facility is not available to everybody. The upper frequency limit is around 6kHz.

Sound intensity measurements based upon capturing sound pressure and acoustic particle velocity are not limited by reverberant conditions. This enables, for instance, vehicle manufacturers to make cabin interior noise measurements without having to create anechoic conditions, as used to be the case. It has opened up the possibility to test while flying, as Microflown demonstrated in 2008 with PZL, a Polish helicopter manufacturer. We hope to test commercial business jets soon.

Are there other examples?

For sure. The most widespread method of assessing the acoustic absorption of materials was to cut a flat sample and put it in a Kundt's tube [experimental apparatus invented in 1866 by German physicist August Kundt for the measurement of the speed of sound in a gas or a solid rod].

Using two pressure transducers, one could determine the acoustic absorption under a normal angle of soundwave incidence.

With the PU surface impedance method, which measures the acoustic quantities right above the material, the need for destructive testing is gone. Furthermore, the new method also works on curved materials and under oblique angles of soundwave incidence. Finally, samples can be tested under realistic conditions.

And also in wind tunnels?

Yes, although it is still a continuous topic of research. In 2008, we tested PU probes for wind tunnel testing, and they worked up to 80m/sec, a relevant speed level as it reflects landing conditions.

PU probes can also be used in non-anechoic wind tunnels, enabling the merger of aerodynamic and aero acoustic wind tunnel testing.

Of course, intrusiveness is the big concern of aerodynamicists there. But we believe our recently introduced match-size 3D sound chip will offer a good alternative to optical non-intrusive testing methods.

What made Microflown enter the defense industry?

This was triggered by an Indian scientist at the Aeronautical Development Establishment in Bangalore. He had read about the possible benefits of using vector sensors based on acoustic particle velocity. They are intrinsically broadbanded and each node provides direction by indicating bearing and azimuth. With some tricks, one can even determine the range. He decided to test.

We offered him an internship when he formally retired. He was our oldest student ever!

So what are the propositions?

They cover the entire range, from air-to-air down to ground-to-ground. Acoustic vector sensors offer unique features for the 'sense and avoid' function on UAVs that should prevent mid-air collisions. Unlike other categories of sensors, they detect in all directions, regardless of day/night or meteorological conditions.

Is it all about situational awareness?

On the ground, noise sources in the entire audio spectrum can be detected, including snipers and mortars. Air-to-ground, Apache fighter helicopters can detect RPG launch position on the ground. And from the ground, helicopters can be detected in a passive manner from a great distance, even behind the mountains.

Most importantly, capturing all phase and amplitude information and using the cross correlations, just four three-dimensional probes can locate and track up to 30 sound sources simultaneously. ▮

Down to the wire

THE USE OF POLYIMIDE WIRING IN AIRCRAFT HAS LONG COURTED CONTROVERSY. CRASH INVESTIGATOR EDWARD B. BLOCK HAS BEEN PARTICULARLY VOCIFEROUS IN HIS DAMNING OF THE MATERIAL, AND HERE HE SHARES HIS FINDINGS

BY ED BLOCK

What would you do if the wires on your aircraft started arcing at 10,000°C at 30,000ft? The new fly-by-wire technologies and the increased volume of entertainment wires add up to about 200 miles of wires per aircraft. A pilot can't simply pull over and fix problems, so why don't we fix it on the ground? The answer to that is complex.

The story starts in 1982. I had been named 'Most Outstanding Personnel of the Year' for saving the US taxpayers US$2 billion in the procurement of radio-frequency cables. I had exposed some bad news, or what my supervisor referred to as 'dirty linen'. I had pointed out that 175 US Navy F-14s had crashed out of the 600 manufactured. The number of crashes was beyond blaming pilot error.

The F-14s, which were fitted with Poly-X wire insulation, had been experiencing control problems due to spurious signals affecting the autopilot, spoilers sticking in the up position, and anomalous signals affecting the entire aircraft's performance.

No one seemed to notice that the same wire insulation was used by McDonnell-Douglas on its DC-10s and by Boeing on its new 747s. Boeing never mentioned that it was experiencing premature aging on its Poly-X wire insulation, resulting in circumferential cracking down to the copper conductors after only 3,000 flight hours. The military had always been a proving ground for wire insulations, but a military aircraft is due to last only 10,000 flight hours, whereas a commercial jet would be in the air for more than 100,000 hours.

TWA 800

The July 1996 crash of the 747 off Long Island, New York (*see box, p9*), was one of those 100,000-hour aircraft wired with Poly-X. I had warned the National Transportation Safety Board (NTSB) a year earlier of the Poly-X wire problems experienced by the F-14s.

The NTSB asked Boeing and McDonnell-Douglas if they ever had any wiring problems. Perhaps because of the FAA view that you can't economically rewire a commercial jet, the companies said no. (This seems odd, when their own documents proved their Poly-X wire insulation failed after only 3,000 hours.) The NTSB decided they would rely on the experience of these two giant aircraft manufacturers and ignored my warnings.

Two years later I came face-to-face with massive piles of TWA 800's Poly-X insulated wire at Calverton, New York, where the metallic portion of the crashed aircraft had been reassembled. The wiring was thrown into piles that resembled hay. The altimeter lay there still reflecting the altitude where the power had

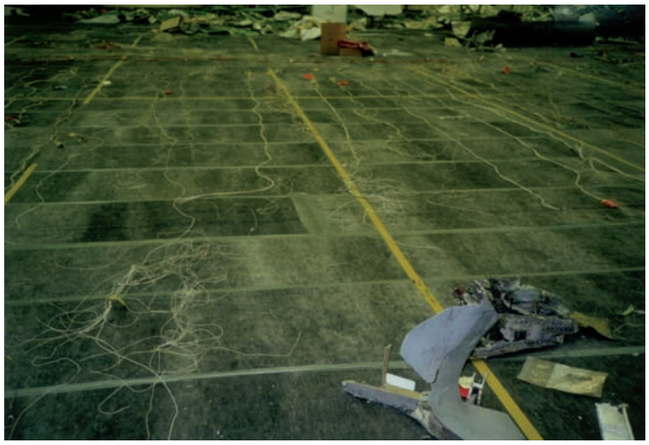
been abruptly cut off. In these piles of Poly-X wire were thousands of those same circumferential cracks that had been witnessed on flight-ready F-14s years earlier.

An NTSB official witnessed my examination and pedaled over on his bicycle to ask me what I had found. I pointed out the numerous cracks throughout the miles of wiring. He asked how I knew they weren't caused by the crash. I informed him of the F-14 evidence, and showed him pictures of the cracks to prove my analysis. He pedaled away.

Later, I found the wire bundle leading from the flight engineer's station to the rear of the center fuel tank. It was burned but flexible, indicating that an electrical fire had taken place rather than it being burned by a flame front. However, it would take the NTSB six years and millions of dollars to admit that the aircraft's wiring (Poly-X) had caused the explosion by transferring high voltages onto the wires of the fuel quantity indicator system that lead to the center fuel tank.

Navy choice

As a result of the problems the US Navy had experienced with its F-14s, it decided to rewire the aircraft. It replaced the Poly-X with a virtually untested aromatic polyimide wire insulation called Kapton. The Navy would request US$360 million in 1982 to accomplish this necessary safety fix.



Above: The search for a crack in the wire from the huge piles recovered from TWA 800

Left: The inch by inch examination. Block eventually found the wire bundle that had 'shorted'.

But Kapton was already causing Lockheed major problems on the L-1011 aircraft. It arced at such high temperatures (10,000°C, according to the FAA in January 2008, melting even titanium) that it was recommended that it not be used in the future. The criticism was dismissed by Lockheed.

Today, still flying, there are 14,000 aircraft with hundreds of miles of Kapton wire insulation. These include military aircraft, commercial aircraft, and general aviation aircraft. Yet the US military banned aromatic polyimide from future use in 1988, and the FAA told the US General Accounting Office in 2002 that Kapton would not be approved today because of its arcing characteristics.

I addressed the same aromatic polyimide or Kapton problem for the UK House of Commons Transportation Committee in 1999, and to the UK Civil Aviation Authority (CAA). Nothing ever came of these presentations.

In 2000 I briefed the White House on the wiring insulation problem, resulting in aircraft wire being declared a matter of 'national concern'. A 14-member inter-agency group was formed to develop a national strategy, but President Bush canceled the group in June 2002 without a strategy.

I spent from 1999 to 2004 as a member of the FAA's Aging Transport Systems Oversight Committee, examining wiring around the world at the request of the US Secretary of Transportation. During this time we found an average of 1,100 cracks in the wiring insulation per aircraft inspected.

I appeared on television, NBC's *Nightly News*, and believed my work was done. However, the FAA had earlier declared there was nothing in the database to indicate that there was a wiring insulation problem at all – hardly surprising because there wasn't even a code to report one.

Air Force One, the US President's airplane, is probably the most well-known aircraft in the world. It was rewired to remove the arcing aromatic polyimide wire insulation. Unfortunately, the replacement wire type had already been banned by NASA for its flammability, smoke emissions (a one-foot section could fill a room with thick poisonous smoke), and it could explode in a pressurized oxygen-enriched area.

I wrote to the President in November 2007 warning him of the danger. I told him of the reason for the F-14's crashes, the 14,000 dangerous aircraft still flying, and his own Air Force One's problems, as well as the retirement of the Space Shuttles in 2010, all being the result of no wire performance tests for aircraft wire. He turned the matter over to the FAA for a response.

Around the Block

Edward B. Block is an international expert on aviation and wiring. From 1985 until the present day he has been president of Edward B. Block Consulting, specializing in aircraft crash investigations including TWA 800, Swissair 111, ValuJet 592, EgyptAir 990, AA587, and the US Marine EA-6B incident.

In 2001 he founded the National Association to Prevent Air Crashes (NAPAC). The organization educates legislators, regulators of the aviation industry, and the public on aviation safety.

> **"Sadly, NASA is retiring the Shuttles in 2010 due to a wiring concern, and will have to hitch-hike to the space station"**

The FAA responded that they had just passed wire performance tests that same month. However, I believe this was incorrect. A review of Part 25 of the FAA's regulations indicated that there are still no tests for wire – other than an antiquated 60°C flame test from 1972. The FAA tests the carpets, the insulation blankets, even the tray-backs, but not what ignites fuel vapors, causes spoilers to stick in the up position, or emits anomalous signals to autopilots and fuel gauges, and causes multiple rudder deflections!

Eventually, in 2008, the FAA issued a report indicating polyvinyl chloride (PVC) and Kapton wire insulations should not be used in airborne applications.

The same report also released the figure of 10,000°C for the arcing of the aromatic polyimide wire insulation or Kapton and the fact that another FAA report said Kapton arcing splatters over 12in, and that the copper BBs, caused by the melting of the copper wire, splatter over a wide area.

This information debunks the Airbus argument that the separation and segregation of wire bundles alleviates the concerns about the use of aromatic polyimide wire insulation on its air refuelers, the A330s, being sold to the US Air Force for US$40 billion.

Crash focus: TWA 800

On July 17, 1996, TWA flight 800, a Boeing 747-131, N93119, crashed into the Atlantic Ocean near East Moriches, New York. TWA 800 was operating as a scheduled international passenger flight from New York's JFK to Charles de Gaulle in Paris. All 230 people on board were killed, and the airplane was destroyed.

The NTSB determined that the probable cause of the TWA flight 800 accident was an explosion of the center wing fuel tank (CWT), as a result of ignition of the flammable fuel/air mixture in the tank. The source of ignition energy for the explosion could not be determined with certainty, but, of the sources evaluated by the investigation, the most likely was a short circuit outside the CWT that allowed excessive voltage to enter it through electrical wiring associated with the fuel quantity indication system.

Contributing factors to the accident were the design and certification concept that fuel explosions could be prevented solely by precluding all ignition sources, and the design and certification of the Boeing 747 with heat sources located beneath the CWT with no means to reduce the heat transferred into the CWT or to render the fuel vapor in the tank non-flammable. The safety issues in this report focus on fuel tank flammability, fuel tank ignition sources, design and certification standards, and the maintenance and aging of aircraft systems.

Below: The TWA 800 hull offered little help except to localize the wire damage

Bottom: TWA 800's altimeter is frozen at the moment everything went wrong

Faulty wire and tests

Generations of aircraft including the Space Shuttles have been plagued by faulty wire. The problem has been compounded by the lack of wire performance testing.

Who is responsible? One wire supplier to Boeing told me that wire choices were made on yachts off Redwood, California. Whether that is true or not will never be known.

In 1999 I appeared on the BBC's *Panorama* program in the UK, and presented these same arguments. There was no rebuttal then, and there is none today. The facts speak for themselves. I would still gladly debate this matter with any aircraft manufacturer, or the FAA or CAA.

Sadly, NASA is retiring the Shuttles in 2010 due to a wiring concern, and will have to hitch-hike to the space station after that date, but I remain optimistic that discussions will begin.

Is there any good wire insulation type? The answer is, yes. It is called Teflon-Kapton-Teflon or TKT. The Teflon melts when the Kapton arcs, putting out the 10,000°C fire. It is used by Boeing on its single-aisle aircraft built after 1992. ▮

Edward B. Block served as the wiring expert for the Department of Defense for more than 11 years and is now a campaigner for aircraft safety

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Cable vision

IT IS ESSENTIAL TO TEST CABLES AND HARNESSES PRIOR TO INSTALLATION AS WELL AS AFTER. ONE COMPANY HAS A SYSTEM THAT SIMPLIFIES THE PROCEDURE

BY PERRY CHATTLER

Aircraft and military vehicle communication systems are vital to successful and safe mission operations. The RF coaxial cables installed in aircraft, ships, and land vehicles are a critical element to properly operating internal systems. Various elements of the cabling system create exposure to weakness or failure in communication signal integrity. Flight line testing ensures the proper installation and configuration of the aircraft cabling systems.

To establish a baseline of a cable's performance characteristics, testing is required on individual cables and cable harnesses prior to installation into the vehicle. Subsequently, to insure installation quality and final system integrity, testing is performed from end point to end point after installation into the airframe or vehicle frame, with cable clamps installed.

RF cable testing is typically performed with a vector network analyzer (VNA). The VNA is used to perform a variety of RF measurements with typical test frequencies from 10MHz-18.5GHz. Newer standards may require testing to 40GHz. The VNA is a complex instrument requiring extensive training and complicated setups. In addition, network analyzers require complex error corrections (calibrations) when connectors or frequency ranges change. This adds to the complexities and error potentials.

The accuracy of network analyzers is greatly influenced by external factors such as connector types, connector impedances, interconnect cables, and other devices connected to the input and output ports of the network analyzer. Vector error correction (also known as S parameter calibration, or VNA calibration) enhances the accuracy of the network analyzer by removing systematic errors inherent in the test setup. Additional factors such as frequency range, number of scan points, sweep time, bandwidth, and output power all affect and necessitate error corrections to be performed in order to achieve accurate measurements.

Vector error correction consists of measuring known standards (open, short, load, and thru) to characterize the system. This task may be performed daily or a number of times each day, depending upon the testing requirements.

With traditional testing methods, operators must be technically proficient and trained to produce accurate test results. The network analyzer error corrections necessitate a vast array of calibration kits to meet each type of cable connector used in the aircraft. Additionally, testing operators must keep track of the cable inventory, tested status, and test pass or fail limits. The complexities involved with both VNA operation and error corrections can create test results that are prone to errors and cause multiple retesting of cables.

