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AEROSPACE TESTING INTERNATIONAL

MARCH 2009

Rotor revolution

THE RECORD-BREAKING SIKORSKY X2 LIFTS INTO THE SKY

Plane sailing

Flight test of the Schempp-Hirth Duo Discus X glider

Prepare to dive

In the aftermath of the Hudson River crash, a timely look at ditch testing

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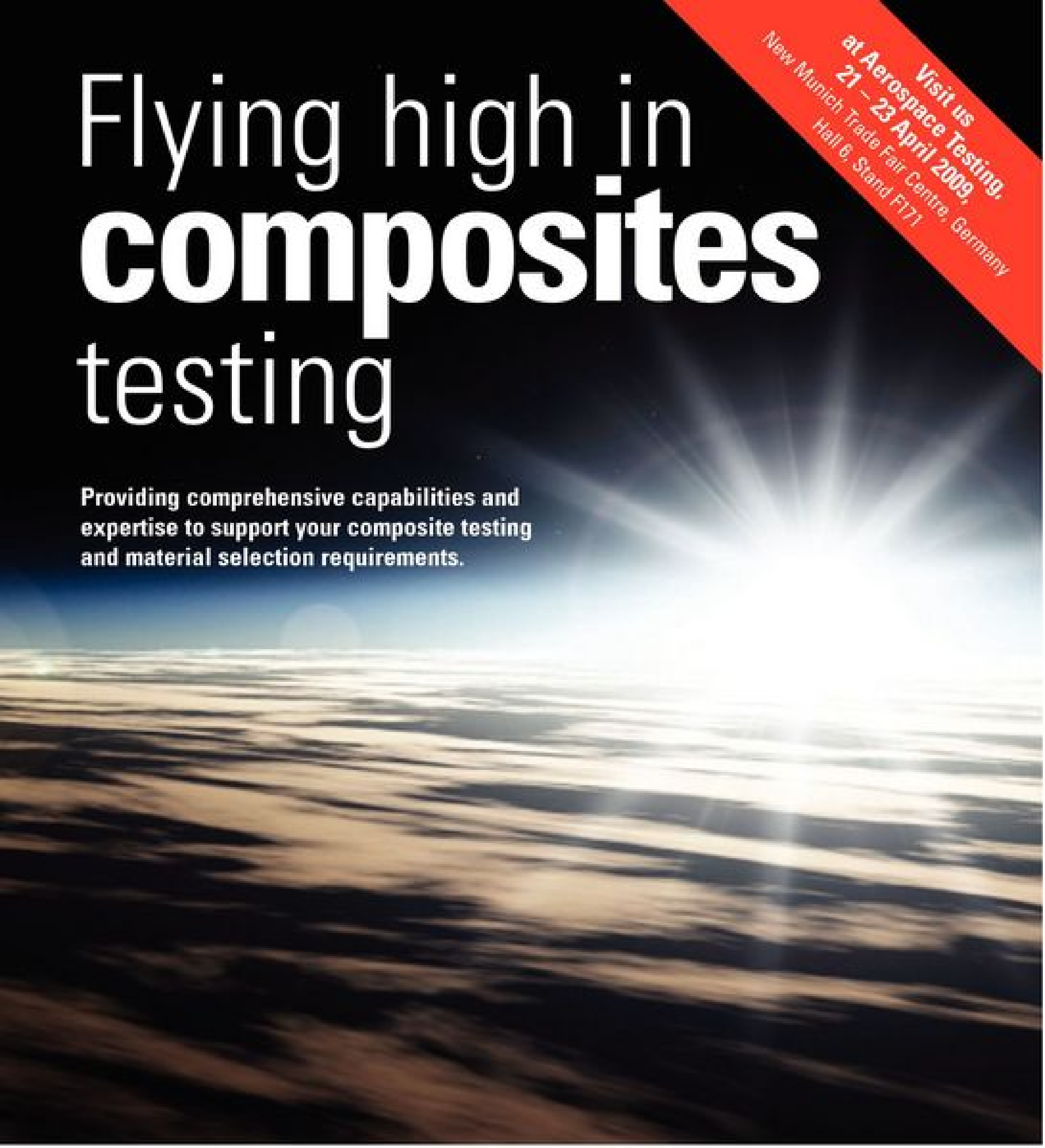

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Hudson hawks

On January 15, 2009, a US Airways Airbus A320 made a forced landing on New York's Hudson River, after a multiple bird strike knocked out both engines. A full investigation is to follow, but no one is disputing the cause, the integrity of the aircraft landing on water, or the courage of the crew, in particular Flight 1549's captain, Chesley 'Sully' Sullenberger. Everyone survived, including people navigating the waters of the Hudson. What makes this particular incident even more extraordinary is the backlash and vitriol about the averted catastrophe… it is truly incredible.

Through endeavors researching my book, *Trailblazers: Test Pilots in Action* (Pen and Sword, UK), I am lucky enough to be on the round-robin email circuit of a number of worthy test pilots. Usually, they reminisce about glorious days gone by, but lately I have received several discussing the Hudson crash, and I was taken aback by the depth of feeling from some ex-Boeing pilots.

I'll call him Jack, and this is an extract: "There are stories circulating now about how the flight computers helped to 'save' the aircraft by insuring the ditching was done properly.

"The stories themselves are absolute nonsense and the contention that the flight computers ensured the proper attitude was maintained for ditching is pure fabrication. So what's wrong with Airbus wanting to steal a little glory for their computerized drones? There is a good chance it was the computers that put the aircraft into the water! I readily admit that I heartily dislike Airbus because of its design philosophy." Strong words. His loyalty comes through later: "I love Boeings. I love to fly them. I also believe in their design philosophy that the last word has to be with the pilot, not the machine. No pilot, no matter how hard he tries, can turn an A320 upside down. It just won't do it. Airbus believes it has designed a computer that is smarter than a pilot. If a pilot moves the controls so as to turn the airplane upside down, the computer will refuse. I can turn the B777 upside down. Once I get it upside down, if I let go of the controls it will turn itself right-side up (smart airplane)."

I got in touch with Airbus to try to extract a comment from pilots, or a company statement. The spokesman said Airbus was unable to comment until the US National Transportation Safety Board has completed its own investigation. Which is exactly what one would expect.

However, experienced pilots kept commenting: "In an older generation airplane such as the 727 or 737-300/400, the throttles are hooked to the fuel controllers on the engine by a steel throttle cable. On the Airbus nothing in the cockpit is real. Everything is electronic. The throttles, rudder and brake pedals, and the side stick are hooked to rheostats, which talk to a computer, which talks to a electric hydraulic servo valve, which in turn hopefully moves something. When you hit birds in an older generation airplane, the engines keep screaming or they blow up. They don't both roll back to idle simultaneously, as happened to Flt 1549." There are hundreds of blogs discussing the safety records between the two giants, but not from well-trusted pilots like these.

My father flew Boeings for two decades and was also one of the first British pilots to fly the A310, so I decided to ask his opinion. At least it would be an independent viewpoint: "Boeing always did have a tradition of 'if it works, keep it', and applied it to many components, which was good. Boeing aircraft have also had many accidents and the 707s I flew were not 'easy' to handle, but they were very successful commercially. British/French and German cultures of aircraft design were born out of a necessity to make airplanes easy to fly because of World War II constraints. We did not have a huge aviation culture in pre-war Europe.

"I flew the new A310 for nearly three years and thought it was a great aircraft. The biggest problem was old-fashioned pilots finding their way around the new technology on the flight deck. It was to my mind a great plane to fly. And you could play games with it!"

I was going to mention the incident in November 2008 when an A320 crashed into the Mediterranean on a handover test flight, killing the crew, then the Turkish Airlines 737 that crashed short of the runaway in Amsterdam in February. But I decided it was best to avoid being sucked into the 'blog syndrome'; the argument would just bounce around like a ball in a tennis match, which is hardly constructive. One grown-up comment from an aviation specialist says that 'maybe' the sophisticated systems on modern airliners are lulling some pilots into a false sense of security. But it is a risky and unproven thing to say. The battle between Airbus and Boeing is about more than finance, orders, and the law. It seems to cross boundaries. I hope not to the detriment of safety.

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BACK ON TRACK

Production of the 787 resumed with the addition of the fifth airplane designated for flight test. The ZA005 is the first to be powered with General Electric GEnx engines. Jack Jones, vice president of 787 Final Assembly and Change Incorporation, said, "This ZA005 airplane signifies our return to a steady production rhythm. Sections are arriving in Everett at the completion levels committed by our partners and close to what is expected for mature production." Five of the six airplanes designated for flight test are now in varying stages of production. Power was restored to the first flight-test airplane, ZA001, and production testing has resumed as the airplane prepares for first flight in the second quarter. Rolls-Royce engines are hung on ZA002, in the fourth and final production position in the factory.

NO SHAKY START

Brüel & Kjær's parent company, Spectris plc, has announced that it has completed the acquisition of LDS Test and Measurement for US$86 million. The predominant part of LDS will become an integrated part of the Danish engineering company. In a statement, Brüel & Kjær said, "The combination of Brüel & Kjær's LAN-XI acquisition hardware, wide range of transducers, and structural testing solutions, combined with LDS's shaker technology provides the perfect solution for structural analysis and vibration test."

The Obama Factor

BY TIM RIPLEY

1 The inauguration of Barack Obama as US President in January set off speculation about the impact his policies will have on the US defense and aerospace industry. Although well known for his opposition to the invasion and occupation of Iraq, the new President is clearly no 'peacenik', and his administration is set to continue to spend heavily on defense and aerospace projects. Ahead of presenting his formal budget proposal later in the year, Obama is looking at launching a multibillion-dollar spending package to boost the economy, but its shape and size has yet to be clearly defined.

US Congress is currently considering a request from industry groups that more than US$3 billion to modernize the country's air traffic management and control system be included in the economic stimulation package. Dubbed Next Generation Air Transportation System, or NextGen, this new system would be at the heart of efforts to make air travel in the USA more fuel efficient and environmentally friendly.

At the heart of NextGen is the automated dependent surveillance – broadcast (ADS-B) system, which would equip all civil passenger aircraft operating in US airspace with automated GPS-based control and monitoring technology.

With ADS-B, both pilots and ground controllers will see radar-like displays with highly accurate traffic data from satellites – displays that update in real time and don't degrade with distance or terrain. The system will also give pilots access to weather services, terrain maps, and flight information services. The improved situational awareness will mean that pilots will be able to fly at safe distances from one another with less assistance from air traffic controllers.

The US Federal Aviation Administration says that the gains in safety, capacity, and efficiency as a result of moving to a satellite-based system will enable it to meet the tremendous growth in air traffic predicted in coming decades. Crucially, NextGen offers huge savings in fuel as a result of more efficient flight management.

Aerospace industry associations have had tentative discussions with the incoming Obama administration about the NextGen project, but aviation has yet to appear in the public pronouncements of the new President. NextGen would appear to tick all the boxes in Obama's vision of a project that would help kick-start the US economy out of recession, but the jury is still out on whether the new President will move it into the fast lane of his economic stimulus program.

"NextGen would appear to tick all the boxes in Obama's vision of a project that would help kick-start the US economy"

A400M Test Bed Takes to the Skies

2 After what appeared to be an age, the C-130 flying testbed aircraft for the TP400 EuroProp International (EPI) powerplant finally took to the air for the first time on December 17, 2008, at Marshall Aerospace's site in Cambridge, UK. The TP400 is intended to power the Airbus Military A400M airlifter, but technical hitches with the newly developed engine have plagued the European collaborative program.

The prototype engine is installed on the inner-left engine mount of the C-130K, which is otherwise powered by three of the usually four Allison T56 turbo-propellers. The testbed aircraft took off at 10:44 local time from Cambridge airfield, which is home to the flight testbed aircraft, and touched down at 11:59 local time. During the 1 hour 15 minute flight, various flight characteristics such as aircraft basic handling and TP400 response at a thrust equivalent to the maximum power generated by each of the other T56 engines were satisfactorily tested in several aircraft configurations up to a speed of 165kts and an altitude of 8,000ft.

This was the first step in the aircraft envelope opening. It will allow progress toward the completion of approximately 50 flight test hours planned to ensure sufficient maturity for the engine itself. Once this is achieved and satisfactory integration is also reached for the global propulsion system, it will be able to fly on the first A400M. To complete the trials, Marshall Aerospace was contracted by Airbus Military to perform the flying testbed trials on a Lockheed C-130K. The aircraft was specifically modified to accept the new engine, which develops about twice the power of the C-130K's standard T56 engine.

Although the first test was successful, it was followed in January with admissions from the senior executives from the Airbus parent company, EADS, that the company was looking to renegotiate the single design, development, and production contract with the customer governments. This would in effect separate design and development from the production contract, resulting in a freeze of production work until the design is considered mature. The A400M is clearly not out of the woods yet.

TAXI, HOVER & TURN

The first flight of Sikorsky's S-76D helicopter, the latest version of the S-76 helicopter, has been successfully completed, maneuvering the prototype aircraft through taxi, hover, hover turns, and forward flight to 40kts in a test flight that lasted approximately 30 minutes.

Sikorsky chief test pilot Greg Barnes and pilot Mike Hardy conducted the test flight at Sikorsky's Florida facility. The milestone was the culmination of more than three years of design, development, and testing of the first prototype aircraft. "The next generation of the S-76 helicopter begins today," said Jason Dumo, program manager. "The S-76D helicopter brings Sikorsky's popular S-76 aircraft to the next level in performance. It is through the dedication of this program team that the 'D' will open the door to new applications for this aircraft model."

THE PATH TO THERMAL VACUUM

A primary operational and science instrument for the National Polar-orbiting Operational Environmental Satellite System (NPOESS) has passed a key environmental test at Raytheon Company. NPOESS is the nation's next generation low Earth orbiting weather and climate monitoring system.

Vibration testing of the first Visible Infrared Imager Radiometer Suite (VIIRS) was completed in early February. Follow-up analysis of the test data and hardware inspection is ongoing.

EXTREME ENGINE

The successful maiden flight of the Hindustan Aeronautics Limited (HAL) Dhruv helicopter took place at the Aero India trade show in Bangalore in January 2009. It was the first flight to feature two Turbomeca Ardiden 1H1 series production engines. According to Turbomeca, the engine demonstrated excellent aeromechanical behavior during its maiden flight. HAL's Chairman, Ashok K Baweja, commented, "We are very confident about the Turbomeca Ardiden 1H1 program."

WING EQUIPMENT AGREEMENT

Airbus and Xian Aircraft Industry Company (XAC) have signed a cooperation agreement relating to the A320 wing-equipping (Phase IV) program. A320 'family' wings for aircraft are to be assembled at the final assembly line in China (FALC), and will now be fully completed and tested in Tianjin, China.