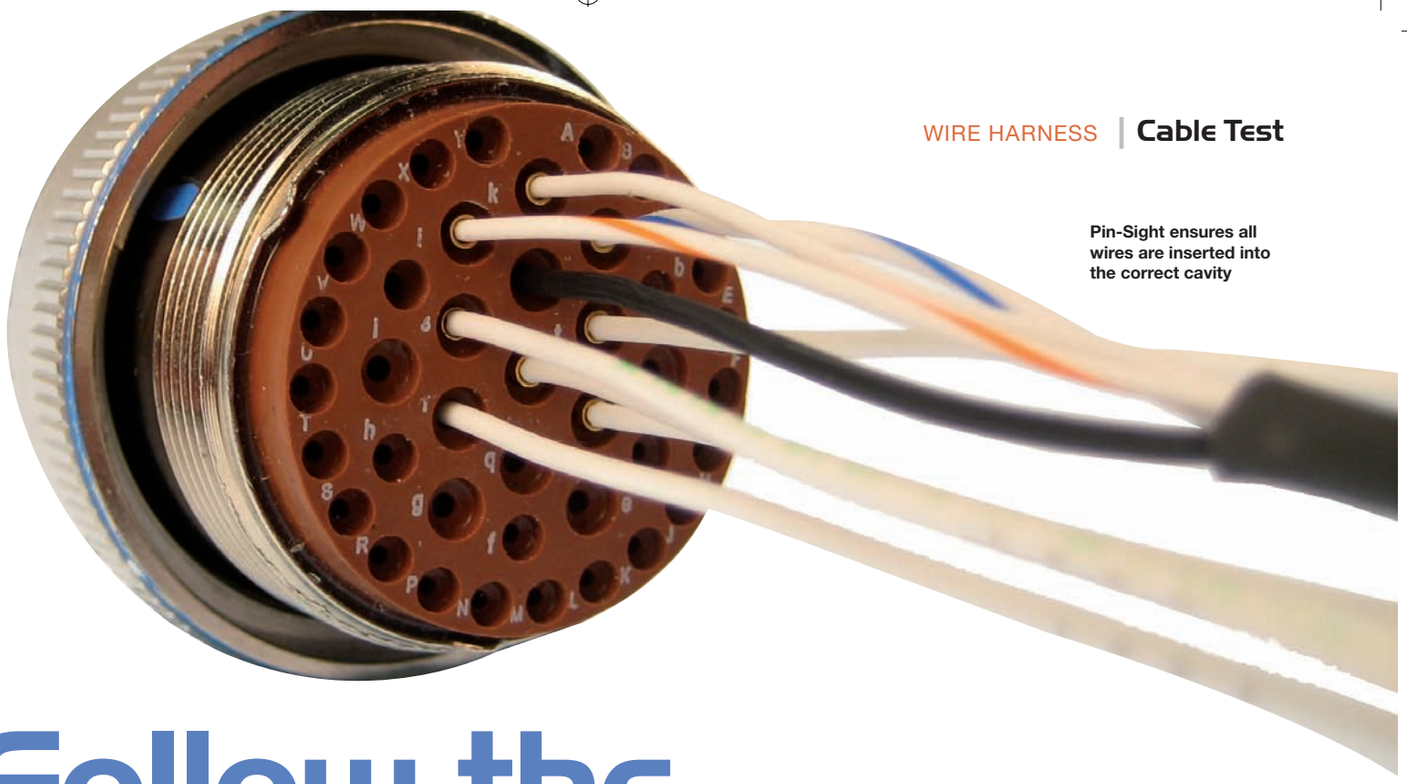
Software automation programs, such as the DCM Model HPCC-iDB aerospace test system, not only simplify the cable testing, but also provide management of cable inventories and pass/fail limits. The F-35 Lightning program is one such program that has adopted numerous DCM HPCC-iDB high-performance coaxial cable test

The F-35 test program has relied on coaxial cable test systems

systems to ensure cable performance. These test systems combine the VNA with test automation software and also include connector adaptor modeling, automatic compensations, cable inventory management, and test limits controls. No programming is needed, and there is no need to touch any buttons on the VNA.

Complex aerospace and defense systems require complex internal communication systems. The testing of these systems can be simplified and automated while producing more accurate and reliable test results. Traditional testing of RF coaxial cabling is complex and time-consuming, and often produces inconsistent results. Automation of the testing process simplifies the testing, enabling non-technical staff to perform complex measurements with a high degree of accuracy and reliability. ■

Perry Chattler is president of DCM Industries Inc, based in California, USA



Pin-Sight ensures all wires are inserted into the correct cavity

Follow the current upstream

ELIMINATING WIRING ERRORS AT THE POINT OF INTRODUCTION IS A COST-EFFECTIVE METHOD OF HARNESS MANUFACTURE

BY BRENT STRINGHAM & DAVID MORRIS

In the world of aircraft wire harness testing there is often little perceived difference between the competing manufacturers in terms of 'what' to test. Surely all harness testers perform similar functions? However, one thing that is universally accepted is that there can be considerable quality improvements and cost savings, depending on when the testing occurs.

Common practice for many aerospace harness manufacturers is to completely assemble the harness, then perform a final electrical test. Although this approach is effective in finding all electrical faults, it is not the most cost-effective solution, as faults found at final test are the most expensive to diagnose and resolve.

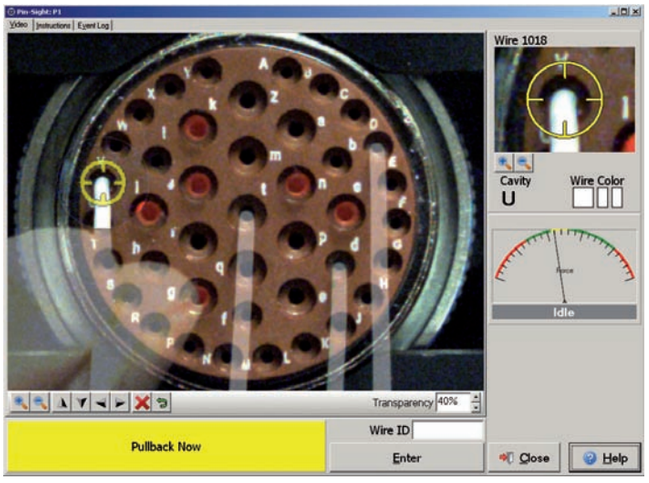
Wiring harness test-equipment manufacturer Cirris Systems Corporation, which is based in Salt Lake City, USA, and has subsidiary divisions in the UK (Cirris Solutions Ltd) and Germany (Cirris Solutions GmbH), has long promoted the concept of moving electrical testing of harnesses as far 'upstream' in the process as possible. If wiring errors can be detected as and when they occur, preferably by the person assembling them, then quality goes up and overall cost is driven down.

To this end, Cirris provides a full range of guided harness-assembly aids and testers, designed to assure quality from insertion of the first wire, through test-as-you-build capability on the form board, to final electrical test.

A typical aircraft harness with many thousands of wires and connections usually comprises several smaller sub-assemblies, which are all brought together and assembled into the desired final state. By placing small, bench-top testers at each sub-assembly cell, operators are only able to pass on good assemblies. They, in effect, self-test their work, ensuring correct wiring of the sub-assemblies. In many instances the testers are set up to use their 'guided build' capability. When used in this manner, such testers can actually guide the harness assembler through the build process, displaying from/to information for each wire and providing on-screen graphical representation of each cavity of the connector as wires are individually being inserted. If wires are inserted correctly, the operator is led on to the next wire, but if a mistake is made, the tester instantly alerts the operator to the error and won't allow continuation until it has been corrected. In practical terms, the 'test as you build' approach ensures a correctly wired harness from the assembly board, as it can't leave the board until it is correct.

Modular design enables multiple, individual, small testers to be combined to form one large test system.

When deciding the required size of a test system, the determining factor is usually the



Computer-aided wire insertion with Pin-Sight

Left: Benchtop high-voltage testers are ideal for testing smaller sub-assemblies

Centre: Pin-Sight visually guides wire insertion and verifies contact retention

Right: Cirris Ch2 expands from 800-20,000 points in 800-point increments

largest harness to be tested. If there are 10,000 wire ends on a harness, this requires 10,000 test points (this is the minimum for two-wire testing). This large harness is often the extreme, and there are usually many other manufactured harnesses that have a far lower test point requirement.

Received wisdom dictates that because there is the one 10,000-point harness, the test requirement is then for a 10,000-point tester, for two-wire (20,000 test points for four-wire testing), which means that all the smaller harnesses get tested on one large tester. This serves to explain the common bottleneck of end-of-line electrical tests.

The company, Cirris has followed a different path to most other suppliers, one that uses the extreme modularity of its test solutions. Visualize test systems that can start at 256 or fewer test points and then expand, virtually without limit, to the required 10,000 or 20,000 or more test points. Now combine this with the ability to morph multiple smaller testers rapidly into one large test system, and then back again into yet another multiple test station set-up. Extreme flexibility delivers cost-effectiveness.

Take a recent practical example where an aerospace company with a harness with 10,000+ points was able to replace its existing 'large' system with 10 x 1,000-point testers, which are networked and distributed around the factory, running a common database, but testing multiple, varied, small- to medium-sized wired assemblies. When production demands it, the 10 smaller systems are swiftly combined to create one single 10,000-test point system.

When the large harness is completed, the company is able to quickly redeploy the Cirris test facility as multiple smaller-test systems. For example, two, 5,000-test point systems could have been formed. This is a great boost to test flexibility, and the effect on quality and in reducing work in progress is rapidly seen. However, it is the effect on the bottom line that really impresses.

Guided pin insertion

Cirris recently launched Pin-Sight, following extensive trials in the global aerospace industry. Although not a test system as such, it is a valuable quality-assurance tool for aircraft harness manufacturers. Pin-Sight uses a CCD camera attached to a connector holder mounted onto a base that houses an accurate force sensor.

This system provides real-time guided assembly instructions for placing wired pins, spare pins, and seal plugs into connectors. It verifies that contacts are correctly 'locked in' by requiring the assembly person to pull back on each wire as it is inserted. The force gauge is set to an appropriate setting so that the operator cannot insert a following pin or wire until the last one was verified as being locked in. Pin-Sight is especially useful for wires with unique IDs. It ensures that the harness is wired correctly, and in addition, each labeled wire is locked into the correct cavity. Otherwise field technicians, who might have to troubleshoot the installed harness at a later date, are blind to the fact that labeled wires don't correctly match cavity location as per the printed documentation.

Electrical wiring harnesses are a critical component of any aircraft. It is essential that they are 100% perfect, not just electrically but mechanically. Connector pins that are in the correct cavity but are not properly locked in can create electrical 'opens' or intermittent connections during flight. Although final electrical testing is an essential part of aircraft harness manufacture, it is a time-consuming and costly process that adds no value to the final product.

Wire harness manufacturers that improve quality by reducing the number of errors found in final test through the philosophy of finding the fault at the point of introduction, stand to be more competitive. By moving electrical testing further upstream, and by using guided-assembly aids and test-as-you-build processes, assemblers can do their job more efficiently with less rework and scrap, and in less time. In today's competitive global environment, these manufacturers will be the ones to invest in. ▮

Brent Stringham is vice president of sales and marketing at Cirris Systems Corp in the USA. David Morris is managing director of Cirris Solutions Limited in the UK

Cirris CH2 high-voltage tester with relay energization points

Dynamic duo

Dr Maximilian Schlemmer and Rasso Braun, co-founders Controllersolution GmbH

CONTROLLERSOLUTION IS A NEW TEST-RIG COMPANY FOUNDED BY TWO AMBITIOUS EXPERTS

Controllersolution GmbH is a young German company that specializes in test-rig automation for fatigue testing of mechanical structures. Its core competency lies in the development, production, and marketing of multipurpose digital control and monitoring systems for servohydraulic control applications.

The company's two dynamic directors, technical director Dr Maximilian Schlemmer and general manager Rasso Braun (who is responsible for marketing and finance), claim to have discovered a gap in the market.

"Controllersolution GmbH is the first company to produce model-based multipurpose servohydraulic controllers that are fully interlinked with easy-to-use FE model generation and system simulation," explains Schlemmer.

"This innovative control and monitoring system provides for maximum efficiency in terms of safety, ease of operation, automation, tracking speed, and control performance," he continues. "Its design is optimized to suit the specific technical requirements and characteristics of mechanical systems using servohydraulic actuators, thus meeting all the basic requirements for efficient implementation of complex and safety-critical servohydraulic control engineering applications."

The company identifies three prime technological areas in the test-engineering industry. The first area is low-frequency control applications and there is a product portfolio of modularly extendable, model-based digital control and monitoring systems for mechanical systems with servohydraulic actuators. As a standard feature, these can be extended to handle up to 200 control channels with a control sampling frequency of 500Hz.

The second area encompasses low-frequency and higher-frequency control applications. The product group here consists of modularly extendable, model-based digital control and monitoring systems for mechanical systems with servohydraulic actuators. These can be extended to handle up to 40 control channels with a control sampling frequency of 2,000Hz.

The third area is model generation and system simulation, and is an FE model generation tool. The company profile states that its systems provide for maximum efficiency. Schlemmer is well qualified to know. In his career, he was responsible for development and implementation of simulation and control engineering systems for large-scale structural fatigue testing of the Airbus A340-600 and Airbus A380 at IABG.

"Our controller provides maximum efficiency in terms of time and money," says Schlemmer. "The test rig can be set up quickly, and it has a high test-operation speed and tracking accuracy by use of system simulation based on the FE model of the plant and model-based control methods. Our FE model generation is based on the modular principle and is easy to use because modeling does not require specific knowledge of the FEM.

So what does the company see as the current important technological developments in aerospace testing, specifically in its own specific field of test-rig automation? "There are requirements to further improve load reproduction and maximize test-operation speed, and concurrently reduce the costs of test-rig equipment," says Braun.

> **"Test-rig controllers in particular require the use of more generally available standardized industrial PC technologies"**

"Test-rig controllers in particular require the use of more generally available standardized industrial PC technologies to reduce hardware costs," he continues. "There are also requirements for an improved control performance, higher test-operation speed and reduced setup times. In the test-engineering sector, we generally see a strong tendency to use more information derived from plant-model and system-simulation tools, as well as model-based control engineering methods.

"In the test engineering field, controller hardware will be based increasingly on standard industrial PC and real-time Ethernet technologies," adds Schlemmer. "For a growing number of test-rig automation applications, performance will be improved by using a dynamic model of the plant and system simulation as well as more sophisticated model-based control engineering methods that take advantage of the availability of greatly increased computing power. This trend will be increased by customer demands with respect to fast setup, high-control performance and tracking speed for test-rig automation.

"In the control engineering field there are challenging demands with regard to higher tracking speed and improved control accuracy for test-rig automation and in particular fatigue testing of mechanical composite structures with highly non-linear transfer behavior," continues Schlemmer. "The key solution to this is the use of more sophisticated modeling techniques in line with further powerful industrial PC technologies."

In April 2009 Controllersolution exhibited at Aerospace Testing, Design & Manufacturing for the first time. Using the latest commercially available hardware and software technology, the company presented a new generation of multipurpose control and monitoring systems.

"We offer an open solution, where the customer can purchase the required standardized hardware directly from the manufacturer through a worldwide supply and support network," says Braun. "In this way, it is possible to ensure all-round customer service and offer the products at prices that are far below those of our competitors.

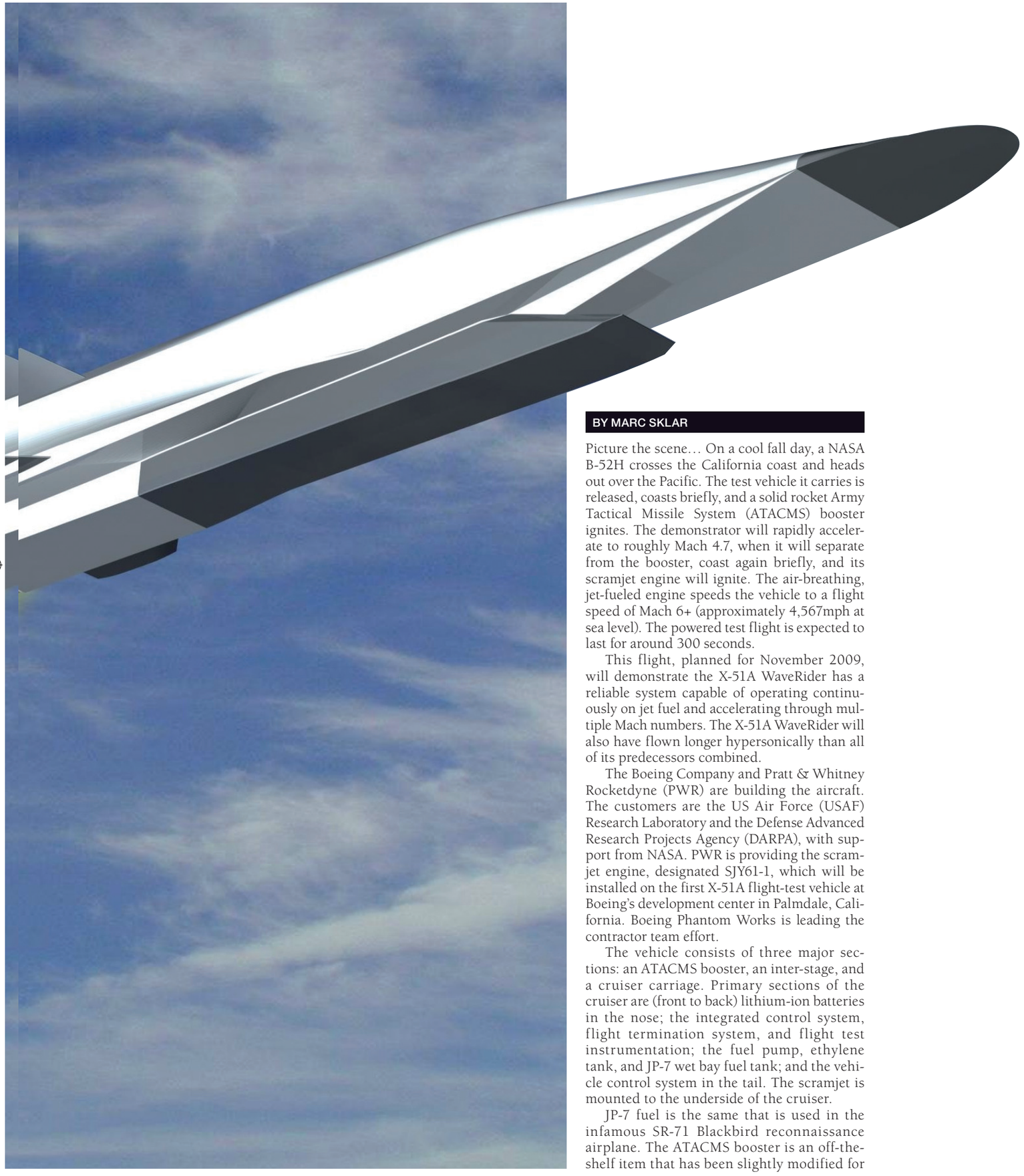
"In the future, test rig controllers will incorporate more commercially available standardized industrial PC and real-time Ethernet technologies to reduce hardware and development costs. Sophisticated model-based control engineering methods and elaborated non-linear modeling techniques, as well as system simulations, will be established to minimize test-rigs' setup time, and improve control performance."

The company also offers its control and monitoring systems in modularized field-structure cases along with compact cabinets, which are custom-made to individual requirements. ▮

Ride the wave

IT WON'T BE LONG BEFORE A SONIC BOOM ECHOES ACROSS THE EASTERN PACIFIC. WHEN THE X-51 WAVERIDER IS DROPPED FROM A B-52, ITS ENGINE WILL IGNITE AND THE VEHICLE WILL HEAD BEYOND MACH 6

"The air-breathing, jet-fueled engine speeds the vehicle to a flight speed of Mach 6+ (approximately 4,567mph at sea level)"



BY MARC SKLAR

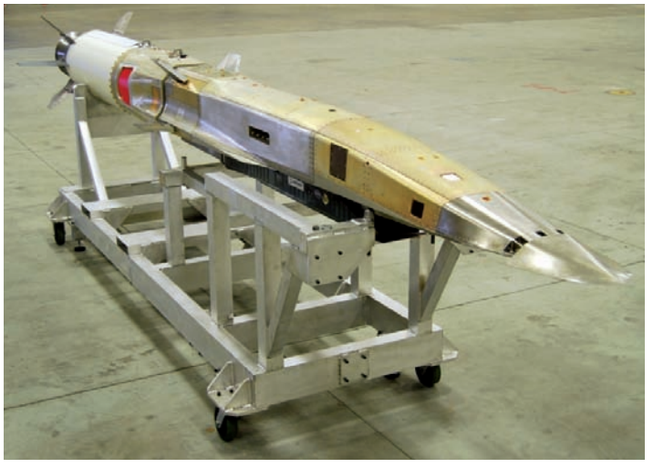
Picture the scene… On a cool fall day, a NASA B-52H crosses the California coast and heads out over the Pacific. The test vehicle it carries is released, coasts briefly, and a solid rocket Army Tactical Missile System (ATACMS) booster ignites. The demonstrator will rapidly accelerate to roughly Mach 4.7, when it will separate from the booster, coast again briefly, and its scramjet engine will ignite. The air-breathing, jet-fueled engine speeds the vehicle to a flight speed of Mach 6+ (approximately 4,567mph at sea level). The powered test flight is expected to last for around 300 seconds.

This flight, planned for November 2009, will demonstrate the X-51A WaveRider has a reliable system capable of operating continuously on jet fuel and accelerating through multiple Mach numbers. The X-51A WaveRider will also have flown longer hypersonically than all of its predecessors combined.

The Boeing Company and Pratt & Whitney Rocketdyne (PWR) are building the aircraft. The customers are the US Air Force (USAF) Research Laboratory and the Defense Advanced Research Projects Agency (DARPA), with support from NASA. PWR is providing the scramjet engine, designated SJY61-1, which will be installed on the first X-51A flight-test vehicle at Boeing's development center in Palmdale, California. Boeing Phantom Works is leading the contractor team effort.

The vehicle consists of three major sections: an ATACMS booster, an inter-stage, and a cruiser carriage. Primary sections of the cruiser are (front to back) lithium-ion batteries in the nose; the integrated control system, flight termination system, and flight test instrumentation; the fuel pump, ethylene tank, and JP-7 wet bay fuel tank; and the vehicle control system in the tail. The scramjet is mounted to the underside of the cruiser.

JP-7 fuel is the same that is used in the infamous SR-71 Blackbird reconnaissance airplane. The ATACMS booster is an off-the-shelf item that has been slightly modified for



The first X-51A WaveRider Stacked Test Vehicle arrived at Boeing in Huntington Beach on April 14, 2009

Huntington Beach

The first X-51A WaveRider Stacked Test Vehicle (STV) is currently undergoing testing after arriving in mid-April at the Huntington Beach site in California from the Boeing Development Center in Palmdale. Each X-51A vehicle is scheduled to rotate through the Huntington Beach facility for onboard system testing prior to final integration at Palmdale in preparation for test flights to begin later this year.

The Phantom Works Advanced Network and Space Systems X-51A team is preparing four test vehicles at Palmdale that include a Boeing-made airframe, an Army Tactical Missile System (ATACMS) first-stage booster, various subsystems, and a Pratt & Whitney Rocketdyne SJX 61-2 main engine.

During late 2009, at approximately 35,000ft (10,700m) over the Point Mugu Naval Test Center's Pacific Test Range, the X-51A test vehicle will be dropped from a USAF B-52H.

The X-51A WaveRider program is a consortium of the USAF, DARPA, Pratt & Whitney Rocketdyne, and Boeing to demonstrate hypersonic flight capability. It will set the foundation for several hypersonic applications including access to space, reconnaissance strike, global reach, and commercial transportation.

the X-51A. Several Boeing-developed thermal protection systems are used on exposed vehicle surfaces to help manage the extreme thermal environments.

Four vehicles are in various stages of assembly at the Boeing Palmdale/Edwards Air Force Base site. The first vehicle, the Stacked Test Vehicle (STV), was moved to Boeing's Huntington Beach facility where it will undergo vibration and structural testing. It will then be used for ground and captive-carry tests this summer, and in September it will be refurbished and flown as the fourth flight test vehicle, FTV4.

Earlier this year the program conducted a successful engine ground test program at NASA Langley Research Center in Virginia.

"The X-51A WaveRider demonstrator will set the foundation for several hypersonic applications, including access to space, reconnaissance strike, global reach, and commercial transportation," says Joseph Vogel, X-51 program manager for Boeing. "The X-51 is a true flying vehicle, not just the engine demonstrator that the program initially established. It has all the systems of an aircraft."

Complicating this development effort is the fact that the autonomous vehicle is unstable in all directions, so the interaction of computers and mechanisms that control the aero surfaces have to be carefully manipulated throughout flight. This fine-tuning has required collaboration of some of the world's most knowledgeable experts in the field of high-speed propulsion, aerodynamics, structures, and high temperature materials.

The X-51A's structure is primarily aluminum, with Boeing Lightweight Ablator (BLA) Thermal Protection System (TPS) enclosing it. There are BRI-16 tiles around the engine inlet and lower fuselage, and spray-on BLA TPS on upper fuselage surfaces. WaveRider's tungsten nose cap weighs approximately 150 lb and can withstand 2,700˚F (1,480˚C). Temperatures on the lower surfaces are expected to reach approximately 1,500˚F (815˚C) and the engine's internal exit temperature will hit approximately 3,400˚F (1,870˚C).

A unique feature of the X-51A will be how long it will actually fly by itself, Vogel points out: "The 300 second duration of the X-51A flight under scramjet propulsion is substantially longer than a lot of the other hypersonic vehicles that have been flying (such as the X-43A, which flew for 10 seconds). Basically, the X-51 is a pretty cool vehicle."

During the test, the X-51A is expected to travel about 350 nautical miles. If the system were optimized for a missile application, a modular version of the X-51A could fly about 600 nautical miles in 10 minutes, according to the program.

When the test vehicle is dropped from the B-52H, the ATACMS will propel the vehicle to about Mach 4.6-4.8. "During that stage, the air will flow through the scramjet engine," says Vogel. "It will warm the scramjet combustion chamber and help to prepare the circulating fuel prior to ignition and exit via the ducted inter-stage."

Next, the unit will roll the X-51A inverted at the top of the boost phase, so the inlet is on top for a positive angle-of-attack for optimum engine start conditions. The onboard guidance control unit and scramjet digital engine controller will control the roll.

A very short coast period will follow the burn-out and separation of the ATACMS. Then ethylene will be injected into the engine to start it (craft carries approximately 6 lb ethylene). Burning the ethylene will heat the engine, then the JP-7 will be added.

"The X-51A will run on the JP-7/ethylene mix until we reach thermal equilibrium, then we'll run on straight JP-7," Vogel explains.

Leading up to the four test flights starting in November, the program plan calls for a captive-carry test in September and an October dress rehearsal.

After the X-51A flights, there are a number of options for follow-on plans.

"We could build an X-51B and also look at larger vehicles and a recoverable vehicle option with fold-out wings, and wheels or skids. This program offers a wealth of opportunities," Vogel concludes. ▮

Marc Sklar is from the Phantom Works, The Boeing Company in the USA

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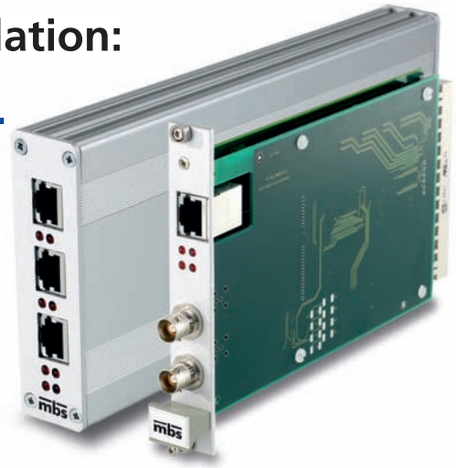

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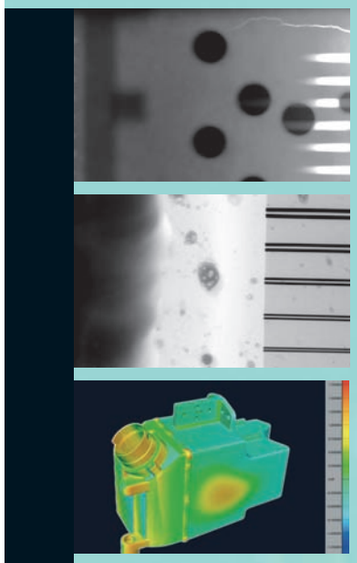

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Missile on wheels

A CAR ATTACHED TO AN ICBM ROCKET AIMS TO BREAK THE SOUND BARRIER, AND THEN PASS MACH 2. ONE OF ITS DEVELOPERS IS A VETERAN OF LAND SPEED RECORD ATTEMPTS, WALDO STAKES

BY WALDO STAKES

Ken Mason and I are aerospace engineering gypsies who work on various projects and conduct rocket-engine tests for clients. Ken designed the rocket system for the Sonic Wind ice racer, which has a theoretical top speed greater than Mach 1 and is powered by a single thrust chamber from a Reaction Motors LR-11 rocket engine. Aqueous ethanol and LOX is fed to the rocket through a modified valve originally used on the Titan 1 ICBM (intercontinental ballistic missile) with helium gas. Sonic Wind's engine is so reliable it was recently used to test a new DeLaval nozzle for a DARPA program.

Sonic Wind is 24ft long and weighs 780 lb. Its engine develops 2,200 lb of thrust for 22 seconds. As an ice racer it was impossible to find sponsorship, so it was decided to build an automobile.

Thrust in time

The car being developed by Land Speed Research Vehicles LLC is called Imagine LSRV. The vehicle itself is a testbed to work out new ideas and theories through the transonic range, and on past Mach 2 speeds on the ground.

Its design incorporates the Zen philosophy of using all the forces that act upon the vehicle to stabilize it in yaw, pitch, and roll. The speeds sound surreal, but are achievable. Currently the company owns all the hardware needed to build the propulsion system, a guidance laser, and much of the car. Imagine LSRV incorporates new ideas in aerodynamics, and the team has had to reinvent the wheel – literally. The wheel calls for extruded titanium rings (tires) slipped over hardened steel drums. This eliminates bearing problems and minimizes wheel mass while keeping centrifugal forces within tolerable limits.

The rocket engine is a modified Rocketdyne LR-105 originally used on the Atlas ICBM. It uses a two-stage technique to develop 25,000 and 40,000 lb of thrust. Propellants are refined kerosene and LOX with nitrogen and helium gases. The vehicle uses a 250W diode green laser in its nose to help guide it.

One hundred years ago when the automobile was new, the land speed record stood at 39mph, set by an electric car. Scientists of the day said that if the automobile could reach a speed of 60mph, its driver would not survive. Today, you can't keep US motorists on California highways under

The engine is essentially a highly modified Rocketdyne LR-105 originally used in the Atlas ICBM. Right: Sonic Wind was designed to set a speed record on ice

70mph. The future being impossible to predict, who knows how fast ground vehicles will be traveling in another 50 years' time?

Tunnel vision

As with all new and experimental vehicles, an elaborate testing program has to be implemented to enable an acceptable level of reliability to be reached, and ensure relative safety for the driver and crew.

First, to ensure aerodynamic stability, a wind tunnel model will be tested in a complex located at Sandia Base, New Mexico. LSRV's technical consultant Oscar W. Sepp is setting that up. The wind tunnel model has already been constructed to exacting standards by an expert modeler. Oscar W. Sepp and I lean more toward wind tunnel testing as a standard for precise aerodynamic measurement as the data is concrete and not given to miscalculations, which can sometimes be the case in a CFD program.

CFD programs are getting better all the time but are currently not an absolute substitute for the hard data provided by appropriate wind-speed testing in a wind tunnel. All you really want to know is, will the car be stable? Will it stay on the running surface throughout its entire speed range? And will the loads it generates possibly over-stress the vehicle? A good CFD program will be used, after the tunnel tests are completed, to corroborate the tunnel data.