SWIMMING CERTIFICATE

The Russian Beriev Aircraft Company has obtained its aircraft type certificate issued by the European Aviation Safety Agency (EASA) for its Be-103 amphibian aircraft. For the first time in the history of the Russian aircraft industry, a European certificate has been received in the class of passenger aircraft, amphibian aircraft, and light aviation in one. The EASA certificate means the aircraft can start being sold to European customers and the Be-103 can begin operation in Europe.

"In the tests Sky-Y flew more than 125km from the ground station and demonstrated a range of capabilities"

FUEL ECONOMY

The first aerial refueling of a 737 platform has now been completed. The historic flights were conducted for Project Wedgetail, Australia's airborne early warning and control (AEW&C) program.

Flying at 25,000ft above Edwards Air Force Base, Boeing pilot Ron Johnston maneuvered the 737-700 AEW&C aircraft into a US Air Force KC-10 tanker's refueling boom envelope, and easily maintained its position below the tanker. The 737 received approximately 14,000 lb of fuel during two connections with the tanker.

"The aircraft was stable, with excellent flying qualities and engine response behind the tanker," said Johnston.

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Euro-UAV takes to the Sky

3 October 2008 saw a major milestone in European efforts to develop an independent UAV capability with the first flight of a European-designed UAV, equipped with all-European sensor and communications payloads. The Alenia Aeronautica's Sky-Y Medium Altitude Long Endurance (MALE) class took off from the Vidsel testing range in Sweden and completed a series of ground-surveillance missions using a European-made electro-optical sensor. This data was then transmitted to the ground through a satellite system. A number of missions were also accomplished in bad weather conditions.

The Sky-Y has been developed as a demonstrator for innovative technologies created for UAVs in the MALE class, and the aircraft has so far made six flights. These debuted the EOST-45 electro-optical sensor, a new mission computer, a new datalink used for remote sensor control and for downloading images to the ground, and new functions of the tactical control station in tandem with a remote-sensor station.

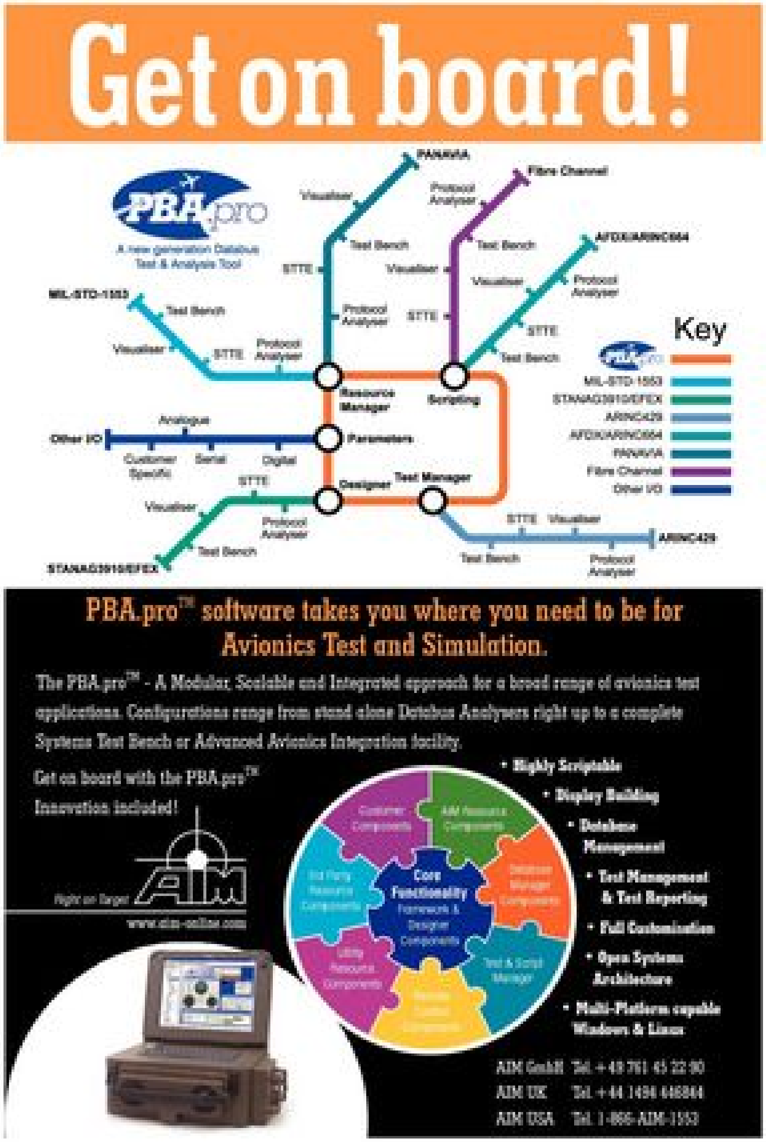
In the tests Sky-Y flew more than 125km from the ground station and demonstrated a range of capabilities. Tests checks were carried out on the systems' automatic take-off and landing; search operation modes, land 'target' identification and surveillance (visible, hidden, 'warm', moving); nightflight and landing; real-time capabilities of reception and image-data management and delivering to several web recipients; video and infrared image transfer to the central operation unit of the Civil Defense Agency of the Piedmont Region.

FIN DE SIÈCLE

Raytheon Company has fired its 45th low-cost titanium base as part of design testing for the Excalibur 1b precision-guided artillery projectile. The projectiles were stable during flight, and the stowed fins deployed after clearing the gun. The tests also demonstrated the fins' structural integrity and ability to deploy and lock. Component testing of the design will continue until May.

STAYING POWER

The high-energy laser from Northrop Grumman has successfully fired multiple long-duration blasts on board the US Missile Defense Agency's (MDA) Airborne Laser (ABL) during intensive ground tests. "The hallmarks of these latest firings are durability and repeatability," noted Dan Wildt, vice president of Directed Energy Systems. "The duration of each firing was limited only by ground equipment."



LET OFF STEAM

NASA has signed a contract with American Tank and Vessel Inc for the installation of a test cell diffuser and 'associated systems' for the A-3 test stand at NASA's Stennis Space Center in Mississippi. The five-year, indefinite delivery, indefinite quantity contract's value is not to exceed US$45 million.

The A-3 test stand is being built at Stennis to test the J-2X engine for NASA's Constellation Program. It will allow engineers to analyze the engine's operating parameters by simulating conditions at altitudes up to 100,000ft. For these simulations, the test stand will generate approximately 4,620 lb/sec of steam and use it to reduce the engine test cell pressure.

Protecting Battlefield Helicopters

4 US and UK military commanders are looking to industry to provide them with new technology to protect their helicopters from insurgent fire in Iraq and Afghanistan. Combat experience points to the main danger to coalition helicopter crews coming from close-range small arms and rocket-propelled grenade (RPG) fire as troops carrying helicopters drop off troops at battlefield landing sites. Stationary helicopters are acutely vulnerable to insurgent fire, and there have been several high-profile incidents in Afghanistan where large CH-47 Chinook helicopters have taken RPG hits while making tactical landings, resulting in great loss of life.

Combat helicopter pilots say the best defense against RPG ambushes is to know where the enemy fire is coming from so that rapid evasive action can be taken. Unlike heat-seeking or radar-guided anti-aircraft weapons, the simple US$50 RPG cannot be decoyed and it is not practical to fit helicopters with the level of armored protection needed to defeat the rockets.

The US Pentagon issued a request for proposals last year for the Joint and Allied Threat Awareness System (JATAS), which aims to replace the existing AAR-47 missile warning system and provide helicopters with a hostile fire indicator. "One of the leading requirements to come out of the recent conflict in Iraq and Afghanistan is to know when you're being shot at," commented one program officer involved in the project.

According to industry sources, the technology for the hostile fire indicator is still very immature. Many of the giants of the US electronic warfare industry are expected to throw their hats in the ring, including ATK, BAE Systems, ITT, Lockheed Martin, Northrop Grumman, and Raytheon.

In the UK, French-owned Thales has been asked to look at this problem by the Ministry of Defence. The company is developing the Elix-IR system that it hopes will be adopted under the UK's Urgent Operational Requirements (UOR) program and installed in the British battlefield helicopters.

"Guns and RPGs are numerous, easy to use, and easy to hide," said Alex Cresswell, managing director of the Thales Land and Joint Systems Division. "When fired, they are difficult to detect, locate, and characterize from a noisy helicopter. The result can be the political nightmare of helicopters full of troops being shot down by simple weapons." With its ability to warn of a weapon firing and give a precise bearing on the firing point, Elix-IR is intended to give pilots the reaction time and vital information they need to take effective evasive action.

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New NASA Rockets to the Moon

5 NASA's plans to put a man on the moon in 2020 has set in motion the development of a new family of launch rockets, and the agency is expected to award the first contracts early this year to begin work building the advanced space vehicle.

In December NASA announced the road map for development of its Ares V cargo launch vehicle that, if ever built, will be the largest ever space rocket. This two-stage rocket is envisaged as carrying the Earth Departure Stage (EDS) and Altair Lunar Lander into orbit, before the moon mission sets out to make the first lunar landings by humans since the 1970s.

NASA asked in January this year for proposals from industry to build the new monster rocket, which will lift 3.7 million kilograms of cargo into orbit. After three years of design and development work, the US space organization says it will award its first production contracts in 2012 to ensure the first test flight takes place in 2018. This ambitious program will see the US astronauts launched toward the moon in December 2019.

Ares V is expected to draw on much of the technology and experience used to build the Ares I Crew Launch Vehicle, which is envisaged as the replacement for the current Space Shuttle when it goes out of service in 2010. However, delays to the Ares I mean that it might be necessary to keep the Space Shuttle in service until 2015. These issues suggest that the Ares V's road to orbit might not be as smooth as NASA would like.

TRIAL BY COMBAT

The RAF's latest 'eye in the sky' has recently returned from its successful test trials in Afghanistan. The ASTOR system (Airborne Stand-Off Radar) on the Sentinel R1 aircraft was used to gather vital information for forces in the fight against the Taliban. The aircraft can detect and recognize moving, static, and fixed targets on the ground, and are capable of operating for more than nine hours at a time. The information gathered is transmitted to ground stations to enable rapid tactical planning and the efficient line-up of assets.

FRESH WEIGHT TO MISSILES

Sagem and the French defense procurement agency DGA have successfully carried out the first firing test of the 125kg version of the AASM modular air-to-ground weapon. The first firing test of the AASM 125 was carried out at the DGA's missile test range in Biscarosse, France, from a Mirage 2000N based at the DGA's flight test center.

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PARTS OF THE PLANE

Airbus has selected two SAFRAN companies, Messier-Bugatti and Labinal, to design, develop, and manufacture critical systems and equipment for its new A350XWB long-haul commercial jet. Messier-Bugatti will supply the wheels and carbon brakes, based on Sepcarb III OR carbon disks, with the lowest rate of wear and best friction performance in the world. Messier-Bugatti will also supply the two nose wheels and eight main wheels.

VISION STATEMENT

Approval from the European Aviation Safety Agency (EASA) for the Bombardier Enhanced Vision System (BEVS) to obtain operational credit for continuing approaches to 100ft has been confirmed. Bombardier's BEVS had previously obtained approval from Transport Canada and the FAA.

According to Bombardier, BEVS provides pilots with improved situational awareness and the ability to observe runway lights and the runway environment in difficult operating conditions, such as low visibility and/or darkness. BEVS also enhances safety by helping to identify runway incursions. The Global BEVS is currently certified with an Enhanced Flight Vision System (EFVS) that will be considerably upgraded when the new Global Vision cockpit is certified.

"Since 2003 the US military has lost some 215 helicopters in Iraq and Afghanistan"

US looks to JSF to guide helicopter design

6 The Pentagon is launching a capabilities-based assessment of its future vertical lift vehicle (FVL) with a view to replacing its current inventory of heavy-lift helicopters from 2030. The US Army's veteran Boeing CH-47s Chinooks and US Marine Corps CH-53 Sea Stallions heavy-lift helicopters are the prime candidates for replacement, along with many of the US Army, US Navy and US Air Force H-60 family of medium helicopters.

Many experts involved in the early stages of the Joint Strike Fighter (JSF) are being drafted into the new team to look at ways to use the latest technology to reduce the risk to aircraft operating in vertical lift mode on the battlefield and the cost of producing such a family of aircraft.

Since 2003 the US military has lost some 215 helicopters in Iraq and Afghanistan, claiming the lives of 380 service personnel, and this has prompted the Pentagon to ask if a one-for-one replacement with new helicopters would actually be the answer to its vertical-lift requirements. The terms of reference of the study allow alternatives to rotorcraft to be examined.

The idea of eventually forming a JSF-style joint project office is aimed at kick-starting the program by bringing the four US armed services into a single organization to reduce costs by merging their different procurement projects into a single program. Dubbed a 'brain-storming session' by many involved, the FVL study is not expected to report until early in the next decade. This will involve principally the US military's main battlefield helicopter users (the US Army and Marine Corps) in comparing their requirements and exploring if they can work together. Although this effort has been welcomed across the Pentagon, it is by no means certain to result in a full development and production contract because significant funding has yet to be allocated to it.

The US Army continues to be hedging its bets and is still pursuing its Joint Heavy Lift technology demonstrator to build a new rotorcraft that can lift 30 tons of cargo.

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Blades of glory

The Sikorsky Aircraft X2 has revived the company's Advancing Blade Concept to hover efficiently and fly faster. Frank Colucci looks at the X2 test program intended to double the cruising speed of future helicopters. Even more details can be read on page 20 from the X2 chief engineer

> Sikorsky Aircraft has long studied high-speed rotorcraft with folding rotors, fixed wings, thruster propellers, telescoping tilting rotors, and stopped-rotor X-wings. The company's latest high-speed concept demonstrator has accumulated 2.2 hours in three flights and completed the first of four test phases aiming for cruise speeds around 250kts. The X2 testbed enhances the promising coaxial rigid rotor layout of the Advancing Blade Concept with modern rotors, flight controls, drives, and aerodynamics. Sikorsky management believes the suite of X2 technologies may scale-up to a new range of manned and unmanned military and civil products about twice as fast as today's helicopters. The X2 demonstrator was nevertheless designed and built to a modest budget at company expense. According to program manager James Kagdis, "If this was done in a traditional military development, the cost of the program would have been several times our cost."

Most X2 integration and test work at the Sikorsky-Schweizer Hawk Works near Elmira, New York, was done on the aircraft itself without dedicated test rigs. First flight, for example, followed 42.6 hours of progressive ground runs. The second-hand YT800-LHT-801 engine in the X2 initially drove only the combiner gearbox that will turn both the stacked rotors and the integrated tail propulsor. The drivetrain then turned the bare rotorhead to check systems. To test integral rotor instrumentation, the four blades on each main rotor were initially fixed at flat pitch without their fly-by-wire (FBW) servos. The six-bladed tail propeller was not engaged for the first test flights.