Because a bi-propellant liquid rocket is essentially a series of tanks, valves, and lines feeding a very thirsty rocket engine, all the fuel, oxidizer, and pressurant vessels have to be hydrostatic-tested for pressure reliability and to ensure a good safety margin. This will not be a one-off performance – a land speed car may make 50 to 100 runs under full loads and stresses before it is finally retired. Once acquired, the fuel and oxidizer tanks were ultrasonically measured for consistent wall thicknesses.

The 4130 chrome moly-tube space-frame chassis sections of Sonic Wind, the ice racer, were Zyglo tested three times during its construction, as well as pressure tested to insure good weld joints. The new car Imagine LSRV is being built around a rectangular mild steel chassis, which will be pressurized at all times. In the event that a chassis crack should occur, a pressure switch tapped into the chassis will sense a change in pressure and shut down the engine, vent all expendables overboard, and deploy the first parachute to initiate deceleration.

Imagine LSRV will use an all-monitoring main computer, which will oversee the vehicle's essential systems. It will be suspended in a hammock to isolate it from heat and shock. Computers are delicate things and a desert playa environment is fatal for them. Having the computer to oversee the vehicle systems means the driver can be concerned solely with a green or red light in his line

Jet bike

Mike 'The Missile' Charlton is one step closer to completing his land speed record motorcycle. The Ohio-based construction worker is hoping to shatter the current record by more than 150mph, by passing 500mph with the aid of a General Electric J34 jet engine, homegrown ingenuity, and a healthy disregard for his own well-being.

The bodywork's rough form has been completed, which makes the bike look much more mobile. Even if Charlton doesn't set a new record, at least he'll look fast doing it.

Charlton says the J34 jet engine will produce 4,000 lb of thrust, 8,000bhp, and makes the motorcycle capable of going 500mph.

"We're going to a knife fight with a gun," says the 49-year-old construction worker. "We're treading new ground."

The bike will have solid aluminum wheels, which he says will spin at 9,000rpm at 500mph.

of sight. If the light is green, the driver can assume that all systems are go and the run can proceed. If the red light comes on at any time, an abort sequence will be initiated.

The driver will have all he can handle just controlling the car and doesn't need the workload of monitoring engine systems or suspension or braking pressures. All those systems will be preset and double-checked before each of the runs by the crew.

Wheel of fortune

The wheels planned for use on Imagine LSRV will be tested on a rocket-sled test track. The wheel concept is so new that major new ground will have to be broken to insure their integrity. Oscar is opening the doors to using the rocket-sled test track at Holloman Air Force Base in New Mexico. The current plan is to use a rocket sled with a sensor-monitored wheel assembly set on one of the rails, and launch it down the track to test its integrity. There are no dynamometers currently built that can spin a wheel to the velocities that are envisioned. That operation will be a bit of an undertaking in itself.

LSRV LLC already owns all of the components for the entire propulsion system (including back-up parts), and the chassis is 50% complete. The first engine tests will be completed in a year, and the car will be up on its wheels in 18 months to two years' time. As with everything, the X factor is that funding stays current. Ideally, we will be ready to run around the same time as the British Bloodhound SSC.

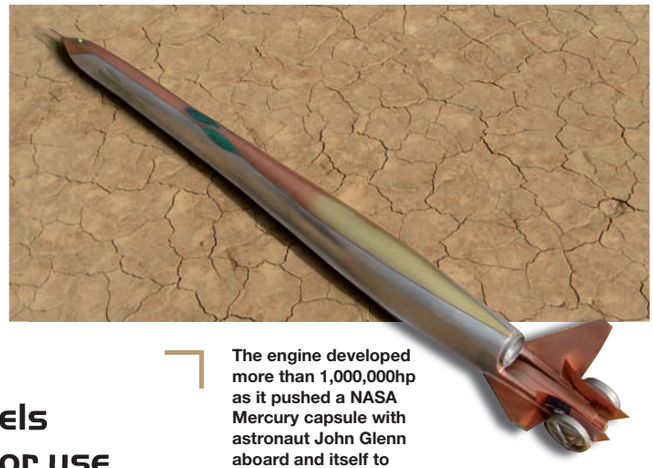
The dream

Picture this… You're standing in the middle of a desolate playa. There is no wind or sound other than the humming in your own ears. The sun has just risen behind you and it is already warm.

Ahead of you lies a 20-mile speed course marked with vibrant green and orange flags. You are standing at the center of the 'measured mile'.

You wonder if maybe you are a bit too close but you reassure yourself that you have seen the Space Shuttle launch and stood at the fence of a Grand Prix, so how bad could it be? Behind you is a pickup truck, the radio tuned to the driver's broadcast. The run is just about to begin.

You are enjoying this beautiful and serene place as you hear the driver's voice: "Push vehicle engaged… Beginning run." Her voice sounds matter of fact and calm considering what she is about to attempt. "Push vehicle clear, engine ignition sequence started… Engine on!" She grunts, her voice reflects the strain of a positive 5g load and ignition hit from the vehicle's powerful rocket engine, which comes up to power in one second. Imagine LSRV is accelerating at 100mph per second.



The engine developed more than 1,000,000hp as it pushed a NASA Mercury capsule with astronaut John Glenn aboard and itself to orbital velocity

> **"The wheels planned for use on Imagine LSRV will be tested on a rocket-sled test track"**

In a couple of seconds she calls out more loudly and a bit concerned now: "Transonic… maximum power!" A few seconds later she calls out, "Supersonic!" There is no doubt that she is under terrific strain now. You know you should be able to see the car soon as it has by now exceeded Mach 1.5. You scan the southern horizon and think you can make out some dust, but it is still difficult to tell.

This is when you notice a beautiful bright beam of green light dancing in front of you. It is floating above the center of the track and bouncing slightly up and down as it stretches to the northern horizon. You snap back to reality and as you turn around, the car is now silently directly in front of you!

For a second your eyes focus on the vehicle. You can see strong shockwaves distorting light just like in a wind tunnel photograph. They radiate out and sweep back 60° from the nose, canopy, and the tail fins, and there is a bit of ground rippling caused by the lower shockwaves. The vehicle is moving fast yet your mind slows down time as it streaks silently by. It is running straight and true like an arrow.

Everything is absolutely silent. A second later, it is past you and… Wham! You have been knocked against the truck. You are now hanging on, looking at the rear of the rocket car as it streaks away. The engine is trailing a powerful, bright yellow plume studded with shock diamonds.

In an instant it is a quarter of a mile away, and the hissing roar of the engine is deafening. You cover your ears but it is no use, your entire body is absorbing its low-frequency, deafening pulse.

As quickly as it had begun it is silent again. The deceleration parachute looks like a tiny, white doily dancing on the horizon in the center of a large, flat dust cloud. You hear the driver's voice much relieved yet strained: "Chute is out!"

You should get into the truck and see how the driver and vehicle have fared, but it is all you can do just to get to your feet. You are humbled and awed at what you have just witnessed and you know you will never find that baseball cap you were wearing a minute ago. ▮

Waldo Stakes is the designer, builder and CEO of LSRV LLC

SGL group expands testing using Zwick equipment

The SGL Group is a leading manufacturer of carbon products. SGL's aim in opening a new research and development department in Meitingen, near Augsburg, Germany is to boost its innovative capacity. The new R&D centre coordinates all the SGL Group's development activities worldwide and employs Zwick testing machines for mechanical testing of materials and components. The advantage is that products, software and service all come from one source.

Carbon and graphite products are employed when other materials such as steel, aluminium, copper, plastics, wood etc. fail due to their limited material properties. Carbon-based products combine several unique properties, such as heat and electrical conductivity, heat and corrosion resistance and lightness combined with strength.

The Wiesbaden-based SGL Group is a world leader in the manufacture of carbon products. The firm's comprehensive portfolio ranges from carbon and graphite products via carbon fibres to composite materials. SGL Group's core competencies lie in their mastery of high-temperature technology and their ability to bring to bear many years of application and engineering expertise. SGL products are principally used in the steel, aluminium, automotive and chemical industries. However, their customers also include the semi-conductor, solar, wind energy, battery (dry/rechargeable), environmental and aviation industries.

EIDEL

- Innovative electronics

EDDAS

EIDEL Distributed Data Acquisition System

EE 250 Data acquisition, telemetry & storage system. The network topology allows up to 7 levels in a tree structure without exceeding the 100ns simultaneous sampling, achived by PTP mecanims.

Characteristics

- Rugged design for flight environment
- Distributed system topology
- Modular and scalable
- Customizable - easy to configure
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- Simultaneous sampling (System accuracy 100ns)
- Data time sampling
- Ethernet based data acquisition bus (DAB)
- iNet compatible

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Expo innovations

AS THE CURTAIN CAME DOWN ON AEROSPACE TESTING, DESIGN & MANUFACTURING 2009 IN MUNICH, IT WAS ANNOUNCED THAT THE SHOW WOULD BE MOVING BACK TO HAMBURG. HERE IS A LOOK AT SOME OF THE HIGHLIGHTS IN BAVARIA

BY CHRISTOPHER HOUNSFIELD

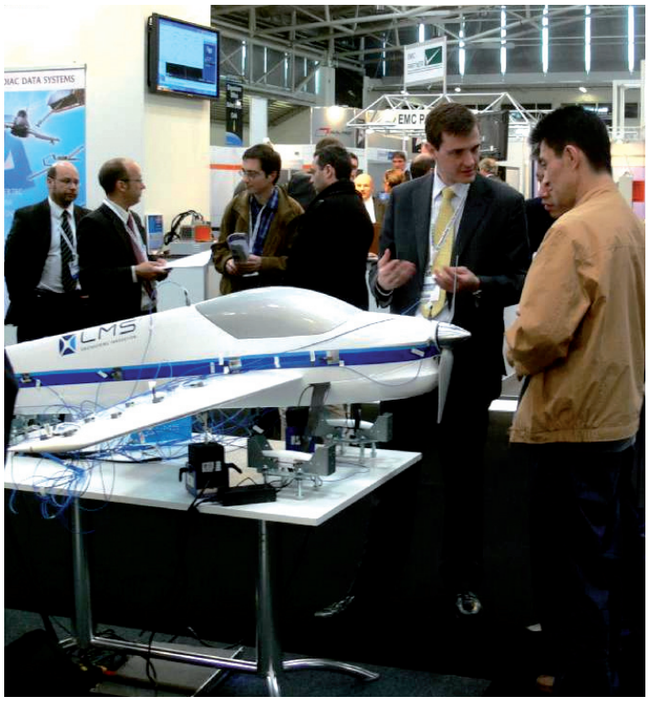
At the conclusion of the show in Munich, the organizer of Aerospace Testing, Design & Manufacturing announced an anticipated return to the Hamburg Messe in 2010, to run alongside Reed Exhibitions' hugely successful Aircraft Interiors Expo from May 18-20.

"Despite the difficult economic situation we are all facing, we welcomed over 2,000 quality suppliers and buyers of aerospace testing design and manufacturing solutions to network and do business under one roof over a three-day duration," says Jonathan Heastie, exhibition director.

"It was super," says ACRA Control's marketing coordinator, David Milson, of the third annual show. "Good-quality visitors and a worthwhile investment." Tim Huppler, director of propulsion systems at Bombardier thinks the show was an excellent platform to present the C Series. "I made some very useful contacts and will certainly look to attend in Hamburg next year."

The opening day hosted a number of international visitors. Day two was the busiest with a large contingent of engineers and buyers from Germany. Day three was focused on young university engineers with a series of student tours and visits to exhibiting companies. Reed Exhibitions also flew in key chief engineers and technology directors from major engineering companies, including EADS, Boeing, Alenia, and Bombardier for the event. They participated in a series of networking lunches and briefings along with other representatives from Airbus from both Hamburg and Toulouse. "These networking events were highly successful and they will be a key feature at next year's Hamburg event," says Heastie.

During the show he also presented Dimitrios Sikoutris, PhD candidate, with the Young Aerospace Engineer of the Year Technology and Innovation Award on behalf of his 13-strong team at the University of Patras, Greece, for the Atlas Project. This involved the development of a radio-controlled fully composite aircraft. The team was praised by the judges for its handling of technical problems with a two-level approach, first with a preliminary concept, then a more detailed one. ▮



More than 200 exhibiting companies took part in the show

DATABUS INTERFACING

MBS Electronic Systems's line of interface products transfer data in real time between an avionics databus and a standard Gigabit Ethernet LAN.

ÆSyBus modules for MIL-STD-1553, ARINC 429, AFDX and RS-485 represent a significant departure from traditional interface cards. They are standalone units which easily connect to any computer operating system. All data transfers are processed in hardware at line speed and communicate with UDP/IP. This results in no software bottlenecks and extremely low latency.

"We looked at the trend in data communications, which is away from parallel and towards high-speed serial," says MBS director Charles Nicholls. "But rather than inventing a new protocol, we decided to leverage what's already there. Ethernet and IP protocol have been in use for 30 years. As technology has evolved and data rates increased, these standards have kept pace – while remaining backward compatible. So unlike PC technologies, which get replaced every few years, Ethernet and IP will likely be around for another 30 years."

Multi-user access is another advantage. Up to 10 users can log-on simultaneously to control and monitor bus transactions. A broadcast option allows some 250 additional users to receive data. "And rather than having to buy expensive custom cables and proprietary software, as with traditional interface cards," adds Nicholls, "you can use readily available, low-cost Ethernet cables and switches… along with your favorite analysis programs, like LabVIEW."

SYSTEM INTEGRATION

For the A380, TechSAT has completely overhauled its System Integration Bench (SIB) design. TechSAT has come up with a core test system concept that is strictly committed to the principles of modularity and standardization, therefore promoting the use of industry and open standards as well as COTS solutions whenever possible. Customers can choose from a large catalog of standardized components, which are then supplemented by all special-to-purpose devices required to accomplish the optimum solution for the unit under test (UUT).

An invaluable asset of the SIB is the integrated Avionics Development System 2nd Generation (ADS2) software package. Its real-time features allow designers and engineers of avionics controllers to simulate the UUT environment, sensors and actuators, to switch from simulation mode to real devices operation, as well as to complete system integration, software verification, performance, and acceptance tests. Additionally, the package contains an ample set of data-acquisition, error-injection and analysis tools for all major avionics I/O types such as MIL-STD-1553, ARINC 429, CAN, Discrete, and RS232/422, including a complete AFDX bus analyzer and simulation utility for the new A380 bus protocol.

BOMBARDIER CONTRACT

At the show, Marshall Aerospace Test Services announced it had been contracted by Bombardier Aerospace to perform tests on the outboard wing flap for their newest aircraft – the CRJ1000 NextGen jetliner.

The CRJ1000 NextGen airliner is Bombardier's optimized solution in the regional airline industry for medium-haul applications. As part of the official approval process, Test Services will be working with Bombardier and TC to provide the data for certification of the outboard wing flap. This will be carried out at Marshall's engineering test facility in Cambridge, UK. "Marshall was selected due to its extensive experience in the area of aircraft maintenance and testing, and its outstanding ability to provide a complete end-to-end solution for the duration of the project," says head of Marshall Aerospace Test Services Michael Da Silva.

SERVOHYDRAULIC SYSTEM

Zwick Roell is a leader in static testing and is experiencing growth with fatigue testing systems. At the exhibition, the company displayed its servo-hydraulic testing machine Amsler HC 10 for testing of rotor blades.

The system can be used for fatigue testing under both tension and through to zero loading conditions, using periodical or random signals. It is also able to perform quasistatic tests.

The machine has an integrated hydraulic whisper-pump, a T-slotted table, integrated measurement and control electronics HydroWin, and software testXpert and Workshop. It advantages include: compact and space saving design, a test frame design which provides a very high stiffness and natural frequency, and simple and safe operation through proven software-controller combination. It can be easily customized to various customer requirements.

ROBOTIC SHEAROGRAPHY

Manual NDT inspections are no better than the quality of the operator. This fact, combined with the complexity of modern composite sub-assemblies, means that NDT systems need to be more sophisticated.

Composite materials have been optimized in order to save on weight, and the shapes are often advanced 3D curvatures. This forces NDT inspection methods to become non-contact to achieve higher inspection quality. Dantec Dynamics' latest robot system was launched in 2008. This system, a fully automatic robotic shearography system, has now been installed with a leading business-jet manufacturer in the USA. The robot system performance is capable of inspecting 1-2m² per minute for arbitrary geometries.

The system operates in a vacuum chamber. It can boost the material with up to 3kW of heat if necessary. Objects are illuminated with eight laser diodes and the shearography sensor reads out real-time phase stepping results. The system's interface is constructed for ease of use. The robot system can also be equipped with a software sound excitation mode for vibration shearography through a piezo shaker or loudspeaker.

CONTROL AND DATA ACQUISITION

MTS Systems Corporation announced the launch of AeroPro 6.1 software, the latest version of its control and data acquisition software for aerospace structural testing. AeroPro 6.1 builds on the powerful test-acceleration capabilities of version 6.0 with new features designed to help aerospace test labs improve the speed, efficiency and safety of aerospace structural testing.

"Test labs are being pushed to perform more complex cyclic and static tests faster and often with fewer test articles," says Mike Englerth, MTS aerospace product manager. "AeroPro 6.1 software provides the capabilities they need to streamline the setup of complex structural tests, ensure the safety of valuable test articles, improve post-test analysis and adapt quickly to changing demands."

New AeroPro 6.1 software features a number of new utilities for accelerating structural test setup, including signal-based command via look-up table, a wizard for simplifying and automating active load-abort system setup, and command based on an external signal.

HIGH SENSITIVITY ACOUSTIC PRESSURE SENSORS

Series 103B ICP acoustic pressure sensors from PCB Piezotronics Inc measure pulsating, transient, and turbulent acoustic phenomena on transportation vehicles and other structures. These high-sensitivity sensors are ideal for applications such as aerospace wind-tunnel testing, aerodynamic testing and analysis, aircraft cabin and cockpit noise testing, and acoustic fatigue testing on airframes.

ICP style sensors feature built-in signal conditioning microelectronics to produce clean, low-impedance voltage output signals, and are offered in three configurations: pigtail wire solder connection, 10-32 top connector, and 3-56 side connector. Each configuration is available in sensitivities of 500 or 1,500mV/psi (72.5 or 217.5mV/kPa) and ranges of 10 or 3.33 psi (68.95 or 22.96 kPa). Discharge time constant allows the sensors to follow transient events up to several hundred milliseconds in duration.

PCB Piezotronics is a leader in the design and manufacture of force, torque, load, strain, pressure, acoustic and vibration sensors, as well as the pioneer of ICP technology. The instrumentation is used for test, measurement and feedback control requirements in automotive, aerospace, industrial, R&D, military, educational and commercial OEM applications.

"The aircraft industry has always developed in this free spirit manner, which has brought very rapid progress from the paper aircraft to the sound barrier"

Laurent Dumortier

Vice president Sunaero, president Aerowing

When a mechanical component fails, it can normally be replaced within a few minutes, or a few hours – maximum. An engine can also be replaced within a few hours. However, when an aircraft structure is damaged, the downtime can be long. A typical example is a fuel leak that can ground an airplane for several days, sometimes weeks.

Sunaero and Aerowing are companies dedicated to developing integrated technologies, enabling maintainers to troubleshoot fuel leaks and repair them in a known and managed timeframe, greatly reducing aircraft downtime. In the example of a fuel leak, they can provide detection systems, rapid desealing systems, rapid curing devices, and repair verification systems. These products provide a process to insure that the operator will be able to return the airplane back to flight within eight to 12 hours.

Laurent Dumortier is vice president of Sunaero, where he is in charge of R&D and business development, and is president of Aerowing.

How will the systems comply and benefit the industry, and where are they aimed?

Sunaero and Aerowing are focused on developing new processes to expedite airframe repairs, and are continually introducing new technologies to the industry.

Basically, all our developments are conducted in collaboration with industry leaders, aircraft manufacturers, worldwide air forces, and the US DoD, etc. Once the process is determined, it goes in-house for the laboratory validation and industrialization phases, which are performed according to our quality system. Once the product is finalized it goes through a batch of field tests, which are performed with launch customers.

This procedure insures that the product will answer a real market need.

Your company says it can operate in hazardous environments. Can you give an example?

In the case of a fuel leak repair, Sunaero and Aerowing have developed an array of high-technology tools that can operate inside a wet fuel tank, considered as a Class1 Div1 hazardous environment. The two companies are approved for the manufacturing of Class1 Div1 safe tools, according to ATEX, FM Approvals and CSA/NRTL standards.

What do Sunaero and Aerowing see as the current important developments in aerospace testing, specifically in your field of leak detection?

The detection criteria are becoming more and more stringent. Aircraft manufacturers and operators understand that leak tightness is very important to prevent downtime, incidents, and environmental issues. The need for new instruments – always lighter, smaller, and more versatile – is obvious. Operators require the capability to transport lightweight tools to on-site repair locations, and leak detection is becoming a tool that maintainers want in their toolbox.

What do you believe are the main testing problems that need to be overcome?

The next challenge is to keep improving sensitivity on simple sensors, because the next step is to jump from leak detection testing to quick, on-site, permeation testing. Most structural tanks, pipes, and onboard gas bottles on new programs are made of composite material, which, by essence, is a permeating material. Permeation rate detection will be a good way of tracking, to follow up composite material aging.

If hydrogen was to become the most prevalent fuel in use in the aircraft industry, very accurate leak detection would be mandatory to insure safety and efficiency.

What message would you like to give the aerospace industry?

Science and engineering are facing a few limits that can always be pushed higher. Small, dedicated companies, when asked by main players, always offer good support to push those limits higher. Why? Because for a small organization operating in the aerospace industry, creativity is vital to ensure company development. The focus is there to invent solutions for the future. The usual vision of the management of these entities is frequently to refuse anyone else from outside to set technical limits.

The aircraft industry has always developed in this non-conventional, free spirit manner. This trend has brought very rapid progress from the paper aircraft to the sound barrier. This remains true today, assuming the financial world keeps financing projects, leaving freedom for researchers and engineers to be creative.

Environmental challenges we are facing now will require a lot of inventiveness and creativity, especially in our industry. A lot of progress is to be made, impulsed by 'limits pushers' coming from various horizons. It is time to again listen to these 'crazy' inventors and give keys to real industrial captains who carry a serious technical vision to invent our future. ▮

The best bit

RF LINK SYSTEMS HAVE EVOLVED QUICKLY, AND NOW ACRA CONTROL'S ANALYSIS PACKAGE GSWORKS CAN BE USED TO VIEW AND ANALYZE DATA

BY STEPHEN WILLIS

In 1903 at Kitty Hawk, North Carolina, telemetry amounted to little more than one Wright brother shouting at the other. By the 1960s, the IRIG-106 standard emerged for transmitting digitized parameters using a continuous PCM stream.

Now, the number of parameters and the sample rates have increased, but the bandwidths available have remained static or are decreasing. Problems such as fading, multi-path, blind spots, interference from other RF equipment, thermal noise, baseline drift, and Doppler effects make recovering the data from the PCM/RF link difficult. Methods to mitigate these effects include: use of commercial networks such as satellite links or telecommunications cells to transfer data; the use of direct RF digital processing techniques to upgrade the current PCM/RF-link technology; and use of existing RF equipment, but with modern bit-synchronizers and combiners.

The third method merits closer examination, considering the extensive and expensive infrastructure already in place to support the PCM/RF link along with the trained personnel to use it.

In sync

Bit-synchronizers lock on to the incoming frequency (and phase), adjust the offset and gain, and then decide if each bit is a '1' or a '0'. The mathematics associated with the bit error rate (BER) as a function of the signal-to-noise power ratio (Eb/No) have been around since the 1940s. Until recently, bit-sync designers had a target of '1dB from theory', approximately 10 times the number of bit-errors per trillion bits of a perfect bit-sync.

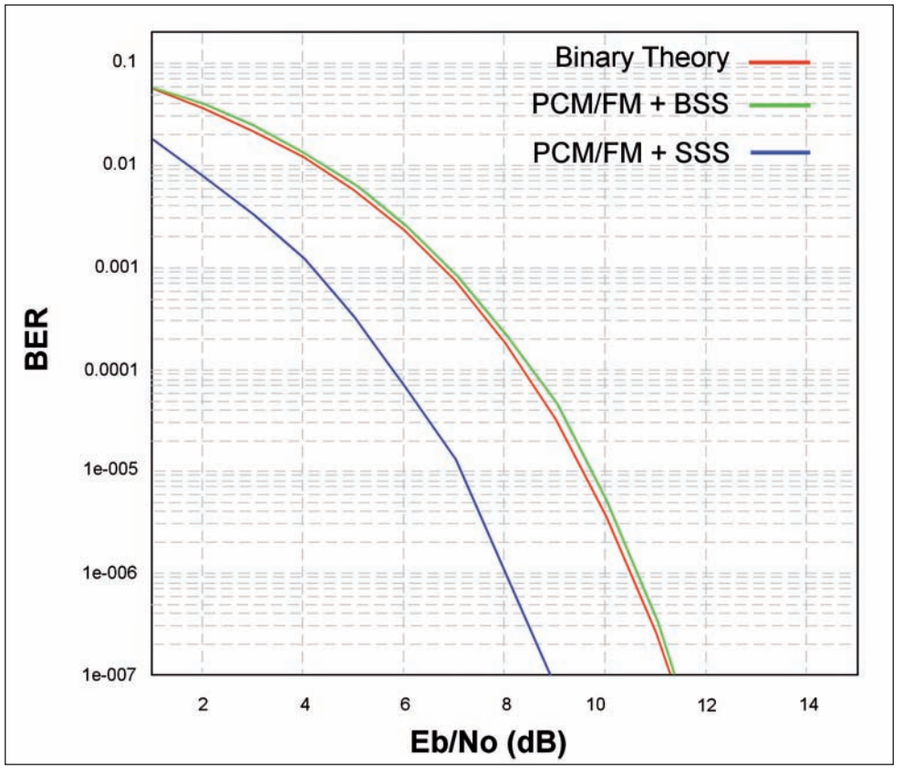
In the last decade the advent of low-power, high-speed (>100Msps) and high-resolution analog-to-digital converters (>14bit) has meant that today's bit-syncs are very close to theory (<0.25dB) – 100 times better than 1990s state-of-the-art. This is because an all-digital phase locked loop means there are no 'valleys' or blind-spot frequencies where bit-syncs underperform, and no analog components that might drift and require calibration.

Plus, ideal results require a 'matched filter' (which emphasizes the data part of the signal while de-emphasizing the noise part of the signal), and these are extremely difficult to implement without digital processing. The threshold used to determine if a bit is a '1' or '0' depends on the values of the surrounding bits. This inter-symbol dependency causes errors unless handled using decision-directed equalizer techniques, or imposing 'root raised cosine' bit-shapes on the transmitted symbols.

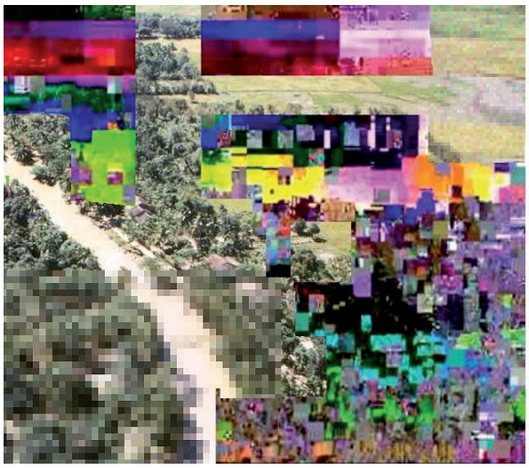
These techniques mean that today's single bit-synchronizers are at the theoretical limit without resorting to bit error detection and correction encoding techniques at the expense of bandwidth.

Multiple bit-syncs

Multiple bit-syncs are only beneficial if each has an input from a diverse receiver, as BER is dependent on Eb/No. Two bit-syncs with diverse RF receivers yield a possible 1,000 times fewer errors (given independent noise at each receiver). The receivers might be far apart (spatial diversity), have different carrier frequencies (frequency diversity), or have different angular orientations (polar diversity). With four diverse inputs, a mil-



Graph showing the BER improvements gained with an Acra Control SSS over a typical best source selector



Left: Useful data can be recovered by applying diverse receivers and smart source selectors

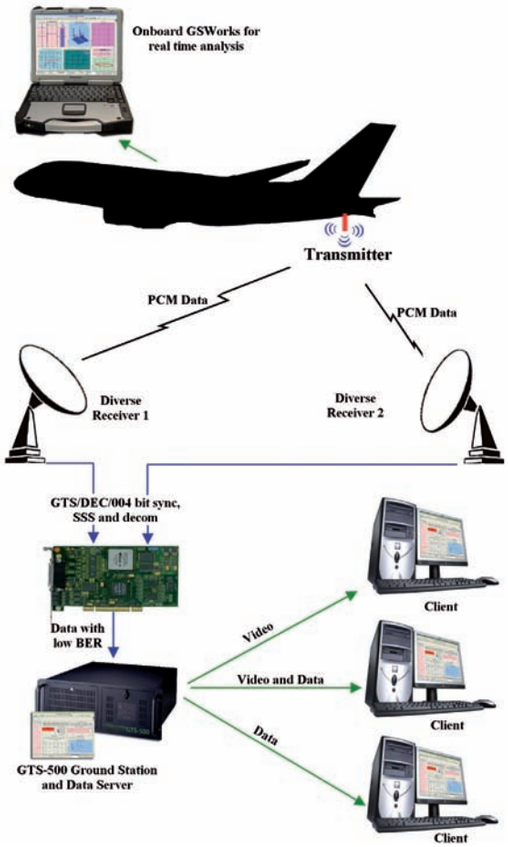
Below: The interaction between transmission, reception, and data analysis

lion times fewer bit errors is possible, a billion with eight, and so on.

Two common methods to combine diverse outputs are 'best data selectors' and 'best source selectors'. Best data selectors examine decrypted data's quality metrics (such as sync-word errors) and typically output the frame with fewest errors. Best source selectors keep switching to the channel that seems to have the best Eb/No. Few of these devices align the streams before switching, thus causing bit-slips further down the chain.

A modern method uses smart source selectors (SSS). They use best data metrics and/or best source metrics to decide which streams are 'good enough to combine' – they then time-align the selected streams and use the soft-bit powers for each bit to decide if it is a '1' or a '0'. With a best-source or best-data selector, the best failure rate you can hope for is that of the best receiver at any one time. With a two-channel SSS you may get one million fewer errors.

The problems of RF reception can be reduced, increasing the coverage of the test area (both in range and by reducing blind spots). The end result could be as important as turning previously corrupted video into valuable data, or major time savings due to increased coverage, higher viable data rates, and fewer data gaps. Increasing the number of diverse receivers and the channel count in the SSS-enabled bit-sync offers further improvements (such as an eight-channel system yields approximately one billion fewer bit errors). Today, two bit-syncs and two decoms (or a smart source selector) can fit on a half-size PCI card – four and eight channels are currently in development – enabling a ground station PC to recover the information and to act as a database server. One or more clients running real-time analysis and display software can be networked to the database server, each receiving some or all of the recovered data. The same software can also be used for in-flight analysis, last-minute line checks, and post-flight mission debriefs and analysis.