The X2 test program was modeled after that flown by the XH-59A Advancing Blade Concept demonstrator. "We have four test phases kind of tied to the configuration," explains Sikorsky director of engineering sciences Steve Weiner. "As we begin to test something new, that signals the start of a phase." Phase 1 explored low-speed helicopter handling up to 40kts. With X2 aerodynamic fairings and landing gear retraction mechanism installed, Phase 2 extends from 40-120kts. Phase 3 with the propulsor turning goes to 180kts. Phase 4 takes the X2 to 250kts or higher airspeeds. Each phase is tied to new FBW software drops.

Innovative as the new technology demonstrator may be, several X2 systems are borrowed from other aircraft. The Moog active vibration control system was developed for the newest UH-60M Black Hawk. Control servos, hydraulic pumps, coolers, and a generator were taken from the Sikorsky S-76, S-92, and CH-53E helicopters. LHTEC, the Honeywell/Rolls-Royce partnership, donated the two engines of the second canceled Comanche prototype to the single-engined X2. Main rotor blades were made by prototyping shop Eagle Aviation Technologies, and specialty propeller maker Aero Composites supplied the tail propulsor.

Sikorsky's X2 high-speed helicopter technology demonstrator made its first flight in the hands of chief test pilot Kevin L. Bredenbeck. The flight lasted 30 minutes

Schweizer Aircraft itself was acquired in 2004 to give Sikorsky added production capacity and a rapid prototyping shop. The light helicopter and specialty airplane maker flew a four-bladed rotor for the improved MQ-8B Fire Scout Unmanned Air Vehicle on a manned testbed just 90 days after go-ahead. Work on the X2 started in 2005, and the experimental high-speed helicopter first flew in August 2008, slowed in part by supplier delays and Sikorsky's need to catch up with Black Hawk and Seahawk deliveries after a labor dispute in Connecticut. The Elmira Hawk Works remains the test site for the innovative X2 demonstrator – the only new fixed test facility was a tie-down hover pad.

X2 tests at Elmira do rely heavily on a fixed-based engineering simulator at the Sikorsky plant in Stratford, Connecticut. "Before the first flight, we began flying the first flight test cards," explains test director David Walsh at the Sikorsky-Schweizer Hawk Works. A year-and-a-half before real take-off, the simulator flew the common GenHel simulator model

"The four blades on each main rotor were initially fixed at flat pitch without their fly-by-wire (FBW) servos"

updated with X2 characteristics. The iterative simulation now funnels real aircraft data into the simulator and back to refine software for the Hamilton Sundstrand flight control computers. Weiner observes, "All the controls are the same as what's in the actual aircraft, and we input the control laws in the actual airplane."

Hawk Works engineers adapted existing Honeywell FBW hardware to X2 requirements and test-flew the modified controls on a Schweizer 333 helicopter. The sidearm cyclic and collective in the X2 cockpit have differential beep switches for the pilot to adjust pitch on the top left and bottom right blades of the coaxial system to trim blade loads and tip distances. Weiner observes, "On a production machine, that would be pre-programmed into the fly-by-wire system."

Walsh adds, "That's what we began to do in flight test – to figure out those schedules and maps."

Studies show that a heavy lift version is possible that can carry up to 20 tons internally or 40 tons externally and still cruise at up to 250kts

Advancing Blade Concept

Between vertical take-offs and landings, helicopters are invaluable in rescue situations by hovering over people, as well as delivering sling loads, taking pictures, hunting submarines, shooting tanks, and inserting and extracting troops. However, as conventional helicopters accelerate to cruising speed, retreating rotor blades have to increase pitch to sustain lift across the rotor disk. At some point, retreating blades lose lift and generate excessive vibration. Retreating blade stall has capped pure helicopter speeds at less than 200kts so far, but stacked, counter-rotating rotors with advancing blades on both sides of the disk keep flying at higher speeds.

Sikorsky first flew its Advancing Blade Concept (ABC) in 1973 on the XH-59A (company designation S-69), sponsored jointly with the US Army. Testing showed the coaxial rigid rotor with differential pitch control made the 9,000 lb helicopter exceptionally responsive. The ABC demonstrated snap-turns, high-rate sideslips, and level transitions from hover to forward flight. One Sikorsky pilot estimated that the coaxial ABC was 50% more maneuverable than a single-rotor helicopter of the same size. With no anti-torque rotor to waste power, the ABC was also efficient in a hover. The high-speed concept demonstrator nevertheless suffered from high empty weight, high hub drag, and persistent vibration. With a Pratt & Whitney Twin-Pac of two coupled PT6 turboshafts, maximum level flight speed at sea level was just 160kts.

In 1978, the ABC demonstrator received two Pratt & Whitney J60-P3A turbojets, each generating 3,000 lb auxiliary thrust. The four-engined XH-59A attained 256kts in a joint Army-Navy-NASA flight test program. However, gross weight increased to 11,100 lb with corresponding increased disk loading. Two fuel-hungry jet engines also imposed obvious penalties in range and operating costs, but a proposed XH-59B with an integrated propulsor lost the battle for government development funds to the tilt rotor. Although Sikorsky considered an ABC offering for the US Army's Light Helicopter, empty weight and vibration resulted in a more conventional layout for the ultimately canceled Comanche.

Try again

Today's 5,500 lb X2 demonstrator revitalizes the ABC with new technology rotor blades, fly-by-wire controls, active vibration suppression, drag-reduction measures, and integrated auxiliary propulsion driven by a single engine. The V-22 and BA609 tilt rotors already promise 240kts and 275kts cruising speeds with near-turboprop range, but they pay for the structural weight and downwash losses of a fixed wing with reduced hover payload and endurance. Although US Department of Defense studies of Joint Heavy Lift or Joint Future Theater Lift alternatives

> "Retreating blade stall has capped pure helicopter speeds at less than 200kts so far"

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apparently favor big tilt rotors over X2 helicopters, Sikorsky leadership still sees market appeal in a 250kts helicopter able to haul heavy external loads or hover for long periods.

The X2 rigid rotor system has all-composite rotor blades that blend three different airfoils to achieve a far better lift-to-drag ratio than the blades on the XH-59A. The blades also reduce structural weight, yet afford the stiffness essential to maintain safe rotor clearance. Careful packaging promises hub drag on a par with single rotor helicopters, and drag predictions were verified with wind tunnel testing and computational fluid dynamics.

The X2 puts a premium on drag reduction. "Because of the high speed, we didn't want all the strain gauges on the outside," says Walsh. The all-composite main rotor blades were autoclaved with strain gauges inside the spars. Each rotor generates 32 strain gauge parameters to measure blade and shaft bending. The sensors feed a Remote Multiplexing Unit (RMU) that provides a single digital data stream from each rotor. RMU data streams from the upper and lower rotors run through slip rings to the databus system. The inter-rotor slip ring for the lower rotor is especially small in diameter to fit within the low-drag rotor fairings.

A foil antenna in the tip of each blade also enables a blade proximity monitoring system to track the clearance between upper and lower rotors. The capacitance-based system uses a transmitter in one rotor and receiver in the other to measure tip separation. A cockpit display circle shows the pilot a digital readout of blade clearance in inches and changes color to yellow and finally red as blades get close. A circle of illuminated dots shows the azimuth of closest approach. Other displays show the pilot propulsor torque and blade angle, but according to Walsh: "We try not to overwhelm him with too much data."

If the X2 flight test phase proves successful, Sikorsky plans to launch a family of new civil and military helicopters based on the coaxial, compound design

"The all-composite main rotor blades were autoclaved with strain gauges inside the spars"

The X2 demonstrator has a crew station up front in a tandem cockpit. Instrumentation fills space for an aft seat, and an avionics bay next to the engine. Sikorsky-Schweizer engineers devised the X2 digital Pulse Compression Modulation instrumentation system to measure 200 analog parameters. "It's kind of scattered all over the airplane," says Walsh. A slip ring on the tail pusher propeller, for example, collects strain gauge data to measure blade bending and propeller torque. Tail cone strain gauges measure bending, torsion and thrust from the pusher propeller.

Despite the coaxial rotors and integrated thruster, the X2 has a very ordinary transmission. "We made this as conventional and simple as we could," says Weiner. From the input drive, two bevel gears turn the upper and lower rotors in opposite directions. A propeller gearbox drives the tail thruster, and a combiner section drives accessories. All gearboxes have internal and external thermocouples, and temperature sensors were installed on all the transmission bearings. X2 engineers installed thermocouples on bearing races inside the gearbox and ran wires out through access ports.

The high-speed demonstrator is the first helicopter application of the Goodrich 'Smart Probe' air data system. Two all-digital Smart Probes (one on each side) eliminate the need for pneumatic plumbing on the X2.

Six different digital databuses monitor and record X2 aircraft data. Most data travels by five ARINC 429 databuses: one bus to serve each of three flight control computers; another to connect the active vibration control system, and another to tie into the air data system. A MILSTD 1553 bus feeds engine operating data from the T800 digital engine control to the flight control computers.

The data system provides a 4Mb/sec stream recorded on a lightweight, solid state Heim Systems D-5000 flight recorder in the aft cockpit. About 1Mb of the available data is telemetered to a mobile ground station. The small X2 team works in a corner of a Hawk Works hangar and may complete its planned program this year, depending on progress at each phase. "We're going to fly and see what discoveries we make," says Weiner. ∎

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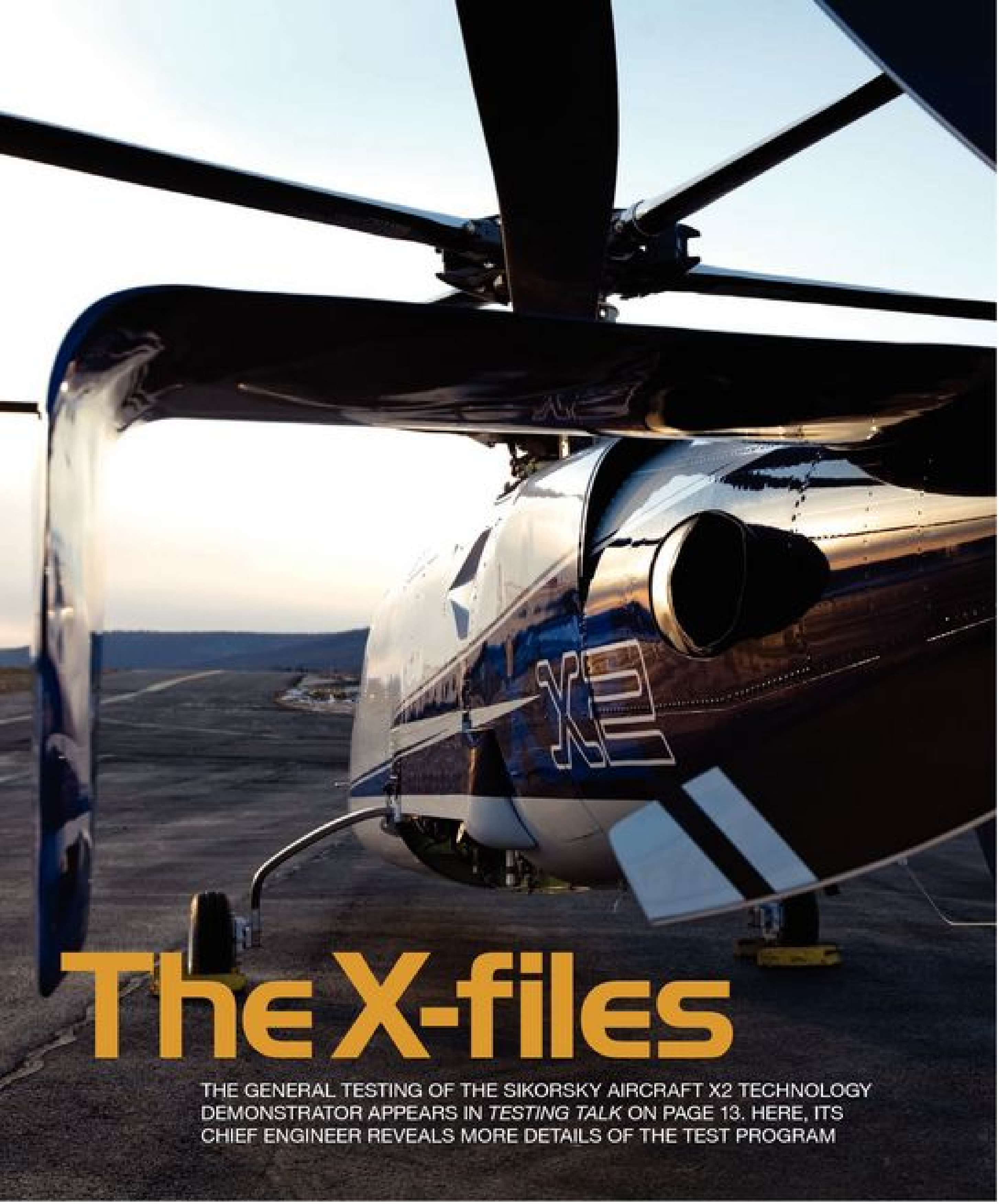
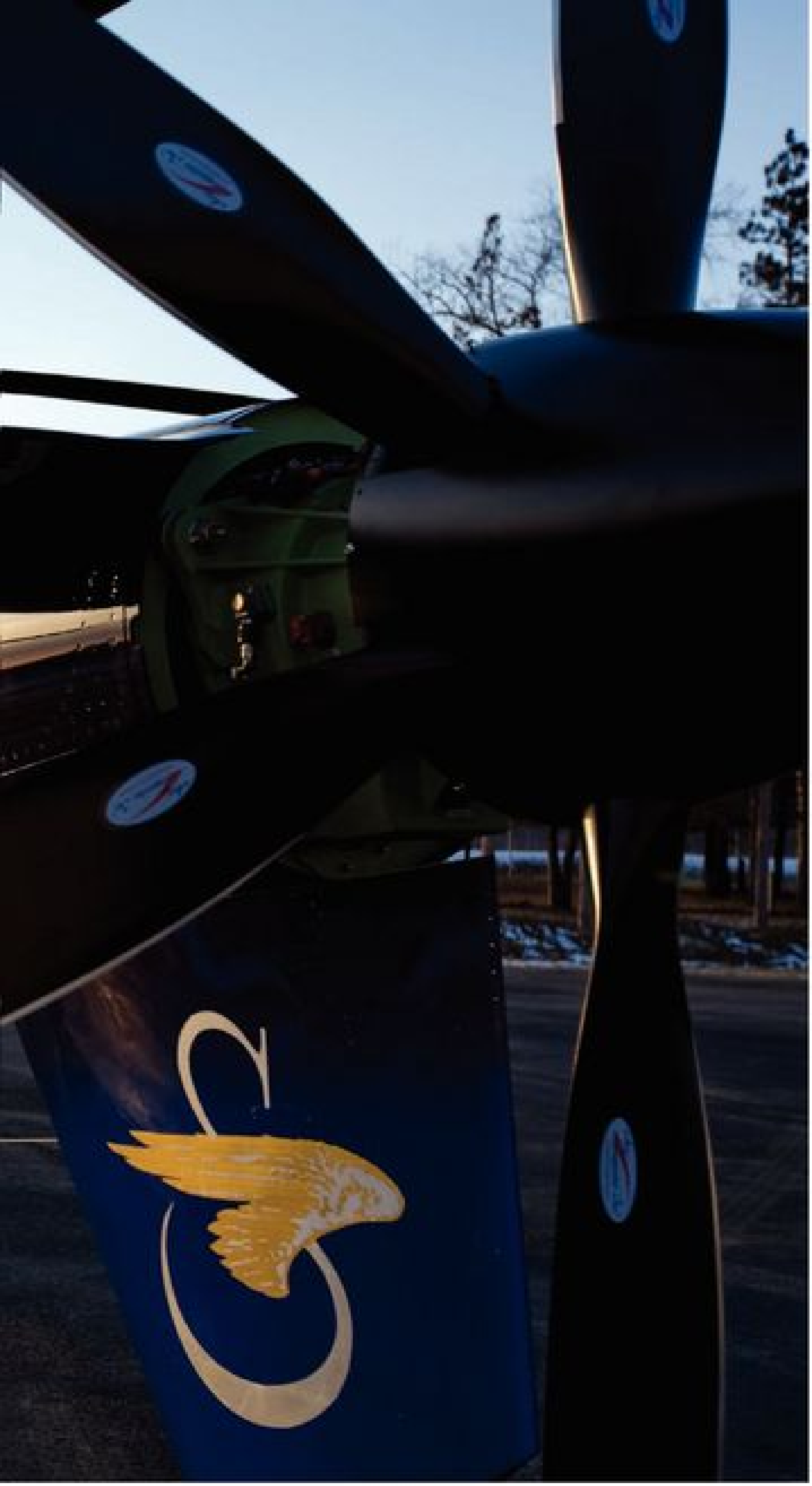


The X-files

THE GENERAL TESTING OF THE SIKORSKY AIRCRAFT X2 TECHNOLOGY DEMONSTRATOR APPEARS IN *TESTING TALK* ON PAGE 13. HERE, ITS CHIEF ENGINEER REVEALS MORE DETAILS OF THE TEST PROGRAM



BY STEVE WEINER

The Sikorsky X2 Technology demonstrator uses a suite of advanced technologies to provide 250kts cruise speed capability with low vibration, low noise, and reduced pilot workload. These advanced capabilities are accomplished in a way that does not compromise conventional helicopter attributes such as excellent hover performance, low-speed maneuverability, and auto-rotation.

The test program for this aircraft provides an incremental development path for the components and systems needed for combination of attributes. It uses Sikorsky's extensive experience in design, test and evaluation of new concepts, which has, over the years, culminated in a standard method of testing by the Sikorsky Test and Evaluation branch, led by Kevin Bredenbeck, who also is the chief pilot for the X2 Technology demonstrator. The X2 Technology program, like others at Sikorsky, has a specific group of test engineers dedicated solely to completing the development testing on the aircraft. This team is led by the X2 Technology chief of tests, David Walsh, who brings with him almost 30 years of experience.

In addition to the experience-based test methods, the unique character of some of the technologies of the X2 Technology demonstrator required that new test methods be devised to ensure that the resulting vehicle possessed the required levels of reliability and safety for an experimental aircraft.

The overall test program combines individual component testing, system testing in a lab setting, simulation, multiple-system testing on the aircraft on the ground, and finally, complete aircraft tie-down and flight testing.

For testing to be successful, the aircraft has to be fully instrumented. Temperatures, pressures, loads, vibration levels, rotating speeds, and torque are all measured by a combination of fixed and rotating system instrumentation. This system uses main rotor and prop drive slip rings, with data telemetered to a mobile test van. The reason for this is two-fold. First, real-time

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monitoring of the aircraft during ground and flight testing is required to ensure that DNEs ('do not exceed' parameters) stay within limits, protecting both the aircraft, and, more importantly, the pilot. Second, the data collected from this testing could be used as the basis for a production vehicle using the technologies developed on the demonstrator aircraft.

To date, the aircraft has completed 2.2 hours of flight testing and 41 hours of ground testing with 97 engine starts. Individual components and systems have completed hundreds of hours of testing.

X2 Technology ground test program

Considerable ground test effort is needed to prepare for any helicopter flight testing. However, the X2 Technology demonstrator program was anything but routine in this respect, with the challenge to assure safety with unique new technologies incorporated in devices and systems that had no precedent to follow. In addition, the X2 Technology demonstrator employed many off-the-shelf components in unique applications. Three of the many ground test programs conducted are described on these pages.

Main rotor blade fatigue test

The most critical main rotor blade attribute to substantiate prior to flight is the fatigue strength. Fatigue stress cycles are applied in a laboratory test set-up that faithfully simulates the distribution of loads expected to occur in flight. The magnitude of the load distribution is incrementally increased, with thousands of cycles at each level, until structural failure occurs. This may happen well above the predicted flight loads; in fact, showing this margin of actual fatigue strength is the essential goal of the program. The test results are presented in the form of an S-N curve, or applied stress or load against the number of cycles to produce a fatigue crack or delamination.

The X2 Technology demonstrator blade in its test facility demonstrates the inboard end of the blade, including the rigid titanium attachment, pitch bearing, and hub, is on the right. The all-composite blade itself extends to the left and is terminated at a special end fitting that allows full centrifugal force and combined bending load to be applied by hydraulic cylinders.

Later, a second loading cylinder was added to the mid-span of the blade to raise the stress outboard. But the very thick and stiff spar construction moved the critical section of the blade to the bond lines on the built-up spar, so the traditional bending moment substantiation became a shear stress substantiation.

Eventually, disbonding and splintering of the composite cover occurred with no spar failures, but there was enough demonstrated strength to begin the flight test program. There will be additional testing on another specimen to increase the spar load, to cover the high-speed flight test conditions.

Main transmission run tests

The X2 Technology demonstrator main gearbox slows the speed and transmits the power from the T-800 engine to the two counter-rotating rotor hubs, the propeller driveshaft, and accessories. This has been accomplished using a very efficient compact design. Preflight testing included gear rap tests to verify absence of critical diametral modes. One of the gears was modified to incorporate a special damping material to assure that no detrimental response occurs in operation.

The principal tool used to qualify a helicopter gearbox for flight is the 'no load lube' test, needed to develop and substantiate the function and performance of the gearbox lubrication system, including excursions to the full steady-state attitudes that can be achieved in flight.

The main gearbox is a green object topped by the two rotor hubs mounted on the contra-rotating shafts. Not directly visible is a short section of prop driveshaft and the propeller gearbox. All of these components are driven to the required speed by an electric motor.

The aluminum box under the gearbox is the remote sump, which turned out to be the principal development problem addressed in the test. Initially, sufficient lube oil flow could not be obtained out of the sump, resulting in high bearing temperatures. Eventually, this and several other issues were resolved during the test, including setting the required oil volume,

The race to beat 250kts

Back in February 2008, Piasecki Aircraft Corporation (PiAC) completed the initial Phase 1 flight test of the SpeedHawk X-49A Vectored Thrust Ducted Propeller (VTDP) compound helicopter at New Castle County Airport near Wilmington, Delaware.

The government's review of test data will be complete in June 2009, and should it identify any additional Phase 1 test requirements, these will be addressed during ongoing flight tests being conducted this summer.

After completion of Phase 1, the X-49A test aircraft will be brought out of flight status and modified to conduct Phase 2 flight testing. These modifications incorporate a supplementary power unit, upgrades to the flight controls, and streamlining various parts of the aircraft to achieve speeds over 200kts. The objective of the X-49A VTDP compound helicopter technology is to improve helicopter speed, range, ceiling, survivability, and lifetime cost. The Phase 1 flight tests' preliminary results indicate a considerable increase in speed over the baseline H-60; hover performance on average appears to be within 3.7% of predicted values; and forward flight vibration and fatigue loads were greatly reduced. Based on these test results, PiAC is confident that it can safely expand the flight envelope beyond the current NATOPS limit of the SH-60, and demonstrate the full capability of this technology.

Once the X2 has completed testing, it will pass through the skies at up to 288mph, making it the fastest helicopter ever built

"To date the aircraft has completed 2.2 hours of flight testing and 41 hours of ground testing" venting, pump orientation, leakage, and cooling. The need for a separate oil cooler for the prop gearbox was also resolved.

Ultimately, the 'no load lube' test made for an uneventful installation and initial run of the gearbox on the aircraft, which is a highly desired result that is difficult to achieve.

Aircraft tie-down testing

The ground test program consists of an incremental build-up approach. Initial engine starting and control testing was followed by extensive bare-head (no blades) testing of the aircraft. This testing provided information on the main transmission, rotorhead components, lubrication, cooling, rotating component instrumentation, and basic electrical system integration.

Once the bare-head testing was completed, the main rotor blades were installed and the next phase of testing began. In keeping with the build-up approach of the overall test program, the prop drive shaft and prop were not installed during this phase, as the focus was on developing the main rotor system.

In general, the test program has attempted to investigate only one or two new systems at each phase, so that issues are well understood and resolved before moving on. In this case, the main rotor system was first tested without the main rotor servos installed, to make sure the blade instrumentation was operating correctly, and to determine basic performance parameters of the engine with its new load and of the initial dynamic balance of the system. The aircraft was tied down on the ground test concrete pad with chains. Load cells were installed in the load path to provide force data as the aircraft came up to operating RPM.

Next, the main rotor servos were installed and the blade rigging performed. This involved setting pushrod lengths to maintain preset baseline collective pitch values and operating the fly-by-wire control system with operational flight software to check clearance throughout the control envelope or 'box'.

Initial runs on the tie-down pad were conducted at ground idle RPM to acquire track and balance data and adjust the rotor paths.

"This initial flight showed the control system to be more sensitive than simulated, so some adjustments were made in the fly-by-wire software"

To accommodate two rotor systems and complete this phase the data system had to be modified. The resulting balance adjustments were successful in that cockpit vibration was brought well within the range of a modern single rotor helicopter, such as the S-76, on the first set of adjustments runs.

The testing that followed explored the rotor performance envelope, with collective and cyclic sweeps, investigation of the sensitivity of the rotor beepers, dynamic inputs to investigate rotor stability and damping, and in general checking out the fly-by-wire system prior to flight.

The blades-on ground runs were also used to finalize ground handling procedures for the crew, to practice emergency procedures, such as use of the manual fuel shut-off, and to test the warning caution panel operation, electrical system and switching to battery back-up in case of a major electrical failure. This testing confirmed that the simulation conducted throughout the development of the aircraft was a good representation of the actual vehicle in use.

The X2's coaxial set-up eliminates torque, allowing the tail rotor to propel the helicopter forward much like the propeller on a ship

Prior to flight, a 25-hour endurance test was conducted. This 'clean run' was intended to confirm that no infant mortality issues remained. Following a detailed visual inspection, the aircraft entered the flight test phase of the program. The aircraft tie-down straps were disconnected and the pilot completed a ground run where the aircraft was brought to a 'light on wheels' state, further investigating controllability.

Flight testing

Following completion of this test, the first flight of the X2 Technology demonstrator was carried out on August 27, 2008. First flight lasted 0.8 hours, and consisted of an initial hover and basic systems check. In addition, the basic controllability of the aircraft was explored, with hover turns, three take-offs and landings, sideward flight to 10kts, and forward flight to 20kts achieved. This initial flight showed the control system to be more sensitive than simulated, so some adjustments were made in the fly-by-wire (FBW) software for the second flight.

The second flight lasted 0.3 flight hours and was cut short due to wind gusts beyond the DNE limits for the test aircraft. Even so, after a clean lift-off to hover, it was apparent that aircraft-control sensitivity had been improved. Additional adjustments in the FBW software were tested in the simulator for the third flight.

The third flight lasted 1.1 hours, and proved that the control system modifications were successful. Pilot workload was greatly reduced and a very stable hover achieved, as well as more than 20kts in forward flight, 10kts in right side and left side flight, 20°/sec hover turns, 30°/sec roll rates, a 20° angle of bank turn, and two take-offs and landings.

It is important to note that, for the first three flights, the X2 Technology demonstrator did not have a stability augmentation system (SAS), making the flying qualities achieved in just three flights a great accomplishment.

The aircraft is currently being updated to the high-speed configuration, which will be used for the remainder of the flight test program. This includes addition of the main rotor-hub fairings, retractable landing gear and door integration, and final installation of the pusher propeller.

As the rest of the flight test program is completed, the test data collected will provide Sikorsky Aircraft Corporation with the information required to decide which path to take for its future products. ∎

Steve Weiner is the chief engineer on the X2 Technology Program, Sikorsky Aircraft Corporation

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Joint adventure

PROGRAM DIRECTOR FRANCIS COMBES REVEALS EXCLUSIVE DETAILS ABOUT THE PROGRESS OF EUROCOPTER AND HARBIN'S LATEST COMBINED EFFORT, THE EC175/Z-15

The EC175 primary markets are to be in support of the oil and gas industry and search and rescue missions

BY JOHN CHALLEN

'A helicopter designed to meet every operational challenge. Even the future.' That is the vision for Eurocopter's EC175, a helicopter that will combine new developments with tried-and-tested elements, such as the PT6C engines from Pratt & Whitney. Deliveries are not expected until 2012, and the prototype helicopters have not yet been built (planned for the end of 2009), but already, the project has broken new development ground for a civilian helicopter. New methods of communication between teams, and more discussions with suppliers and potential customers than ever before has meant a very different approach by the 800-strong testing team.

Despite having a range of aircraft, Eurocopter's main reason for the development of the EC175 was to fill a void. "There was a helicopter missing in our 5-ton to 10-ton range, and we needed to develop a product that would complete the range as well as better serve our customers," recalls Francis Combes, who has been program director on EC175 since late 2004, and has spent 35 years of his life at Eurocopter and French Aerospatiale, prior to the latter's merger with Daimler-Benz Aerospace. The helicopter, which weighs in at around seven tons, is a twin-engine design, with each of the Pratt & Whitney units pushing out 1,325kW of power. The main rotor is a Spheriflex with five blades, backed up by a three-blade tail rotor. The cost and weight of an auxiliary power unit (APU) is saved as the main de-clutchable gearbox incorporates two accessory gearboxes.


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Initial discussions about EC175 took place within Eurocopter in 2004, and later that year contact was made with China's Harbin Aviation Industry Group (HAIG). Combes explains more: "There were two reasons for entering into the partnership with Harbin. First, it needed a helicopter in the same range and at the same time as Eurocopter. Second, the investment is huge, so with two parties involved, obviously, the cost is halved." Combes reveals that the program will total approximately €600 million (US$770 million), which will be split 50/50 between the two companies. Eurocopter will use the tag EC175, but the HAIG-produced model will be called the Z-15.