Putting it together

Acra Control's analysis package GSWorks (based on Symvionics IADS) is used to view and analyze data on board while a subset of this data is transmitted through a traditional PCM link to multiple ground receivers. A dual-channel smart source selector decom is used in the GTS-500 ground station to recover the data. The ground station, running GSWorks, now acts as a local database server for multiple clients – each analyzing different sub-sets of data at different rates over different intervals of time (real time and historic). One advantage of this system is its scalability. The technology can be used in a small mobile ground station that uses a single PC to recover, store and analyze the data. By simply expanding the number of receivers, SSS channels, and client PCs, a ground station can gather data from a large test site, and send data to dozens of control-room workstations. ▮

Stephen Willis is an engineer with Acra Control

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Up close and personnel

STAYING EMPLOYABLE OR COMPETITIVE IS AN ONGOING CHALLENGE IN THIS DIFFICULT CLIMATE, SO THE PERFORMANCE REVIEW INSTITUTE HAS DEVELOPED A PERSONNEL QUALIFICATION SYSTEM FOR THE AEROSPACE INDUSTRY

BY ARSHAD HAFEEZ

Aerospace is not the industry it used to be. This is for a variety of reasons, ranging from an aging workforce to globalization. The industry is working hard to ensure continuity and knowledge transfer, not least with regular conferences and events to address these issues. At the Paris Air Show, for example, there is now a dedicated careers and training area, which follows the success of the 2007 event, which had 50,000 visitors. Clearly, those in the industry are well aware of the issue and understand that the way to retain their jobs in this increasingly difficult environment is by making themselves as attractive as possible to their employers. The same is true of manufacturers and OEMs: few of them are the end user, and they also know that to keep their customers and market position, they must be as competitive as possible.

In April 2009, Bombardier Aerospace announced 3,000 job cuts, approximately 10% of its workforce, blaming the global financial crisis. The lay-offs are in addition to the 1,360 job cuts announced in February when Bombardier adjusted the production rates of its Learjet and Challenger aircraft. This year's total employee reduction of 4,400 at Bombardier Aerospace represents 14% of its 32,500 aerospace workers. Of course, Bombardier Aerospace is by no means alone; it is just one example among many.

Staying employable or competitive is an ongoing challenge in this difficult climate, and it is not just about cost. The focus instead is on value. It is the responsibility of the individual and organization to make sure they are optimizing their capabilities. The aerospace industry as a whole has recognized its role, working with the Performance Review Institute (PRI) to ensure consistency and competency validation across all manufacturing personnel, while mitigating knowledge loss or disparity due to attrition, turnover, and/or relocation.

As part of PRI's Customer Solutions and Support (CS&S), aerospace experts have worked together to develop eQuaLified, which is an industry-recognized special process personnel qualification system developed and validated by subject matter experts. This is complemented by the existing eQuaLearn, which offers general quality training, another area identified by the industry as needing attention. With involvement from major industry representatives such as Alcoa, Rolls-Royce Corporation, Spirit Aerospace, and Vought Aircraft, the topics include internal auditing and root cause corrective action.

By using the industry's subject matter experts to develop this training and qualification program, eQuaLified will contribute to the successful knowledge transfer to the next generation within the aerospace workforce.

"The ability to develop this training together with an industry consensus is the real strength of the program," notes PRI business development engineer Stan Revers. "Industry input has

Engineer Elsa Muyco washes excess penetrant from a test piece during the eQuaLified Non-Destructive Testing pilot training class

been absolutely vital. To be able to tap into these resources as needed is highly beneficial for PRI in developing the program, and ultimately, a truly positive activity for the industry as a whole."

Based on 'bodies of knowledge' established by participating 'primes', industry experts have objectively characterized the special processes, skills, and knowledge of aerospace personnel levels.

These levels include: process operator (personnel who understand and perform the basic hands-on operations of the special process), and process planner (personnel who are capable of designing manufacturing processes and interpreting process procedures to conform to customer specifications and requirements). Process planners are also capable of problem solving and resolving day-to-day issues.

Then there is the process owner level, which includes personnel who are capable of writing, reviewing, and approving processes, procedures, and qualifications of lower levels. Process owners are capable of designing new processes and resolving issues among all the other levels.

Laurie Strom, special processes manager at Honeywell Aerospace, says, "Honeywell and others in the aerospace, transportation, and technology businesses recognize that trained, talented engineers are key to our success. eQuaLified enables us to identify and work with the best."

How heat treating can affect the atomic arrangement of structures

No one is more qualified to size up the effectiveness of a training program about a special manufacturing process than the people who perform that process day in, day out. PRI, the organization that administers Nadcap, the aerospace industry's cooperative program for ensuring that companies performing special processes comply with exacting standards, got just this kind of 'guru validation' from Goodrich and Honeywell employees.

In February 2009, PRI instructors were at the Goodrich Chula Vista facility in California to conduct a pilot training program on heat treating, non-destructive testing, and welding.

"Inadequate training in special manufacturing processes, or the lack of any training at all, is a common finding during Nadcap accreditation audits conducted around the globe to ensure the competency, capability, and consistency of companies performing special processes," according to Goodrich Enterprise quality director Kevin Ward. "In recognition of this shortcoming, prime aerospace contractors and suppliers, including Goodrich, have pooled their resources to help PRI develop special manufacturing processes training. By gathering input from these sources, PRI has put together a cohesive, global training package."

To validate the training with subject matter experts before rolling it out to the world, PRI has been conducting pilot programs in various places. In December 2008, for example, the first pilot training took place in London. Attendees included employees from the Goodrich Engine Controls and Actuation Systems business units, as well as personnel from Aircelle, Bombardier, BAE Systems, Eurocopter, and Honeywell.

"Through eQuaLified, we can reliably judge the suitability of a candidate to perform special process tasks because it indicates a certain level of individual proficiency, all over the world," explains Chet Daté, director of quality systems and regulatory compliance at Honeywell Aerospace.

As the industry, and the economy, becomes increasingly global, this will be all the more important. ▮

Arshad Hafeez is executive director of global business operations and corporate strategies at the Performance Review Institute

Lord of the rings

WHAT EXACTLY IS AN INDUCT-A-RING SHAKER? UNHOLTZ-DICKIE HAS BEEN MANUFACTURING ITS ARMATURE SYSTEM SINCE THE 1970s

BY PHILIP ROGERS & MICHAEL GAROFALO

Conventional electrodynamic (ED) shakers use the same basic design configuration as a loudspeaker: an AC voice coil suspended in a DC magnetic field that's driven by an audio amplifier to produce vibration (sound). All conventional ED shaker designs have used this basic configuration, stepped up to industrial-strength proportions. Therefore most of today's conventional shakers use a multi-turn wound armature coil (air-cooled or sometimes water-cooled), which interacts with a fixed DC magnetic field (produced by field coils) to develop output force when the driven armature coil receives AC current from a power amplifier.

This 'moving driver coil' design philosophy completely dominated ED shaker development until about 1970, when two important things happened. First, Unholtz-Dickie engineers developed a line of solid-state (low-voltage/high-current) power amplifiers that soon replaced the earlier high-voltage/low-current vacuum tube amplifier designs. Then, in concert with the new power amplifier development, Unholtz-Dickie engineers came up with a breakthrough shaker design that moved the driven AC coil from its original position on the moving armature frame to a stationary location within the ED shaker iron structure, but closely surrounding the bottom half of the moving armature. The lower section of the armature was changed to a solid metal, single-turn coil made from an aluminum forging. In this new shaker design, the power amplifier delivers AC current to the relocated stationary driver coils (called stators). These stator coils then induce AC voltages into the single-turn armature ring they surround. The inductive coupling action produces AC currents in the armature ring, delivering AC force output at the moving armature.

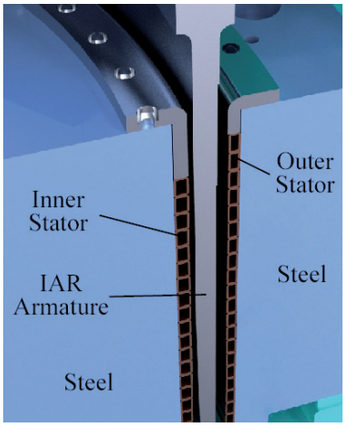
This armature design was named Induct-A-Ring (IAR) and was put into production in the early 1970s.

Since then the Induct-A-Ring shaker family has grown into a formidable line-up of vibration test systems rated from 15,000-55,000 lbf (67-245kN).

Unholtz-Dickie is the only electrodynamic shaker supplier offering Induct-A-Ring armatures.

Conventional shakers use a wound-coil assembly, attached to the lower frame of the moving armature. In many high-force shakers, the power amplifier must deliver 1,000+ amperes of AC current to this moving coil to generate AC force output. A conventional driver coil winding is typically made with hollow tubular wire that must be water-cooled to achieve sufficient heat transfer to cool the armature coil. As a result, this 'wound-coil' configuration requires a high-current-carrying linkage between the moving coil and the stationary shaker body, and also flexible hose linkages to deliver cooling water in and out of the coil.

At low frequencies, both these linkages (current and water) are flexed up to the full stroke rating of the shaker. At higher frequencies they are subjected to high g inputs that can occur at the resonant frequencies of these linkages. Current linkages and water-cooling hose assemblies are the proverbial Achilles heel of a wound-coil armature, and are the cause of many armature failures.



The Unholtz-Dickie T4000 IAR Armature

Also, the wound driver coil consists of multiple turns of wire held together with many epoxy joints. These joints are potential failure sites due to fatiguing of the joints or voltage breakdown (shorting) between adjacent wires. To remain within the temperature limits of the epoxy, the coil temperatures must be kept under approximately 2,500°F (1,210°C).

The Induct-A-Ring armature uses a solid metal cylinder (ring) as the moving coil, with approximately 0.5in (12.7mm) wall thickness. The force-generating AC currents in the IAR single-turn coil are produced by induc-

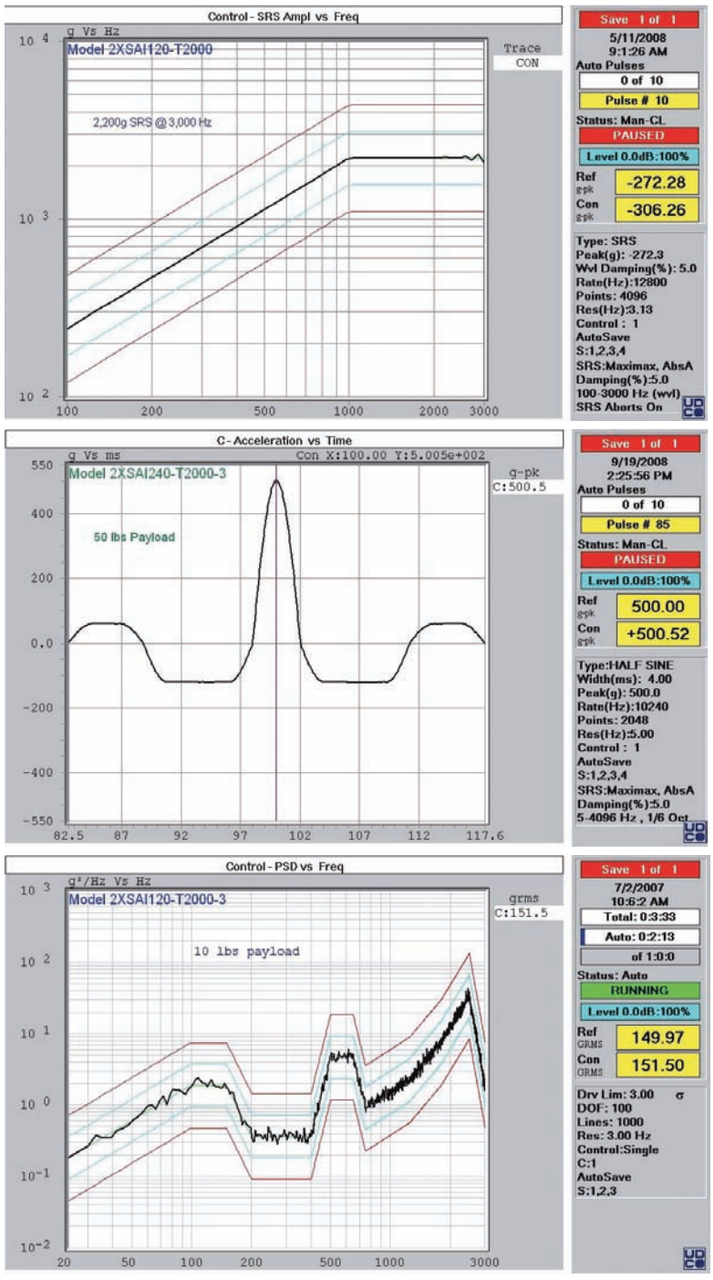
FAQs

How big are Induct-A-Ring armatures?
They come in two sizes: 17.5in diameter and 25.5in diameter (444mm/648mm).

What kind of low-frequency output can you get with Induct-A-Ring shakers?
Although operation to absolute DC is not possible, the usable low-frequency range limit for all T2000/T4000/T5000/T5500 shakers is 2Hz.

What about high-frequency performance?
IAR armatures have much higher resonant frequencies (Fn) than comparable wound-coil designs. The IAR's high-frequency performance advantage is tied to its solid metal construction and lack of epoxy joints in the moving armature. As a result of these superior Fn numbers, the T4000/T5000/T5500 shakers deliver full rated force to 2KHz, and some T2000 system configurations deliver full rated force to 3KHz.

Why do IAR armatures have higher 'max *g*' ratings than wound-coil armatures?
The standard IAR armature structure comprises a solid metal-forged ring that's bolted rigidly to its upper web casting, producing a mechanically preloaded metal-to-metal interface joint. This solid metal assembly contains no epoxied windings, current-carrying flexures or water-cooling hose fittings. Consequently the solid metal IAR armature can tolerate extreme vibration and shock *g*-levels that typically destroy wound-coil armatures.



From top: Test for SRS 'complex' shock; test for 'classical' shock pulse; and test for random vibration

tion, thereby eliminating the need for current-carrying linkages between the armature and the shaker body.

The solid metal ring has uniformly distributed electrical properties along its circumference. When induction occurs, any unit length along the ring has a voltage induced in it that's proportional to the length of that segment. That same conductive segment has an electrical impedance (Z) that's proportional to its length. The distributed voltages (E) along the length of the ring's circumference produce a current flow in the single-turn ring. However, the voltage potential between any two points on the ring's circumference is equal to the induced voltage rise minus the IZ drop that occurs when the induced current flows in that same segment.

The end result is this: the net voltage on the Induct-A-Ring coil itself is zero at all times, even at full shaker output – hence a zero voltage armature coil. This important design factor means that the armature ring requires no electrical insulation from the ground, and because all the current is conducted by the one-piece ring, the need for epoxy-bonded coil wires is eliminated. With no electrical insulation or epoxy joints to worry about, the current-carrying areas of the ring can be operated at 6,000°F (3,150°C) and higher without concern. The resulting high surface temperature of the ring actually becomes an advantage, enabling extremely effective heat transfer with simple forced air cooling, therefore eliminating the water hoses and fittings required by conventional wound-coil armatures. ▮

Philip Rogers is Unholtz-Dickie's regional manager for the west coast of the USA. Michael Garofalo is an applications engineer with the company

Up to data

The Eidel distributed data-acquisition system (EDDAS) is cutting-edge. It was developed initially for aircraft testing of the JAS Gripen fighter, in cooperation with Saab, but Eidel has designed the EDDAS to be of use in other aerospace and industrial applications.

The system is designed to be highly modular and flexible, covering a wide area of user applications ranging from basic encoder tasks to some of the most demanding data-acquisition challenges. Due to its scalability and distributive aspects, EDDAS is essentially platform-independent. Using FPGAs and soft-core microprocessors, it is easy to customize functionality and adapt to new standards such as iNet.

The core of the system is based on IP communication and is therefore scalable in width and depth. The system can be built in one chassis for simple designs, up to clusters of several EDDAS systems, with a large quantity of modules and sensor interfaces.

System capabilities

The EDDAS systems have reconfigurable and intelligent software on each module. This has an advantage for the user because it opens the possibility to send commands from ground stations to retrieve single channel values in IP packets from modules in a given timeframe during ground testing. This makes it easy to change setup on parts of the system instead of setting up the whole system each and every time there is a change or alteration.