The fact that the EC175 program was to be a collaboration between Eurocopter and HAIG threw up the first challenge to the development team. How can a project be run successfully when the two parties are based 10,000km away from each other? Fortunately, Combes and his team had technology on their side. "We have tested numerous new tools during the development of EC175, many of them in communication," he explains. "One of these tools is the Digital Mock-up Unit (DMU), which is a hugely effective way of communicating with Harbin, and also with the vendors."

> "With the aid of the DMU, I think we have saved probably years on the development of EC175"

Project timeline

Early 2004	Initial internal discussions about an aircraft to fill the gap between 5- and 10-ton helicopters
October 2004	Cooperation Framework Agreement signed to say that Eurocopter and Harbin Aviation Industries agree to enter discussions about a new aircraft
November 2004	to November 2005 – Negotiations with Harbin about development of the EC175
December 5, 2005	Contracts signed for the helicopter's development. Francis Combes describes this day as the best so far on the program
December 5, 2006	Completion of the Preliminary Design Review
December 5, 2007	Completion of the Critical Design Review
February 24, 2008	Formal launch of EC175 at Heli-Expo in Houston, Texas
November 15, 2008	Ceremony at Harbin to mark the completion of the first full EC175 structure
Late 2009	EC175 test flights due to begin with two prototype aircraft
2010	Z-15 test flights begin
Late 2011	Certification of EC175
Late 2012	Certification of Z-15

The DMU

The DMU is a full design of the aircraft, which integrates the various designs of each potential part. We can look at the design of the items such as the hydraulics and gearbox to see if everything is compatible." Combes says that, as well as contributing to a smoother program, the system's biggest advantage is that it saves time and money. "With the aid of the DMU, I think we have saved probably years on the development of EC175," he says, before extolling the benefits of CAD in the development program. "The DMU has avoided clashes with our partners in China on parts discussions, especially when dealing with suppliers in different regions of the country. We have used CATIA V5 more than ever before on a number of different parts. For the gearbox, for example, we have used specific tools to shorten development time."

Prior to development of the DMU, a team from HAIG was dispatched to Eurocopter's Marignane plant. This move proved to be invaluable to Combes and Eurocopter: "We have a common design office in our Marignane plant, and this is where we worked together for a year," explains the program director. "It was a good way of getting to know each other as well as being an opportunity to decide the technology and interfaces that we should use when designing the helicopter." After that 12-month period, Combes says that the Eurocopter team now relies on video conferencing and also "a lot of trips to China", as well as the DMU. "Harbin people are also spending a lot of time here in France," he adds.

The first EC175 airframe structure was delivered by HAIG to Eurocopter Marignane in November 2008

Eurocopter has taken the role of project leader and systems integrator, but HAIG has plenty of responsibility regarding the new aircraft. "We have shared out the aircraft in terms of the sub-assemblies, and each partner is responsible for their specific sub-assemblies," says Combes. As part of these shared responsibilities, Eurocopter will develop the main gearbox, tail rotor, avionics, autopilot and hydraulic and electrical systems. HAIG will be in charge of the airframe, tail, accessory gearboxes, main rotor, fuel systems, flight controls and landing gear. "The first structure was manufactured by Harbin and delivered to France at the end of 2008," says Combes.

Key players

As well as Eurocopter and HAIG, there has been another key player in the development process. Combes says, "EC175 is being co-developed with our customers. When we started the development program we submitted our ideas to what we call CAT (customer advisory team). We asked these customers – who are mainly in the oil community – what they thought about what we planned to do with the aircraft." Combes managed to get a good cross-section of the community to respond, but not 100% agreement. "We talked to about 15 customers in total, including Total and Shell, as well as Bond and Bristow Helicopters. When we showed them what we planned to do, they told us they did not want that kind of concept, so we had to completely redesign the concept."

Fully aware of the tight schedule, Combes ensured that changes were made immediately. "The redesign takes into consideration all of the customer needs and requirements. There was a big change between two meetings because we had gone from what was originally planned to what they requested." Combes remains convinced that the efforts to alter the design was instrumental in gaining 111 orders from Heli-Expo in Houston, Texas, the scene of the official unveiling in 2008.

One requirement that came from the CAT meetings was the capacity for 16 passengers to travel in comfort. "Although there are aircraft with 12 and 19 seats, nobody was offering the capacity of 16," says Combes. "Our discussions with the customers revealed that this is exactly what they wanted. The first time we presented our ideas, they said, 'OK, you can forget 16 passengers because the access is not so easy and comfort is not good.' But we were not prepared to give up. We had to redesign the cabin to be able to accommodate the passengers, and changed the shape and size of the doors, strengthened the cabin, and made the windows larger." Combes says that for added comfort levels, a nice view when in flight was an essential addition. "The seats are not fixed, so there is great flexibility," he explains when quizzed about accommodating a stretcher or a medical set-up. "We have some interesting ideas about configurations, and we will have discussions about these with the oil and gas communities."

Eurocopter sets up in Scotland

Away from the development program of the EC175/Z-15, Eurocopter is making further investments to support other members of the fleet. The company has announced that it is to strengthen its UK operations with the construction of a helicopter service center and simulator facility on a commercial park in Aberdeen, Scotland. Currently home to Bristow Helicopters' European Operations and Bond Offshore Helicopters, the city's Kirkhill Commercial Park location of the new Eurocopter site already acts as a maintenance center for 59 Super Puma EC225 helicopters, which accumulate around 85,000 flying hours every year. With the addition of the new facility, due to be completed in December 2009, the company will be ideally placed to service one of the world's busiest offshore and gas helicopter maintenance hubs in the world.

As well as logistical and technical support, Eurocopter says that the Aberdeen facility will house the company's first UK-based EC225 flight-training simulator. The flight simulator, which will occupy close to 500m², will be joined by a logistics warehouse covering more than 900m², and 465m² of offices. Markus Steinke, Eurocopter UK's managing director, says, "The new state-of-the-art Eurocopter facility in Aberdeen reinforces the company's commitment to investing in the UK, and to bringing the best technical and logistical support to where our customers need it most. The Eurocopter Puma/Super Puma/EC225 helicopter family has proved very popular in the UK, supporting the UK offshore oil and gas industry and in military missions as a key part of the Royal Air Force helicopter fleet. The new Aberdeen facility is the latest in a range of high-quality support services that we provide to our UK customers, both civil and military. We aim to have a network of local operations close to our customers throughout the UK. With our already strong presence in England, Wales, and Ireland, we are pleased to be making a further commitment to Scotland."

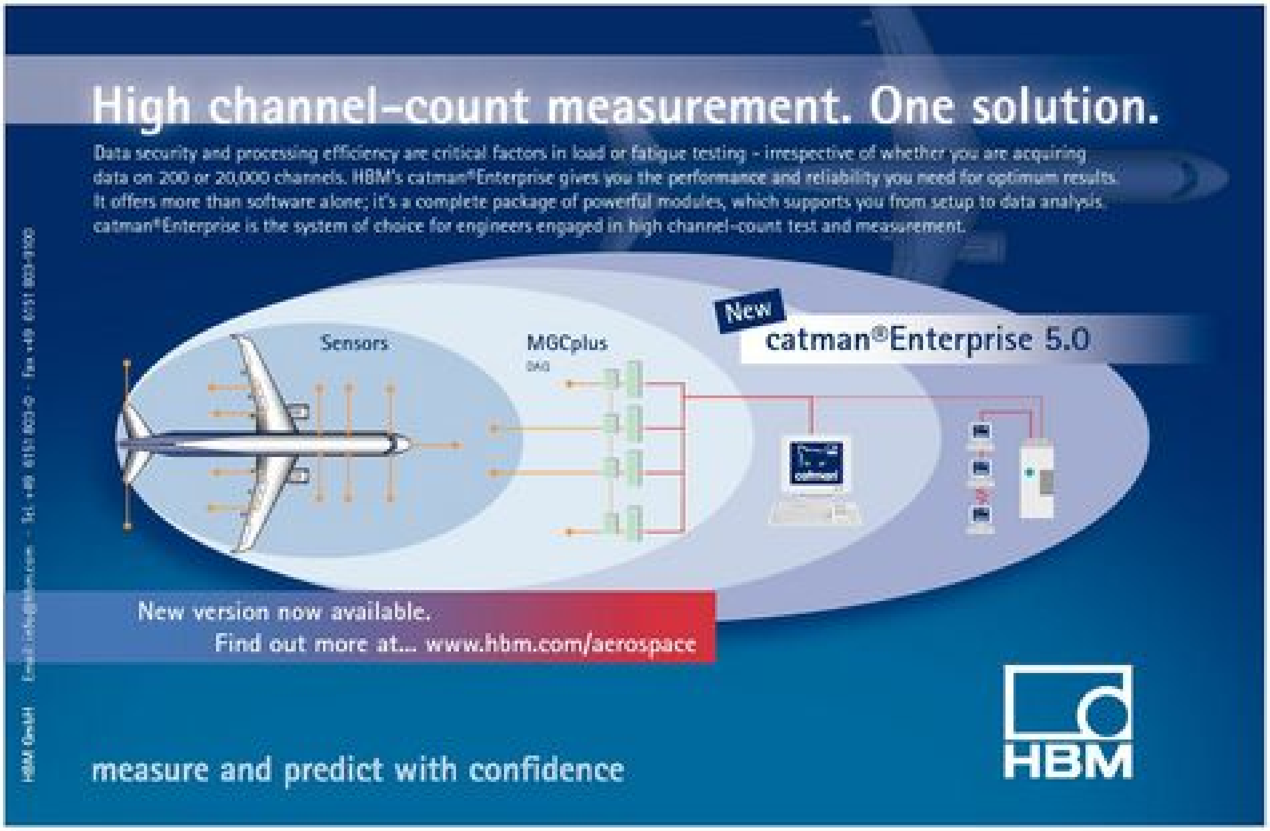
"We are in the laboratory phase now and we have started assembly of the first prototype, which will go for its first test flight in 2009"

Design features

Those flying the EC175s will not miss out either. The cockpit – designed by pilots for pilots, according to the company – features four multi-function LCD screens, plus an optional central mission display. Avionics are derived from the EC225, and include a four-axis duplex autopilot, which is linked to the aircraft's flight management system.

Test flights are due to start at the end of 2009, with two EC175s based in Europe and one in China. "We have two helicopters in France because we started the setting up here, and the Chinese will start to fly later than us," explains Combes. "In 2011, when we have completed all of our development work, we will send the second development helicopter to China. We are in the laboratory phase now and we have started assembly of the first prototype, which will go for its first test flight in 2009. The next aircraft might have slightly different equipment on board, but otherwise it will be the same."

The EC175 exceeds the EASA CS29 crashworthiness requirements, but Combes is aware that there is a long way to go and plenty more targets to meet. "We have a full development schedule for our two aircraft, the goal being to complete certification by the second half of 2011. The Chinese will do the tests to get certification by 2012, and they will start test flights in 2010." Eurocopter's involvement in the program will continue until 2060, as it takes on the role of service support of the EC175 helicopters produced at the Marignane plant. The expectation is that 800 units will be sold over a 20-year period. ∎



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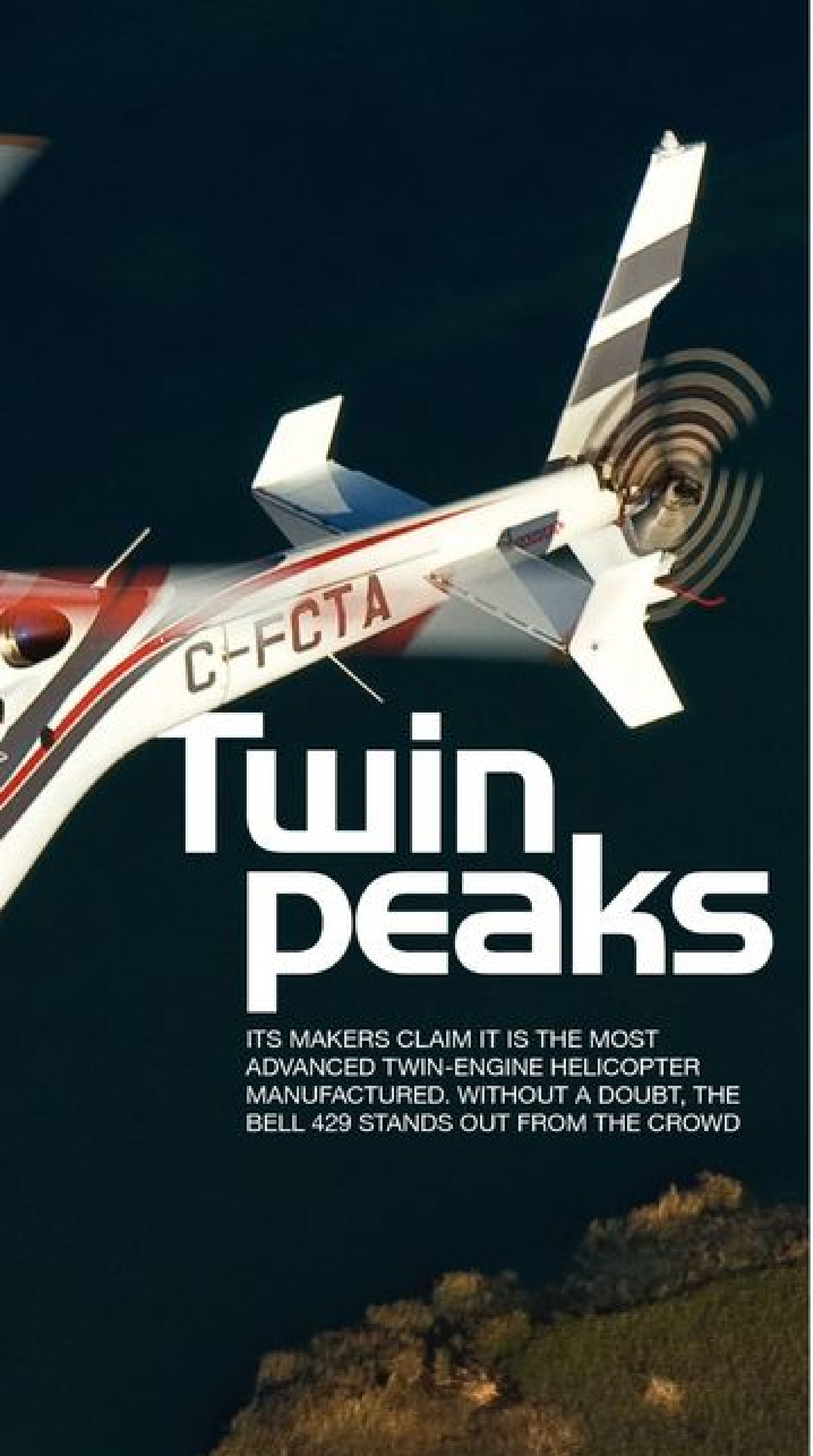

Twin peaks

ITS MAKERS CLAIM IT IS THE MOST ADVANCED TWIN-ENGINE HELICOPTER MANUFACTURED. WITHOUT A DOUBT, THE BELL 429 STANDS OUT FROM THE CROWD

BY NEIL MARSHALL

The latest commercial aircraft development from Bell Helicopter is the Bell 429, a twin-engine Part 27 rotorcraft intended for use in a variety of roles because of the flexibility its innovative design offers to the marketplace. The 429 is the first of a potential fleet of aircraft variants built under Bell's modular affordable product line (MAPL) designation, which is intended to reinvent its commercial product line.

The Bell 429 was conceived in 2004 and launched at Heli Expo 2005 in Anaheim, California. It presented a brand new product concept for Bell with a wide open cabin, large doors and openings, rear clamshell doors, and new rotor and avionics systems. With this came the challenge of a large development program with considerable testing requirements to show compliance against the latest airworthiness requirements.

The development test program involved three levels of testing: equipment level, component level, and aircraft level. The equipment level testing is generally conducted by suppliers to Bell, and is designed to demonstrate that their equipment meets Bell's and government regulatory airworthiness requirements. The component level testing is generally conducted by Bell to demonstrate that the components and assemblies meet airworthiness requirements. The aircraft-level testing is also conducted by Bell and demonstrates that the aircraft and its integrated systems also meet airworthiness requirements.

Flight test

For flight testing, Bell used one 427 aircraft (a predecessor product to the 429), two prototype 429 aircraft, and three pre-production 429 aircraft for aircraft level testing. The 427 'concept demonstrator' was used to prove out some of the major 429 systems as early as possible, and earlier than any 429 aircraft was able to take to the air.

In February and March 2006, while the first 429 prototype aircraft was being assembled on the Mirabel production line north of Montreal, Quebec, the 429 main rotor, flight computers, engine cowlings, and other subsystems were being flown in Mirabel, and in Arizona at high temperatures on a 427 aircraft. That testing was

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crucial to Bell to reduce the risk of finding issues later when they first flew the 429. Indeed, some changes were found to be required with the main rotor blades, which would have surely delayed the 429 testing when it first flew in 2007. The engine cowlings' shape was developed off this 427 aircraft flight testing, reducing the risk of tail wag, a phenomenon on all helicopters that can occur in certain flight regimes where the turbulence off the fuselage, engine exhaust, and rotor causes the empennage to oscillate.

The first 429 prototype aircraft took to the air one year later in February 2007, and was used to start envelope expansion. The aircraft was flown to all corners of the flight envelope, considering altitude, speed, gross weight, and center of gravity (CG) locations. This envelope expansion was completed with one configuration to establish all issues, for which solutions were then developed and introduced into the prototype and early production aircraft. This testing was started at Bell's Mirabel facility north of Montreal, and was followed by high-temperature and high-altitude testing in Arizona and Colorado.

The second 429 prototype aircraft flew in August 2007 and was used with the first prototype to complete development flight testing. Having confirmed all issues with the prototypes at all corners of the envelope, the task was to freeze the aircraft configuration, the shape of the cowlings, and the size and span of the empennage with a design that met Bell's desired specification and airworthiness requirements.

Bell claimed configuration freeze in October 2007 after flying many different sizes and shapes, and in a timeframe that was much faster than previous developments. The company had innovations in their flight-test plans that enabled a quick change of cowlings and empennage components to minimize aircraft downtime, and even had the ability to adjust the angle-of-attack of the empennage in flight, something that took one day of removal and installation on earlier programs.

With configuration freeze came the opportunity to start some certification flight testing, and the Transport Canada and FAA pilots first flew the Bell 429 in November 2007. In the cold winter months of early 2008 the prototypes were used for cold weather flight testing to ensure the aircraft would operate and perform to the desired specifications down to -40°C.

Certification testing

The first pre-production aircraft took to the air in February 2008, and was Bell's first opportunity to fly a production-like version of the aircraft. Two more pre-production aircraft have since entered the flight-test program, in October and November 2008, completing the fleet of five aircraft being used for the development and certification flight-test program.

The three pre-production aircraft have been used for the majority of the certification flight testing by Bell, and with the Transport Canada and FAA pilot staff. This phase of testing is used to show compliance to the airworthiness regulations and will draw to a conclusion in early 2009. The first prototype was grounded in November 2008 and converted to a ground test vehicle. The ground testing involved running the drive system, with the aircraft tied down and cycling the aircraft with many start/stops, for more than 100 hours. This testing was successfully completed in January 2009, and that aircraft is now being readied for delivery to the Bell Customer Training Academy (CTA) in Fort Worth, Texas, as a maintenance trainer to provide the early customer pilots and maintenance personnel with hands-on experience on the Bell 429.

The second prototype will remain in the flight test program after certification to support future development activities and potential testing in support of possible variants of the 429, one with single engine and one with a higher gross weight. The three pre-production aircraft will be retired from the flight-test fleet over the course of 2009, and converted to the type-certified design configuration. After this they will be used as flight trainer aircraft at the Bell CTA, and also for some potential testing in support of the possible variants of the 429.

The component-level testing was started in 2007 and is used to prove out the components

Emergency vehicle

The Bell 429 is similar in structure to the Bell 427, with a composite tailboom and advanced tail-rotor driveshaft. The new main and tail rotor blades are designed with lower tip speed and swept tip to reduce noise levels. Safety features include a reinforced cabin that can withstand rollover.

The helicopter has a new cabin with a wide, flat floor for use as utility/passenger/offshore operation, or air medical transport, or for any other mission requirement. The helicopter is powered by two turboshaft engines. The basic helicopter is fitted with two sliding cabin doors. In addition to the sliding doors, the Emergency Medical Services (EMS) variant can be configured with optional clamshell doors to allow ease of access with a roll-on/roll-off stretcher-loading system operated by a single person.

The emergency medical services variant can carry two patients and two medical attendants. The helicopter has tubular skid landing gear, either high or low skid gear as specified by the operator. Wheeled landing gear is fitted as an option and will be available 12 months after the basic aircraft certification.

The launch customer for the Bell 429 is Air Methods Corporation, the largest medevac provider in the USA

"The first prototype was grounded in November 2008 and converted to a ground test vehicle"

The 429's maximum airspeed with maximum continuous power (Vh) has improved from 142 to 147kts

"Failure of this test is not uncommon, yet for Bell and its supplier this was the first successful first-time pass for a new product development"

The Bell 429 has a single pilot IFR-certified glass cockpit with 3-axis autopilot and flight director standard, 4-axis autopilot

on the aircraft. This includes static and fatigue testing of structural and dynamic components. The Bell 429 has a considerable amount of fiber composite components, all of which have been tested in the component test laboratories at the Bell facilities in Fort Worth and Mirabel.

Although sufficient testing will have been completed in early 2009 to demonstrate compliance and enable the aircraft to be put into service, some of this testing will continue into 2011 and 2012. When this testing is complete, the full fatigue life of 10,000 hours or final inspection requirements for composite components will have been demonstrated for all the main rotor components.

Many components also have to be tested to demonstrate that their structural integrity remains intact after a lightning strike. Blades and airframe structure were struck by lightning in test labs in the USA, after which the components were returned to the Bell facility in Canada for inspection and then static testing to demonstrate they can sustain limit design loads.

Another component level test was carried out at the NASA Glenn facility in the USA to demonstrate that the engine inlets still operate within specification when the aircraft enters icing conditions. A full set of engine cowls were installed into the wind tunnel and cold, icy air was run over the cowlings. The testing was successful for both the basic, open, inlet and the barrier filter installation.

Fuel tank drop

A dramatic test on all rotorcraft development programs is the fuel tank drop test. This requires the fuel cells and surrounding structure to be dropped from 50ft onto a hard, flat surface. On the Bell 429 program this test was conducted in France at Bell's fuel system supplier. Months of effort to construct a full floor assembly with fuel system installed is rewarded with a split-second drop and the resulting crash damage. Failure of this test is not uncommon, yet for Bell and its supplier this was the first successful first-time pass for a new product development. After dropping, and despite the obvious structural damage resulting from the crash, the fuel system remained intact and no leaks were detected.

The seat crash testing required by the latest airworthiness regulations was also dramatic. All the seats on the Bell 429 are new and will meet the latest regulations. They were subjected to sled testing with impacts of more than 30g in some cases. This testing is also used to determine the head path of the occupant in such an impact, and that head path is then used in Bell's 3D engineering models to demonstrate that the occupant's head will remain safe despite the impact.

Equipment level testing has been underway since 2006, mostly by Bell's suppliers, to demonstrate that avionics boxes, pumps, valves, and springs meet Bell's stringent design specifications and the airworthiness requirements. This equipment is tested to demonstrate reliability, subjecting the equipment to temperature variations, vibrations, and abuse loads, and the testing can at times uncover problems with the equipment that need to be rectified before entry into service. Design changes are made to the equipment, tests are repeated, and new equipment is installed into the flight test aircraft, ensuring the integrated systems of the aircraft meet Bell's reliability standards way before the aircraft enters into service. ∎

Neil Marshall is Bell Helicopters' 429 program director


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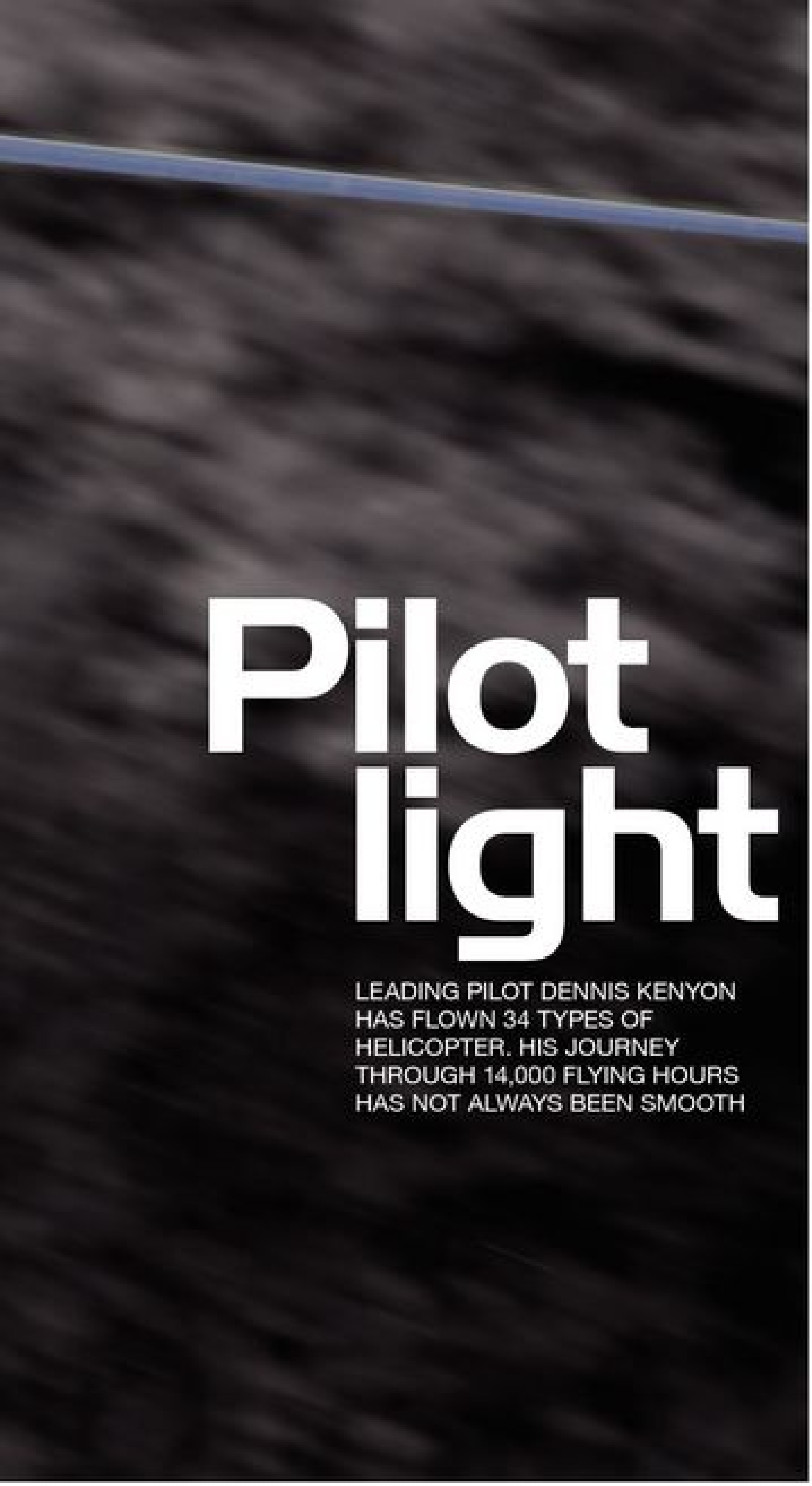

Pilot light

LEADING PILOT DENNIS KENYON HAS FLOWN 34 TYPES OF HELICOPTER. HIS JOURNEY THROUGH 14,000 FLYING HOURS HAS NOT ALWAYS BEEN SMOOTH

BY DENNIS KENYON

I have been involved with various test-program requirements in the helicopter industry for 40 years, and in particular the flying required to see the Enstrom F28A and 280C 'Shark' series of helicopters become eligible for UK Civil Aviation Authority and other European Agencies certification. The British Civil Airworthiness Requirements (BCARs) are the bible, of course, and even as a 'non-professional' flight tester, it seemed a good idea to have a grasp of the general requirements. However, such certification rules aren't always sensible, and bureaucratic dogma can take over from common sense and safety.

An opening example concerns the first production Enstrom F28A, which was fitted with a one-piece hoop to offer protection against the danger of the spinning tail rotor (T/R) blades.

In 1975, the introduction of the sleeker Enstrom 280 Shark sported a snazzy but less effective T/R stinger. This useless guard consisted of a metal strip that projected from the underside of the tail cone, but which actually offered zero protection in the T/R blade area. Fast-forward a year or two to when I purchased a 1983 Enstrom Shark and had it shipped to the UK to add to my stock. Opening the sea container, I was intrigued to see that the US operator had retrofitted the earlier all-enveloping hoop. Good going, I said to myself.

When I tried to put the Enstrom on the British register, I hadn't reckoned with the intransigence of the British CAA. The area surveyor duly arrived. "This machine isn't eligible for UK certification with that T/R guard," the man announced with obvious pride in his detailed type knowledge. Pointing out that the earlier fit was a safer system fell on deaf ears. Being an awkward so-and-so myself at times, my parting shot to him was something like: "That's all fine, but I promise you if this particular machine is ever involved in a personal injury T/R accident, it won't be too long before your name comes into the picture." Yes, I appreciate certification rules are rules, but where safety is compromised, I'd personally tear them up!