More than one configuration can be stored in each module and this gives the system the possibility of changing all parameters, for all modules, while airborne. This can be controlled by commands or by discrete signal values. It is useful when several test scenarios are required on different phases in one single flight, such as changing parameters as sampling rates on channels and a selection of data channels. It can also be starting and stopping high-speed data going to onboard data storage.

The EDDAS consists essentially of bus interfaces, sensor interfaces, simultaneously sampling, signal conditioning, data processing, controlling capabilities, time synchronization, and storage capabilities. Acquired flight data can be stored on board the target application as well as encoded and sent via a telemetry link to the ground station. The system supports the common telemetry standard of today – IRIG106. Different electrical interfaces are supported for the data output. Data can be collected on the ground through the Ethernet interface either as module/channel packets or Ethernet packets with embedded telemetry IRIG106 bit stream.

How it works

All functional modules are designed to be hardware configurable within their functional nature. For instance, an analog input module is able to interface a range of analog sensors, therefore limiting the number of different hardware modules. All data sampled at a given time, are time-stamped synchronously within an accuracy of 100ns between all equipment units. This requires that a chain of equipment units is below eight from one master synchronization clock. If the user does not require 100ns accuracy, more modules can be included, with 12.5ns added per module on the accuracy.

The bridge and power modules are the cornerstones of the data-acquisition bus and the power distribution net, providing message forwarding, time synchronization, and the powering of the equipment units. These two modules directly interconnect to every functional module present within the same equipment unit.

Every equipment unit has multiple Ethernet connections to the bridge module, so the equipment units can be interconnected in a multidimensional network. The distributive and highly modular nature of the EDDAS enables it to be easily tailored to the target application.

The bridge and power modules enable an arbitrary interconnected functional module to communicate with any other functional module within the airborne EDDAS, regardless of the hardware configuration and location of the functional modules.

The Eidel Data acquisition system was developed for the JAS Gripen fighter

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Thinking out of the box

Coda is m+p international's integrated data acquisition solution that reduces test time by eliminating costly application programming and long learning curves through comprehensive out-of-the-box functionality. The user-friendly, intuitive graphical user interface in the familiar Microsoft Windows environment ensures that engineers' time is focused on the task at hand. It enables fast and safe setup, operation, data analysis, and reporting, leading to high-quality results, quickly.

The system supports any type of transducer and any mix of transducer types, and can measure temperature, voltage, stress, strain, pressure, force, acceleration, frequency, power, or length. Even high channel count applications using hundreds or thousands of channels can be configured within a very short time and are handled safely and efficiently.

Because of its scalable architecture and easy parameterization, Coda is ideally suited for a wide range of applications such as performance test of jet and rocket engines, and static and dynamic structural testing, including experimental stress analysis as well as measurements and data analysis on component test stands and test assemblies. For structural testing, Coda supports full-bridge inputs as well as rosette strain gauges, and can communicate with the load control system.

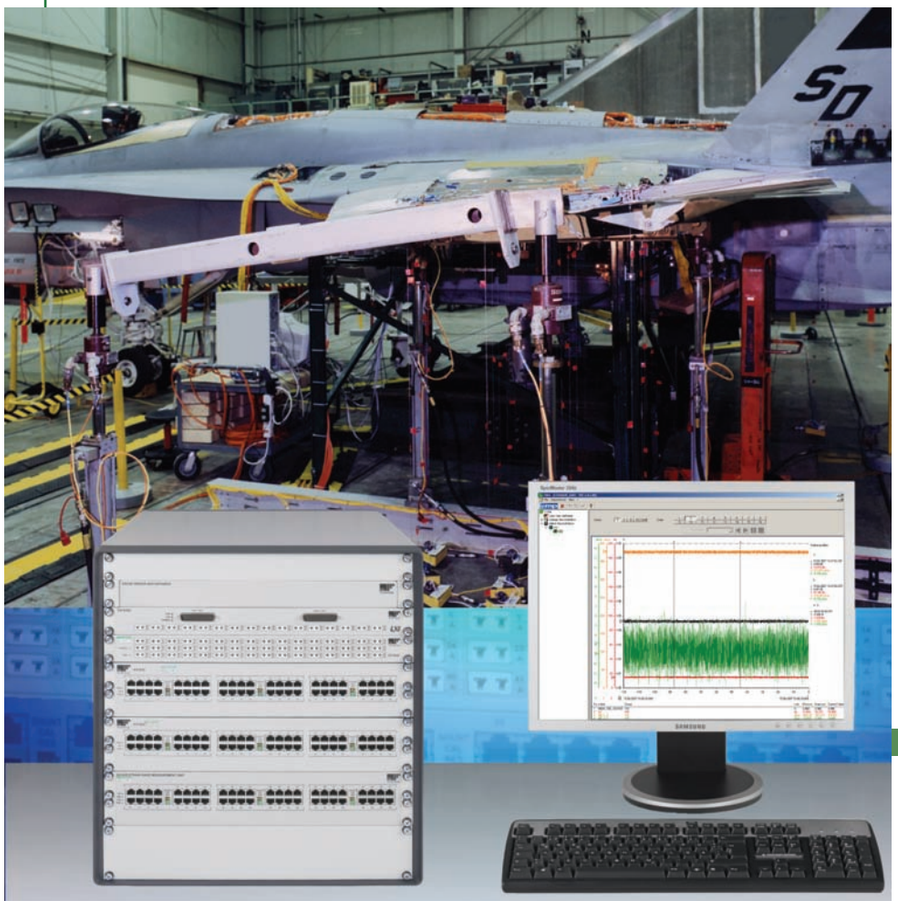
The turnkey Coda solution enables customization and integration with the existing process. m+p international's development team realizes customer-specific enhancements along with powerful and flexible acquisition hardware to meet today's and tomorrow's challenges.

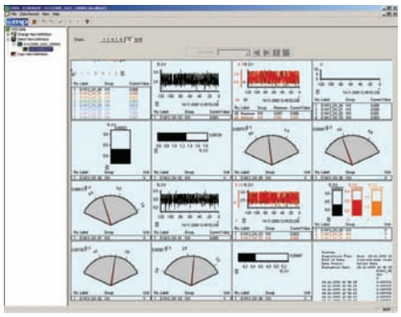
Coda supports as standard a great number of high-precision, industry-standard LXIbus, VXIbus, and USB acquisition hardware, which is scalable for small and large channel counts. LXI (LAN extensions for instrumentation) is the new instrumentation platform for test and measurement that combines the advantages of the industry-standard Ethernet technology with the simplicity and familiarity of GPIB. Coda can be combined with the powerful 48-channel LXIbus-based EX10xx series and EX1629 instruments made by VTI Instruments Corp for voltage, thermocouple, and strain gauge measurements.

The software enables different hardware platforms to be integrated, so customers who want to keep their existing hardware can profit from Coda's extensive functionality by upgrading paths to additional hardware. For example, new LXIbus instruments can be added to existing VXIbus hardware, a system that grows as the lab grows, using the newest hardware platform while protecting the investment.

The client/server system architecture enables shared use of acquired data, so several users can have concurrent online access for data display and analysis operations. Coda's powerful built-in tools and features include an SQL database for flexible and reliable parameter management, an automatic identification of connected hardware, and standardized data interfaces for easy integration of different measurement devices. The measured values can be graphically displayed in y/t- or y/x-diagrams, as bar charts or tachometers with up to 16 diagrams per window. The data replay function with adjustable replay speed enables the user to review all measurements and calculations without affecting the real data-acquisition process. Coda supports a variety of mathematical functions to calculate virtual channels in real time. These channels are treated like the measured channels for analysis and reporting purposes. In addition, it provides limit checking and alarm monitoring on every channel so the engineer is always in control of all important events during the test. Data storage is flexible – all, or selected, channel groups can be stored temporarily or permanently, pre-programmed or event-controlled.

Coda is the ideal solution for demanding acquisition applications that require high accuracy, efficiency, and economy. It combines comprehensive out-of-the-box functionality with ease of use, and it supports any type of transducer and any test size, from tens to thousands of channels.





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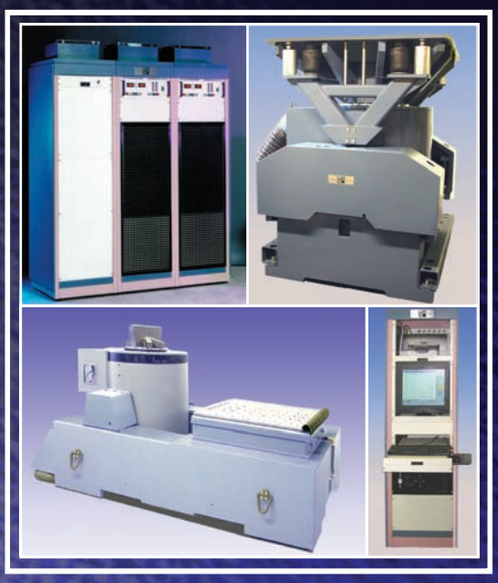
VIBRATION
TEST EQUIPMENT



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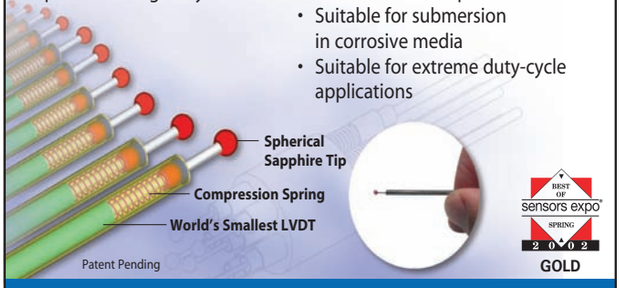

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Forward thinking fiber systems

Fiber optic communications is already in limited use in the aerospace industry, due to it's obvious and significant advantages of size, weight, electromagnetic immunity, reliability and capacity.

Most fiber systems have a telecommunications background, so need a significant level of re-certification and adaption for use in aerospace, where temperature, vibration and reliability are paramount. These issues have been steadily overcome with significant recent improvements in components and testing, so widespread adoption is imminent.

All current fiber types are likely to be deployed, such as single-mode, multimode, ribbon, and plastic optical fiber. Multimode fiber is likely to achieve the widest deployment. When working with all fiber types, rigorous inspection and cleaning of connectors must be enforced on all operators. This is critical, and usually just assumed. Fiber connectors can be permanently damaged if mated when dirty, thus causing costly degradation to wiring looms.

When plastic fiber is used, it's likely to be in ancillary areas such as entertainment. Although non-critical, this can be a large amount of equipment, and therefore in need of significant testing and maintenance. Testing traditional plastic fiber is generally quite simple, and usually involves a suitable optical power meter, and a light source.

Testing multimode fiber with any level of accuracy has been quite problematic to date. The major problem has been to do with varying modal distribution, or beam geometry, of the test sources, which causes varying loss test results in the fiber and components. This has recently been improved via various standards efforts, and for example Kingfisher's LED test sources now all incorporate standards and compliant mode control as standard, resulting in an excellent level of uniformity.

Once the correct test equipment and methods have been selected, the overall test uncertainty is usually then determined by the test leads, so good practice here requires tight control and maintenance of test leads and other specialized probes used.

The most common tool is inexpensive and also very simple to use: a red laser coupled into the fiber. This visual fault locator can be used for simple continuity testing, it may show up a break point, and if a fiber is bent, it shows if the light has got to that point. Another method of locating problems is by using a clip-on fiber identifier in combination with a test source attached to one end of the fiber.

The most sophisticated fault finder is an OTDR (Optical Time Domain Reflectometer). This is essentially an optical radar, and analyzes optical reflections to accurately determine the position of cable events. They have an effective accuracy of around 1%, so in a typical airframe can locate a fault with an accuracy of 1m or so. Special high-resolution and short-distance OTDRs can achieve much higher resolution.

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or go to online enquiry 103

Lightning effect

D.L.S. Electronic Systems has added to its already extensive lightning and HIRF capabilities. An NVLAP accredited organization, D.L.S. operates 13 testing chambers, with scheduling flexibility that very few can offer. This includes several 5m chambers equipped with large door openings and support equipment such as shielded auxiliary load rooms, air intakes with up to 40,000CFM airflow, and specialized cooling/air-conditioning ethylene glycol distribution system.

The company performs all EMC testing, including: indirect lightning effects testing for

RTCA DO 160F, MIL Std 461F, increased HIRF capabilities to 2000 V/m pulsed up to 18GHz; Airbus, Boeing, and JAA, DEF 5941, FAA AC20-136, EUROCEA/ED-14E, and SAE ARP5412/5416.

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All-in-one bridge signal conditioning

Data acquisition systems typically mate bridge signal conditioning modules with a separate ADC module or subsystem. System architectures that require a separate signal conditioning chassis, modules and external cable connections, in addition to an ADC module or subsystem, increase cost and complexity as well as overall system noise that can affect accuracy.

The signals from strain gage based sensors are often very small in magnitude and may require amplification to match the input range of the data acquisition systems' ADC. Scaling the signal as close as possible to the full-scale input range of the ADC (without over-ranging the ADC) will provide the best measurement resolution. Additionally, the low level signals from these sensors are susceptible to noise interference. Therefore, bridge signal conditioners may include low pass filters and differential amplifiers with a high common-mode rejection ratio for noise suppression.

KineticSystems' new CP246 CompactPCI/PXI module incorporates eight bridge signal conditioning channels and eight independent 16-bit 250Ks/s ADCs, as well as 16 multi-function digital I/O channels on a single-width 6U module. Since all of these functionalities are available in a single module instead of two or three separate modules, the CP246 eliminates the need for complex field wiring. As a result, system noise is reduced and overall accuracy of the data measured is increased. Since the number of modules required in the system is also reduced, the size and number of chassis required is minimized.

One must try to obtain the most flexibility and best performance in a data acquisition purchase. Flexibility is obtained through software programmability of features such as bridge-completion configuration, current/voltage excitation, remote/local sense, end-to-end calibration, per channel gain and filter, shunt calibration/bridge balance and ADC sample rate. The ability to configure the system for a specific static or acquisition is important.

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Mass interconnect system

Virginia Panel Corporation has recently released a new mass interconnect product for large scale fixturing needs. VPC's G12x offers all the benefits of the popular G12 in an 18 module interface. G12x accepts both G12 and G12x ITAs and uses the same platform as G12, supporting up to 180 lb (350 lb when the optional leg kit is used). G12x offers reliable connectivity beyond 20,000 cycles and can withstand temperatures from -55°C to +85°C.

A range of slide kits are available to ensure the proper fit into a test system. A multi-positional handle offers flexibility by not restricting the width of your ITA enclosure. And with a range of optional accessories, including leg kits, keyboard trays, and rack extender kits, so the user can easily customize its solution.

For more information, go to
www.vpc.com/solutions/g12x
or go to online enquiry card 106

Accelerometer for flutter

Flutter testing is crucial to ensuring aircraft performance to design specs. Accurate amplitude and frequency measurement is required to manage excitation resonance of wings, tailplane, fuselage and control surfaces. Not only is accurate data essential for design integrity, it is central to avoiding very costly repetition of in-flight tests.

Endevco offers unique experience in providing highly reliable accelerometers for flutter testing. These devices deliver optimum performance and superior phase response for precise matching of data from multiple sensors. And they are built to handle the extremes of speed and temperature experienced in flight.

The Endevco model 7290D variable capacitance accelerometer with onboard, microprocessor-based temperature compensation is ideal for this application. Gas damping and internal over-range stops enable its anisotropically etched, silicon sensing element to withstand high shock and acceleration loads. The model 7290D delivers 2.5% total dynamic accuracy over the entire military spec temperature range of -55°C to +125°C. In addition, custom signal conditioning enables the device to operate with a nominal excitation of 8.0Vdc to 30.0Vdc and provides a high-level, low-impedance output. A custom ASIC provides factory programmable temperature compensation, with all adjustments incorporated within the accelerometer so no post-processing is required.