Stability problem

Taking a second look at the Enstrom, I want to raise a stability problem that required more than a few air tests to discover the cause. Once again I took the view that the manufacturer was at the root of this particular problem. A cosmetic modification to the F28A was made when industrial designer Greg Focella was approached by the factory owner, the well-known defense attorney, F. Lee Bailey. Focella was asked to 'sex up' the snub-nosed F28A, which he did by designing a pointier nose section. The later Enstrom boasted a 205bhp turbocharged Lycoming engine. More power and a sleek 'nose job' would


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rack up the sales, Lee Bailey decided. The Enstrom 280C Shark was the result. Incidentally, it was the same Greg Focella who did a similar 'nose-job' for the Hughes 500 when the aging D-model developed into the more attractive E-version.

In the mid-1970s, I was displaying the Enstrom at the SBAC Farnborough Airshows. The original F28A used a ventral fin to provide directional stability, even though the type already possessed a large keel area due to its slab-sided semi-monocoque tail cone. My 1975 display was planned for the usual week in September, but the moment I went for a practice fast run in the Shark, I experienced a handling problem. The revised nose design brought with it a pronounced fish-tailing yaw at any speed above 60kts. I noticed that the yawing reduced as the flight progressed, so burning up fuel was improving the situation either because of the reduced weight or due to the shift in center of gravity (CG). Back at the airfield, I discussed the problem with an ex-Army Scout pilot. Captain Bill Bailey DFM suggested that constant yawing usually occurred on an over-directionally stable airframe.

I held a CAA authority to carry out Certificate of Airworthiness tests on helicopters and fixed-wing aircraft up to 12,500 lb, and had some paper experience as a graduate of the British Institute of Engineering Technology. I had also conducted a series of flights to determine the main rotor (M/R) blade flapping limits on the Enstrom prior to starting a program of display flying. I felt confident enough to investigate the problem by drawing up a schedule of airspeeds starting at 60kts up to the type's VNE of 117, starting with a low take-off weight up to the maximum permitted gross.

I grabbed a convenient crayon and ruled in a range of yaw angles on the windscreen at two degree intervals, the idea being to fly at progressively increasing speeds and record the maximum airframe deflections. The results were intriguing. At 60kts, the fish-tailing didn't occur.

The 3 person 280FX was certified in 1985 and in addition to the F28F is the only turbo-charged piston powered helicopter in production

"At 60kts, the fish-tailing didn't occur. But as the speed increased so did the yaw"

But as the speed increased so did the yaw, and by 80kts was reaching 8° either side of the normal axis. The odd thing I discovered was that at any speed above 85kts, the stability improved.

This time, I was lucky enough to discuss the problem with the one-time Boulton Paul Delta P111 test pilot Ben Gunn. The genial Gunn supported Bill Bailey's view that the increased area presented by the new fin was the source of the problem. The next step was obvious... remove the dorsal fin.

My test flight was an eye-opener. The excessive fish-tailing about the normal axis disappeared at speeds up to 80kts, but above that speed the airframe began Dutch rolling about the longitudinal axis. As the only airframe change had been the dorsal fin, I concluded that the existing ventral fin was now initiating the lateral roll about the longitudinal axis due to its lower position. A further flight at greater weight and the Dutch rolling got worse.

At the time, I was working closely with the Menominee factory as their appointed European sales distributor, so I was able to discuss my findings with the chief engineer, Dave Brandt. He asked me to pass my flight test schedules to the factory, but interestingly, no modifications were made at the time. However, the Enstrom Shark replacement was in the offing, and when the first production machine designated the Enstrom 280FX appeared, the maximum gross weight had increased by 450 lb, and the horizontal stabilizer now sported just two end plates. Problem eliminated.

Aerodynamic investigation

I would like to recount a personal instance of an aerodynamic investigation carried out 'on the hoof'. Once again my subject was the Enstrom helicopter and, as mentioned earlier, I had already embarked on a program of flying

Vortex ring

As an amateur test pilot I'm intrigued by the airflow patterns around the M/R hub when the infamous Vortex Ring configuration is practiced. This can occur when a helicopter adopts a 500fpm or more rate of descent accompanied by zero or low airspeed, and power is applied.

As the helicopter descends, the normal induced airflow is opposed by the up-flow, and in the extreme condition, will actually punch through the inboard sections of the M/R disc. If the vortex condition is allowed to continue, the up-flow can spread from the M/R hub out along the disc area and 'join hands' with the ever-present turbulent tip vortices. A fully developed Vortex Ring is the nearest a helicopter will get to a fixed-wing deep stall, and the consequences can be equally risky: anything up to a 5,000fpm descent; considerable airframe buffet; random yaw; and in the fully developed stage, loss of control. The pilot fix isn't difficult. A simple forward push of the cyclic usually enables the rotor disc to move clear of the vortex tube, which results in an immediate recovery. I was intrigued and decided I'd like to see this airflow reversal. In investigative mode, I superglued 12 wool tufts a couple of inches long to the non-moving section of the M/R mast. For the air test I used the Hughes 300C model (later Schweizer, now Sikorsky). I was using the type on my flying school, and it has particularly good overhead vision through the large area of cabin glass above the pilot.

I mounted a small cockpit camera to record the happenings. The 300C has a small disc diameter (26.7ft) and when the Vortex Ring configuration is set up, the condition can be demonstrated especially well. The exercise is now a requirement for the EU/CCA-approved PPL syllabus.

I am happy to report that my amateur sleuthing was successful, and from a sensible safety height, I looked up to observe my wool tufts, all flapping obligingly in an upward direction! I'd found the airflow reversal, but this was not a position in which one wants to spend too much time.

displays at the various air shows around the country with the object of promoting sales.

So with a full program of displays booked, it was necessary to investigate the handling and in particular how the M/R rotor hub was affected by the aerodynamic loads. Once again, I embarked on a series of flight tests. An 8in (20cm) balsa-wood extension was taped to the existing fiberglass dorsal fin positioned directly below the M/R blade tips, where maximum flapping travel occurs. This extension provided a 34in (86cm) clearance from the T/R driveshaft with the blades stationary on the lower droop stops. Additionally, tell-tale markings were added to the M/R damper-rod ends to reveal maximum lead-lag and flapping travel under display loadings.

A series of progressive display maneuvers was flown, and at the completion of each sortie, I was gratified to find that even at the maximum 'wing-over' angle of roll and the lowest *g*, the maximum blade flap had not disturbed the tell-tale balsa wood extension, or scored the damper lead-lag pen markings. Based on these findings, I felt confident to copy Mike Meger's routine and work up my own sequence. Following a display demonstration, the chief design engineer of the Enstrom factory, the innovative Herb Moseley, told me that none of the maneuvers I performed came close to compromising the structural integrity of the Enstrom.

"As I rolled the airframe and applied corrective left pedal during the maneuver, I found I had lost directional control"

Control failure

In the early 1970s, the Enstrom factory moved the T/R assembly on the F28A model to the left side. Thus, the forward leading edge of the blade was now rising in the induced 'down flow' of the M/R disc, a modification that was later combined with a wider chord, greatly improving T/R authority. The F28A employed a metal stop in the gearbox spindle to limit maximum flapping. With the introduction of the later 280 Shark, the metal flapping stops became rubber inserts. T/R control consisted of two cables routed via suitable pulleys to the pilot's yaw pedals.

I was scheduled to take part in the 1986 World Freestyle championships at Cranfield Aerodrome in the UK. I had planned a standard routine that required several maximum power torque turns with the airframe at a 90° angle of bank rolling into a 60° descent for a 100kts fly-past. As I rolled the airframe and applied corrective left pedal during the final maneuver, I found I had lost directional control as the nose continued to yaw right with full left pedal applied!

At the time I didn't know that the leading edge of the upgoing T/R blade had severed the left-hand control cable. The flailing loose end wrapped itself around the blade root and seized the T/R gearbox. Happily for me, I had previously experienced a similar failure when a T/R driveshaft sheared when a sharp flint was sucked up to lodge between the shaft and the tail cone. The flint made a radial cut on the driveshaft, which then failed.

On that occasion, I was lucky to be able to simply dump the collective lever into 'autorotation', which stopped further right yaw. However, being close to the surface, my subsequent raising of the lever to cushion the landing coincided with the opposing left yaw as the airframe turned left, so the resulting right yaw as I raised the collective actually saved the day. Having avoided a nasty accident, I took it upon myself to learn more about the T/R failure principle, which from that day I routinely practice.

That practice stood me in good stead at the Cranfield event as I safely completed a 60kts run-on landing with no further damage. On a happy note, the judges were sufficiently impressed to award me fifth place in the championships. The helicopter owner wasn't so pleased, however, because had I crashed, the insurance would have paid up. As it was he was simply left with the cost of a T/R repair!

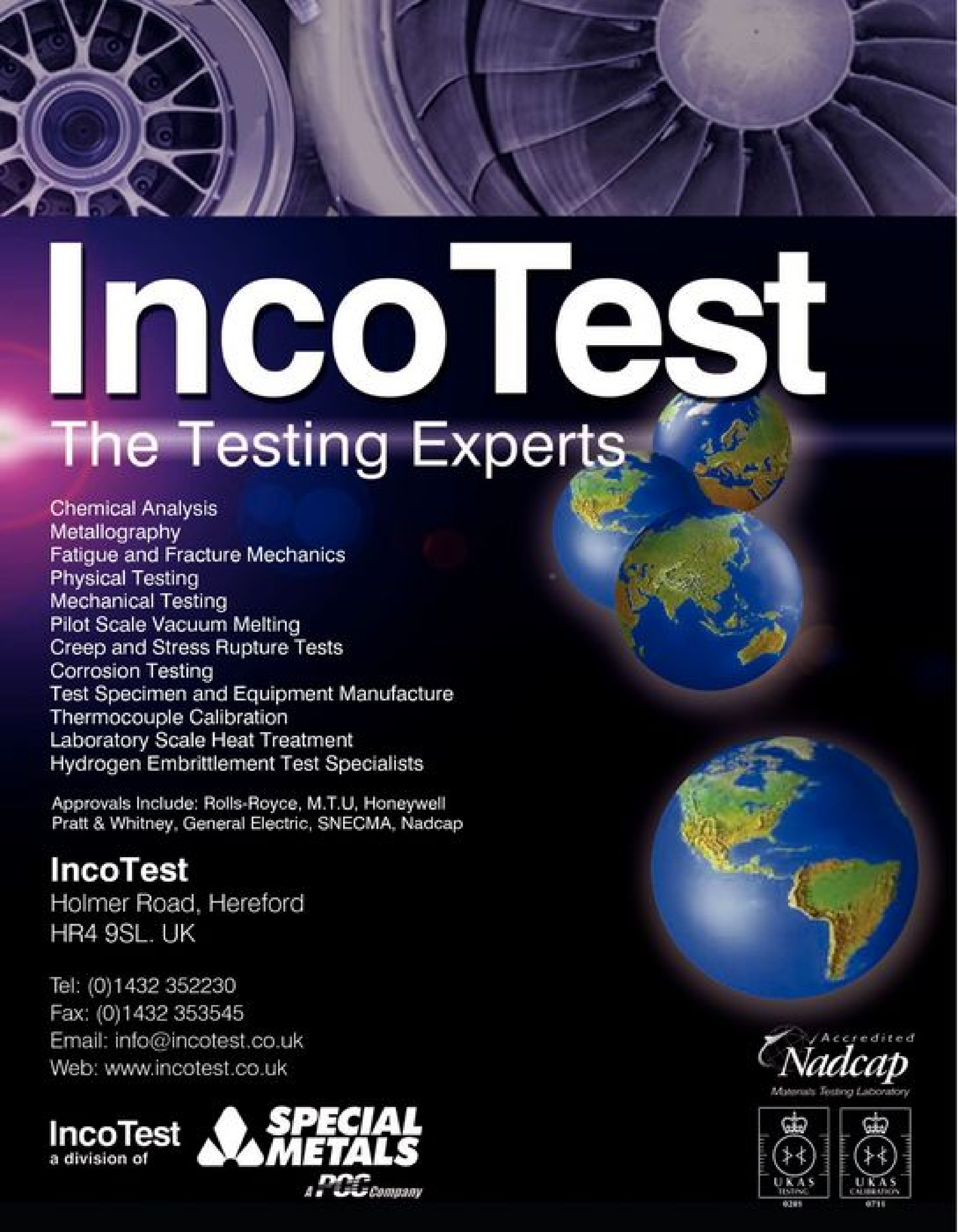
Subsequent examination revealed that the failure occurred at high power when the upgoing blade could flap sufficiently to make contact with the left-hand control cable. The position was exacerbated by an oil-soft rubber flapping stop and a slack control cable. Knowing the problem, I carried out subsequent displays with new stops fitted and cable turnbuckles tensioned to the maximum Maintenance Manual (MM) figure.

Several years later I was asked to display the later FX Shark at the 1999 Biggin Hill Air Fair. I requested that the appropriate adjustments be made for my display, but in the event I actually asked for the T/R to be 'checked', believing the engineer in question understood what I meant. The engineer did as I asked, but his interpretation was to simply check that the cables complied with the MM tension requirement. A classic case of poor communication! Once again as I confidently ran through my standard display routine for the airshow crowd, the T/R control cable snapped! I won't say I was getting used to it, but certainly my extensive practice enabled me to land the machine safely for a third time.