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Support for scanners

Since its launch two years ago, Pressure Systems' DTC Initium wind tunnel-pressure system has achieved widespread take-up within wind tunnel-test facilities of all types. The DTC Initium system provides support for up to eight directly connected scanners of the latest industry leading Digitally Temperature Compensated (DTC) type. Achieving up to 0.05% performance without the need for online calibration, customers also benefit from a one box solution delivering high speed engineering unit data via Ethernet. The system is easy to use, with the system automatically uploading calibration data from connected scanners on startup. Following a simple rezeroing operation, the system is then immediately ready to acquire and log high speed data using the provided Windows software.

Also, as the command set is of an open architecture, this allows customers to develop and integrate their own software. The DTC Initium command set is a subset of that used within Pressure Systems existing wind tunnel 8400 system. Thus existing 8400 customer specific software can be easily adapted to run the DTC Initium.

As David Copley, European sales director explains, "The DTC Initium was originally conceived to deliver a lower-cost pressure scanning system solution for the smaller wind tunnel, that could utilize the proven capabilities of our high accuracy DTC miniature pressure scanners. While this group of customers have been delighted with the enhanced capability that the DTC Initium system has delivered for their facilities, larger wind tunnels have also benefited from the flexibility of operation and installation of the system."

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Out-of-the-box data

Requirements on DAQ systems especially in the aerospace industry are becoming increasingly demanding. High scalability, flexibility, performance and ease of use are particularly important criteria. Therefore HBM has introduced the Genesis HighSpeed product family. Perception software is HBM's high-end software to control Genesis HighSpeed products. These range from rugged data acquisition systems with sample rates of 100kS/s to the GEN DAQ series with sample rates of up to 100MS/s. A fiber optic-based master/slave mode enables simultaneous acquisition of up to 1,080 channels.

Modular Perception software integrates multiplatform hardware control, live display, data acquisition, review, analysis, report generation and data export in a single 'out-of-the-box' solution. Moreover, the Perception software package has basically and essentially been designed for ease-of-use to allow easy control of both small- and large scale systems. The new Perception software version 6 adds live FFT capabilities to the HBM Genesis HighSpeed product family. The new Basic FFT option of Perception 6 opens up new opportunities for visualizing signals in the frequency domain rather than in the time domain. As purely PC-based software it can be used with any Perception-controlled DAQ system like the portable GEN5i, GEN7t or GEN16t rack mainframes, or LIBERTY.

The Basic FFT option offers various choices of window lengths of up to one million samples, four different weighting filters, and analysis functions in the frequency domain like FFT Spectrum, auto power spectrum or power spectral density.

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Rotary motion tables

ACUTRONIC is proud to announce a new series of single-axis rotary motion tables. The new rate tables close the gap between the high-accuracy, high-payload AC1125 series and the medium-accuracy, low-payload AC1120 series. Applications range from calibration and testing of angular sensors such as gyroscopes and accelerometers to testing of complete Inertial Measurement Units (IMU) and Inertial Navigation Systems (INS) used in the aerospace and defense industry, as well in the automotive and consumer goods industries.

The motion test tables are designed to provide stimuli to the unit under test such as angular rate, acceleration and position. To further improve the real environment, they are often integrated with a temperature chamber.

All test tables feature a closed-loop direct drive servo system consisting of a drive assembly, a servo controller and a state-of-the-art digital power amplifier. The customer has remote access to the system via CANopen Bus and also two analog outputs and two inputs. Local control is provided through a Graphic User Interface (GUI), based on the proven ACUTROL3000 standard.

Several modes of operation are available: position mode, with precise absolute positioning; rate mode, with precise and smooth continuous rate (without drift); and test generator mode, with sinusoidal motion, rectangular motion and random motion options.

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Index to advertisers

Engine washing trolley MTCE1

Test-Fuchs just recently added a promising product to the successful standard product range: the Engine Washing Trolley MTCE1. The objective of washing engines is mainly to avoid 'compressor fouling'. Especially during start and landing, and also in the taxi phase, engines may be contaminated by aspiration of various substances such as dust, sand and hydrocarbons causing higher fuel consumption and CO_2 output. This is why all major engine producers have established sophisticated washing procedures, extending the lifecycle of their engines.

Test-Fuchs, a specialist in equipment for aircraft testing and maintenance equipment, has responded to this increasing demand for engine washing devices of airlines and MRO organizations by creating its new engine washing trolley MTCE1. The trolley contains two washing tanks with 120 liters each and one rinsing tank with 700 liters, all with an up-to date thermal insulation. Should the waiting period for the cleaning process become too long, the integrated generator operated with standard unleaded fuel will allow regaining lost tank-temperature.

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Databus test cards

PXI and CompactPCI are based on the latest mainstream PC technology and deliver all the advantages but in a small form factor. The growing industry demand for PXI and CompactPCI based solutions is pushing the development of high performance intelligent interface cards for aerospace applications. In support of this growing demand, AIM has introduced the world's first true PXI/CPCI 3U card designs which implement support for the PXI instrumentation bus with support for protocol testing, simulation and monitoring of MIL-STD-1553, STANAG3910/EFEX and ARINC429 databuses.

As true PXI solutions, ACX-3U modules provide full instrumentation bus support (TriggerBus, Star Trigger Input, 10MHz Reference Clock Input) compliant with PXI-Specification Revision 2.2. ACX-3U modules can be used in standard CompactPCI (3U) slots, legacy PXI slots and PXI hybrid slots. PXI builds on the CompactPCI specification but adds electrical features for instrumentation by providing additional triggering and system clock capabilities. The high level of integration offer solutions with a complete STANAG3910/EFEX channel including onboard fiber optic front-end or up to four MIL-STD-1553 channels or up to 16 ARINC429 channels on a single 3U CompactPCI/PXI card. Significantly higher Bus Interface Processor Speeds and the enhanced GRAM and I/O-FPGA access guarantees real time performance.

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Doors with brains

EUROCOPTER GERMANY DESIGNS AIRCRAFT DOORS, AND THOSE ON THE A380 HAVE PROVED TO BE VERY INTELLIGENT

BY DAVID OLIVER

Airliner doors are something we take for granted. We walk through them at the beginning and end of our flight, and the emergency exits – which we hope we will never need – are pointed out to us on every trip. Few passengers ever realize how vital doors are, and how much thought and time is spent on their design and construction.

Eurocopter is one of the world's leading manufacturers of airliner doors. Having worked on a research program funded by the German government on the design of electrical doors, Eurocopter Germany has subsequently won the contracts to design, develop, and manufacture 70% of all the doors for the Airbus range of commercial aircraft, including all the cargo doors and escape hatches.

The company's biggest challenge to date is as the main contractor for all Airbus A380 doors, which included the research and development of complete aircraft systems and subsystems in the following areas: strength and optimization; safety and reliability; fatigue life; endurance and fatigue tests; documentation for certification; damage tolerance analysis; and qualification.

Eurocopter Germany has developed a high-tech door assembly processing line to meet the fundamental goal of finding a suitable technical production solution in order to be able to carry out structural assembly of a large number of highly complex Airbus parts in a limited space and using as little equipment as possible. Using the flexible frame stations, all structures for various types of passenger doors are produced in a single assembly jig.

The use of a robotic workplace enables accurate positioning of drilling holes for the door-side system fittings in the edge beams, and drilling of all positions for door cowlings and the fittings for the emergency escape slide holder. The spatial precision of the robot for the aircraft system is 0.2mm with a repeat precision of just 0.05mm.

The adjustment and the acceptance of the eight A380 passenger doors is all carried out in a single multiflexible acceptance gauge. For this, size inspection and the adjustment of doors is done relative to the theoretical CATIA comparison model of the fuselage section using a Leica LTD800 Laser Tracker and its T-Probe application. This method enables precise pre-setting for the respective fuselage section, and allows the data to be compared online with various Airbus manufacturing sites such as fuselage segments in Nordenham and A380 section assembly in Hamburg, which is a great competitive advantage.

The largest passenger airliner in the world, the A380 is a double-decked, wide-body, four-engine airliner manufactured by the Europe-based corporation Airbus, a subsidiary of EADS. The A380 was designed to carry 525 passengers in a typical three-class configuration, and was certified by airworthiness authorities to carry a maximum of 853 in a single-class configuration. The 853 figure represents the number of people that were safely evacuated from the aircraft within 90 seconds under simulated emergency conditions, with no warning, no cabin lights, and half the 16 main and upper cabin doors closed.

To enable this to happen, all 16 passenger and emergency exits are fitted with Goodrich-designed inflatable emergency slides, which all have to be deployed at the same time using only the aircraft's emergency battery power. But before this can occur, all the doors have to open fully.

> **"Each A380 door design undergoes 150,000 test cycles by Eurocopter"**

Embedded in each of the doors is a 'brain', the door and slide management system (DSMS) designed by the German company Diehl Aerospace GmbH. Each of the 16 DSMS actuators on the A380 incorporates Maxwell Technologies' ultracapacitor cells in a triple redundant configuration to ensure reliable operation even if individual cells should be damaged or fail.

The ultracapacitor-based system is lighter than batteries and is more reliable because the ultracapacitors remain fully charged during normal operation, getting their power from the main system during normal operation, and they store up to eight hours of standby power to operate the actuators in the event of a main system failure. They also reduce operating expenses over the life of the aircraft because they require no routine maintenance, and their robust construction and ability to charge and discharge hundreds of thousands of times with minimal loss of function means they can perform for years without replacement.

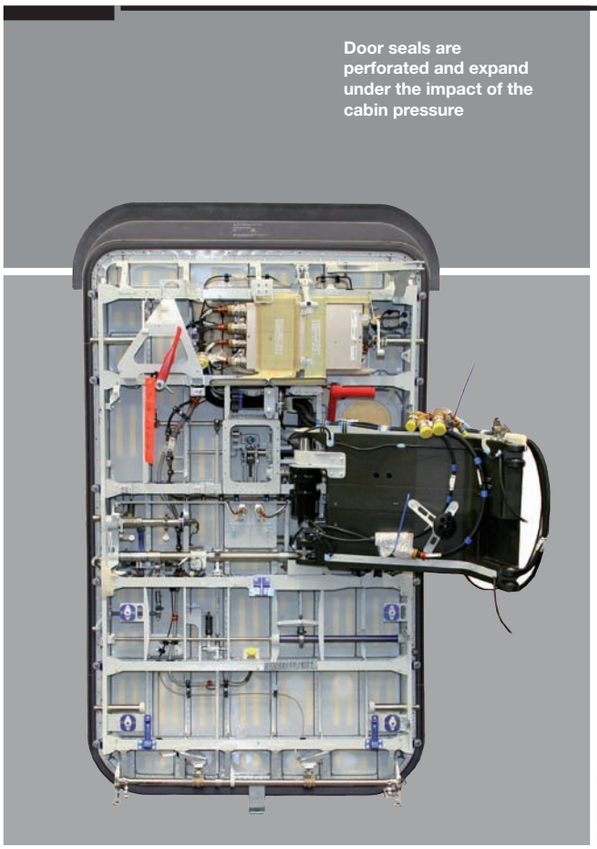
In addition to this innovative technology, the A380 doors manufactured by Eurocopter have an extra lobe to the brain: the local door controller (LDC). This system recognizes any disconnection in the aircraft's emergency power and reacts to outer loads, such as wind pressure, during the automatic emergency opening of the doors and the deployment of the slides.

Yet another feature of the A380's remarkable door technology is the pitch attitude sensors fitted to the passenger doors and emergency exits on the upper deck (they are more than 8m above the ground). Should the nosewheel undercarriage suffer a puncture or run into ditch during an emergency landing, the height of the doors above the ground will change.

These sensors compensate for any change of pitch by automatically increasing or decreasing the length of the emergency slides to maintain the angle from the door to the ground. If the angle is too great, evacuees will be in danger of sliding too fast, and if the angle is too flat, they will take longer to evacuate and delay those behind them.

Each A380 door design undergoes 150,000 test cycles by Eurocopter, the equivalent of the three-and-a-half times its lifetime, and more than 50 ship sets have been delivered to date.

The company is currently designing and developing sets of doors and emergency exits for the next generation of Airbus airliners, the long-range, mid-sized, wide-body A350, which is due to enter airline service in 2013. Watch the doors for future brainwaves. ▮



Door seals are perforated and expand under the impact of the cabin pressure

CONTROLLER SOLUTION

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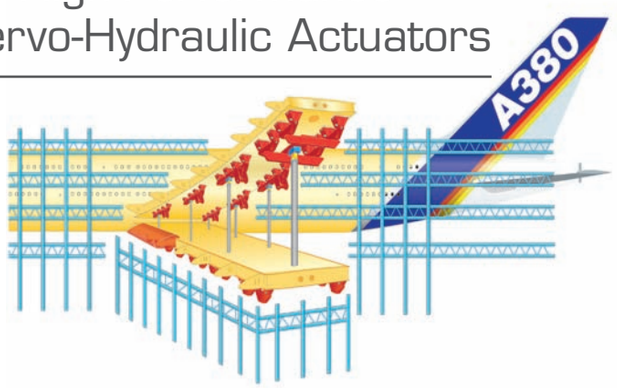
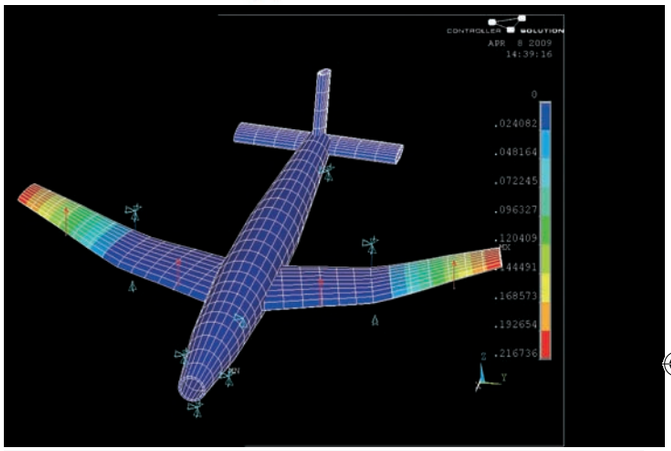


A new generation of multi-purpose control- and monitoring systems

ControllerSolution GmbH supplies model-based multi-purpose digital control and monitoring systems tailored to the functions of mechanical systems driven by servo-hydraulic actuators. In the test engineering field typical applications of our controllers range from low-frequency control-engineering applications such as large-scale aircraft structural fatigue testing right up to higher-frequency control-engineering applications such as implementation of road tracking profiles by means of test stands, vibration tests and structural component testing.



Features of our product

- The multi-project capability of the operation level allows efficient implementation of multi-project applications
- High automation level of our control- and monitoring system by direct interlinking to the model generation and system simulation
- Fast setup by easy-to-use system simulation tools: trajectory generation of optimal command signal, automatic closed-loop system design-optimization and actuator design and analysis
- For higher frequency control applications: RPC-method and model generation by plant excitation
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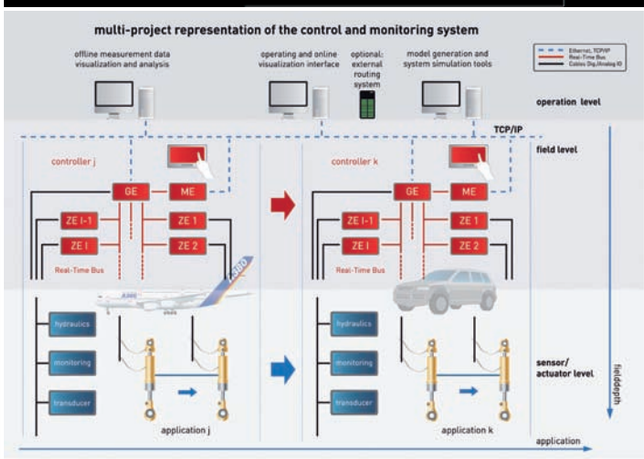

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