The problem was reported to the Enstrom factory, which had a record of similar failures with aircraft involved on crop spraying operations. The modification was simple: the cable exit point from the rear bulkhead was moved inboard to increase the clearance by 1in. The fix promptly became known as 'The Kenyon Hole', about which I'm supposed to laugh! I certainly don't display the non-modified Enstrom now unless I personally observe the necessary cable adjustment and fitment of a new flapping stop. ∎

Dennis Kenyon learned to fly fixed wing with the RAF. He flew the Gloster Meteor, Vampire, Lincoln, Varsity, and Canberra operationally. In 1970 he became a civilian rotary ATPL instructor, CAA-approved display evaluator, and display pilot. He has flown 82 aircraft types of which 34 were helicopters, and completed 13,859 hours. He won the world freestyle championships in 1992

Enstrom produces three models, the F-28, the more aerodynamic 280 and the turbine-engined 480, each with their own variants. The F-28 and 280 both use Lycoming piston engines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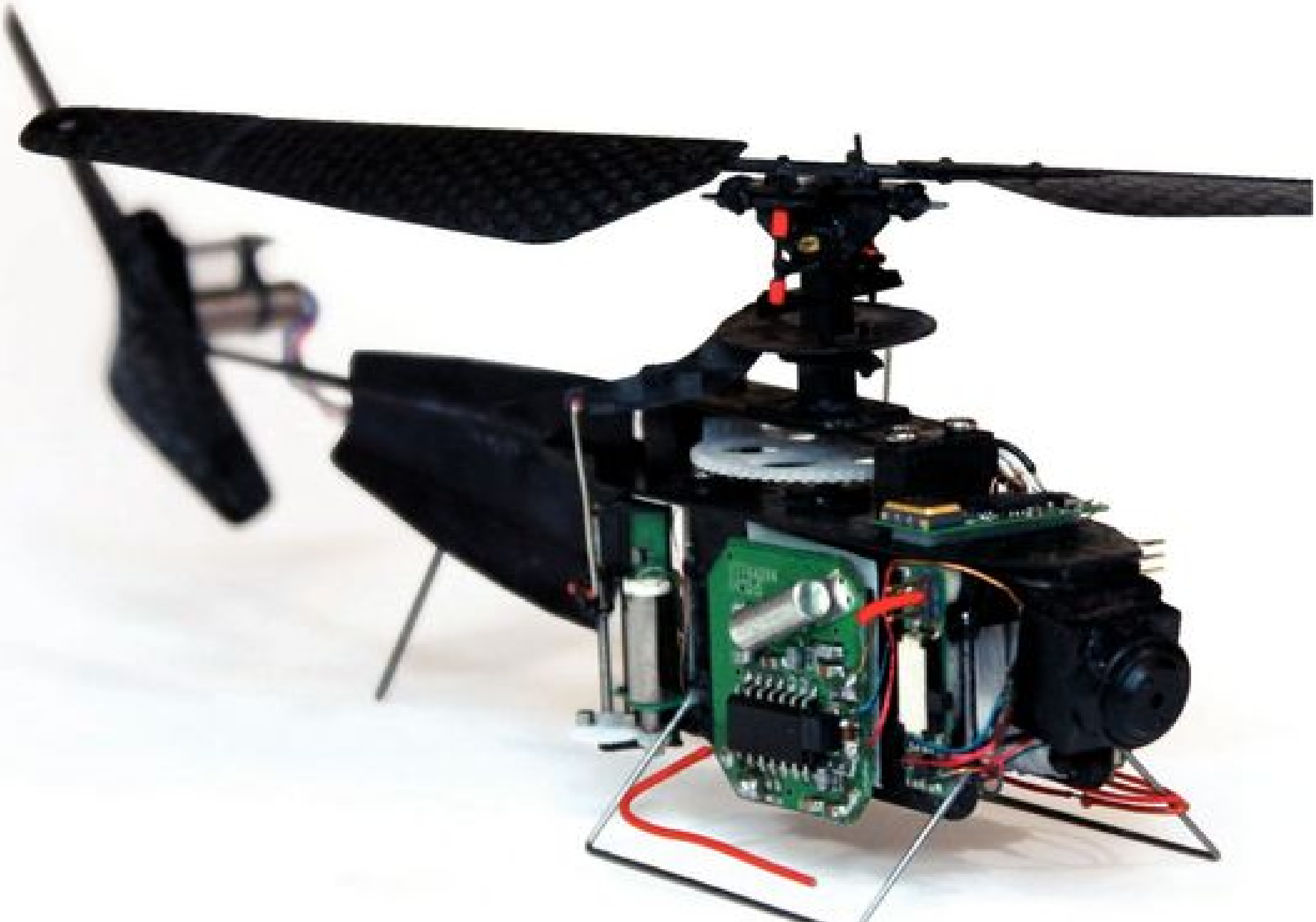
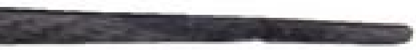


Tiny dancer



IN JULY 2008 THE WORLD'S SMALLEST FULL-AUTHORITY HELICOPTER LIFTED OFF. IN AN EXCLUSIVE INTERVIEW, LEAD DESIGNER PETTER MUREN LIFTS THE LID ON THE BLACK HORNET

BY CHRISTOPHER HOUNSFIELD

The first flight by the world's smallest full authority helicopter lasted for more than two minutes, and was considered a major success. Hornet-1 is the first prototype of the advanced Nano-UAS PD-100 Black Hornet

The Black Hornet concept is for a helicopter less than 10cm long, weighing less than 20g, and equipped with a video camera. It can be held in the palm of the hand and is designed to be launched within seconds. Norwegian company Prox Dynamics plans to release the first version of Black Hornet later in 2009, with expected volume shipments to key customers in 2010.

Take-off, forward movement, turning, and landing were demonstrated in the flight. Engineer and test pilot Pål Sandberg said at the time, "It's surprisingly easy to fly." This was all the more remarkable as most of the technology used in this aircraft had never previously been tested in a complete aircraft.

Flight control is based on a standard radio system and servos designed and developed in house. The rotor system is described by the company as a 'completely new design' comprising a two-bladed single rotor with some inherent stability. This is controlled by its own PDS-2 servo, which, at less than 0.5g, is claimed to be the smallest and lightest in the world.

Hornet-1 will primarily be used to verify the concept of the rotor-system mechanics, gather aerodynamic system data, and to some extent demonstrate the operational concept to potential users.

Small in the genes

The GEN H-4 from the Gene corporation in Japan is the world's smallest personal helicopter. It comes with a seat and landing gear so all the pilot has to do is strap into the harnesses, and they're ready to go.

Unlike traditional helicopters, it has two sets of coaxial, contra-rotating rotors (KA-52 Hokum, which are only 4m in diameter), which eliminates the need for a tail rotor for balancing. It is powered by four lightweight 125cc two-cylinder engines fueled by standard gasoline.

The GEN H-4 flies to a maximum altitude of 1,000m at a top speed of 90km/h (59mph) for up to 30 minutes. The controls resemble those on a bicycle handlebar. Indeed the inventors claim it is as easy to master as riding a bike and needs only two hours of practice to learn. In Japan a license is not needed to fly the GEN H-4.

Launching the program in March 2008, chief technology officer Trygve Marton said, "We will develop a kind of aircraft so far only seen in science-fiction movies. Potential customers will range from scientists and engineers to police, fire fighters, military, and even special forces."

The machine is designed to be carried in a pocket and launched within seconds to give immediate situational awareness. The new ultra-small aircraft is a valuable tool in situations when it is crucial to obtain a closer look at a hostile area or inside a contaminated building, for example.

Northern light

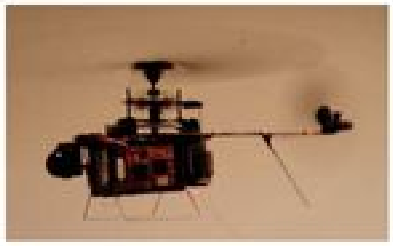
Petter Muren, CEO and president of Prox Dynamics, has 20 years' experience as an R&D engineer, he holds an MSc from the Norwegian Institute of Technology, and is an expert in developing micro-sized helicopters and toy helicopters. He invented the passively stable 'Proxflyer' rotor system, and designed the successful Bladerunner series of RC toy helicopters and the iFly series of micro ornithopters. He also designed and built the four smallest remotely operated helicopters in the world. He is a technical consultant working in support of DARPA's nano-air vehicle program.

What is the range of the Black Hornet UAV, and how did you test power systems?

The planned range is about 1km. It is the radio link that limits the range, and it consumes a substantial portion of total power.

"The helicopter is so incredibly agile and unstable that it is not possible for anyone to control it without the gyros. It is not even possible to lift off"

According to Muren the long term goal is to establish a 2% market share in a US$ 3 billion market



Power comes from lithium polymer batteries that are tested separately, as are the motors and propellers. We work with the University of Wageningen and ISAE in Toulouse, France, to test the propellers and motors.

What makes the vehicle unique?

Its extremely small size: about 100mm long, weight of less than 20g, and the capability to fly indoors and outdoors. Its low noise means that it can fly very close to people without being detected.

At what stage is the test program?

We are currently testing concept generation 2 (of a planned program of four generations with 2-3 versions in each generation). After that we will start on prototypes for PD-100 (the final product). These prototypes will undergo extensive test programs. We are also increasing the cyclic control of the rotor blades step-by-step, and combining this with increased forward flight speed testing. Different center of gravity positions are also being tested; and how this affects stability in horizontal flight is recorded. Most of the test flights are video filmed for internal use.

How was the flight control system tested?

We are still testing Hornet-2, which has the three-axis gyro for stabilization. The control parameters were mathematically derived from our computer simulation models and then tested in our lab. The next generation with more sensors will be tested using a combination of video documentation and real-time data downlink of all sensor data. That way stability and step response can be recorded and analyzed. We have not started outdoor testing of the control system yet.

How is the test program affected when you are working with something so small?

The small dimensions are a real challenge for the model builder and test pilot. Everything has to be done under the microscope. However, there are several benefits from working on something so small.

The vehicle requires very little space for initial hover testing and most of this can be done inside the lab. The small size and low weight means there is no safety risk to either people or equipment and therefore simplifies testing a lot. The low weight (mass) also ensures that crashes do not normally damage the helicopter, which means tests can continue without delay. If something does go wrong, it is often possible to repair it within minutes. The cost of a prototype is low compared to larger models, and therefore we can also start flight testing with much less testing on the ground.

Does the system use any lightweight composite material. How did this affect the program?

The Hornet concept helicopters are built entirely out of carbon-fiber composites. We have great experience with vacuum molding and working with these materials in tiny structures, and find it to be a good prototype building material. It would have been difficult, maybe impossible, to build the Hornet models without using carbon fiber. Ensuring sufficient strength would result in it being too heavy.

How does it cope in more extreme weather systems?

This weather test has not yet been tested, although simulated gusts in the laboratory are handled well by the onboard gyro stabilizing systems. The helicopter is so incredibly agile and unstable that it is not possible for anyone to control it without the gyros. It is not even possible to lift off – the helicopter flips itself over before you can get the skids off the ground.

What do you feel has been the greatest success with the development?

That we are flying, have electronics that are capable of controlling it, and that we have been able to follow our plan with respect to technical development.

What has been the biggest problem you have faced during development of the Hornet?

We are still early in the development and we expect to hit more problems as we go along, but up until now we have identified the stability part of the autopilot and the low-power radio link to be the two biggest challenges.

How was this overcome?

Hard work and experience.

What is the next phase?

We are about to start testing of the first generation of our onboard autopilot in Hornet-3. This is a complete autopilot with gyros, accelerometers, compass (all three-axis), and pressure sensors, but without GPS. Final generations will have GPS, and will still weigh less than 2g. ∎

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Last ditch effort

THE DITCHING OF A US AIRWAYS A320 IN THE HUDSON RIVER IN JANUARY 2009 WAS EXTRAORDINARY. HERE, TWO OF THE WORLD'S LEADING EXPERTS GIVE AN INSIGHT INTO DITCHING EVALUATION

BY DAVID GEORGE & DAVID ELDRIDGE

When the captain of US Airways Flight 1549 skillfully ditched his Airbus A320-214 in New York's Hudson River following a major bird strike and resultant double engine failure, it was a testament to the years of ditching research, test, and analysis. It was akin to witnessing an impeccable live performance following thousands of carefully managed rehearsals.

For more than 50 years British hydrodynamics test specialists have led the way in evaluating the water landing performance of fixed and rotary wing aircraft. Data records from actual ditching events during World War II led to the evolution of dedicated equipment and

procedures, which formed the basis of airworthiness authority legislation in the UK, USA, and latterly throughout the world. Today, advanced digital electronic-event recording and monitoring equipment in conjunction with lightweight and sophisticated composite aircraft models allow for a comprehensive insight into the entire ditching and subsequent flotation sequence.

Full-scale log

Commercial multi-engine jet aircraft ditching events are fortunately rare, but contrary to much of the recent media reporting, they have happened and proved survivable, as in the latest case. The most notable prior to this year was a Boeing 737 that made a forced estuarial ditching on the Bengawan Solo River in Yogyakarta, Java, in January 2001. The aircraft was largely intact following the incident, and remained stable and afloat for a long period. Of the 60 passengers and crew, 59 escaped and were rescued.

A less fortunate outcome awaited a highjacked Boeing 767 belonging to Ethiopian Airways. Forced to ditch off Grande Comoros Island near Madagascar in the Indian Ocean when fuel ran out, the aircraft was heavily rolled on approach, causing wing impact, and then did a tight, high-speed ground loop, causing considerable airframe damage. There were, miraculously, 56 survivors.

Of the many military ditching events, one of the most remarkable and well documented was in May 1995 when a Nimrod R.1P went down off the Scottish coast near Lossiemouth. All seven crew survived and analysis of available footage revealed that the ditching characteristics were very similar to those recorded during scale model testing. As predicted from scale-strength testing, the airframe fractured in line with the rear wing spar.

Potential correlation?

It is particularly interesting that the FD 728, an aircraft recently tested in the UK, is very similar in fuselage, wing, and engine layout to the Airbus A320. During testing (as happened during the Hudson ditching) an engine broke away and the wing fairings detached, resulting in dramatic

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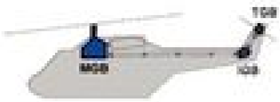

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Three prototypes of the FD 728 were built. TAC 01 was completed with equipment, the second prototype was a complete fuselage in an unfinished stage of installation. TAC 03 was just a fuselage for structural tests

Center of flotation

Following GKN's decision to downsize its Osborne Hydrodynamic Test Facility, the UK's Cape Engineering, based in Warwick, has guaranteed its initiative in fixed-wing aircraft ditching and flotation technology by actively pursuing enquiries from major aircraft manufacturers such as CASA, Embraer and Airbus Industries, and has secured its first major contract with CASA.

By agreement, the 20m catapult launch system, formerly housed in the GKN facility, will be fully refurbished, installed, and commissioned in the imposing Reynolds building of the Civil Engineering Hydraulics Research facility in Wallingford, Oxfordshire, UK (HR Wallingford).

spray patterns especially around the exposed wing roots following water entry. These failures were apparent on the A320, as was potential failure of the rear fuselage baggage door, which together with possible skin deformation and rupture could well have accounted for the fairly rapid flooding of the lower bays. Resultant flotation levels would be lower so when doors were opened, water would flood in over the sills and compromise the flotation state normally experienced by a pressurized (sealed dual skin) cabin.

Model techniques

Since the inception of dynamic model testing on flying boats and early propeller-driven aircraft when weight and limited availability of materials challenged builders and testers alike, techniques and the ability to use smaller scales have kept pace with increased aircraft speeds and all up mass. In order to produce models that accurately reproduce the dynamics of Concorde at one extreme to L-1011 Tristar at the other has been an enormous challenge. Models are ballasted, balanced and swung as a compound pendulum to establish correct moments of inertia. They need to be light enough to meet this demanding criteria at the lowest operational weights, and yet when representing the fully laden condition, not exceed the abilities of the launching equipment in terms of acceleration and terminal velocity.

Models are designed at scales ranging from 1: 8 to 1:14, and faithfully reproduce the geometry of the full-scale aircraft, incorporating as many features as required given the nature of the test program.

Traditional fuselage construction is of balsa wood, which facilitates lightness and ease of modification as required. The model is reinforced with hardwood and fiberglass where necessary, all carried out in accordance with strict operating procedures generated and refined over the decades. Flying control surfaces, doors and bays, many of which need to be removable, can be constructed from modern composite materials, including carbon fiber.

Dynamic similarity is achieved by ballasting the model to yield the correct scale weight, center of gravity (CG) location, and moments of inertia about the principal axes of pitch, roll, and yaw. It is known from previous experience that certain features may be particularly vulnerable to damage during ditching, or may, if damaged, have a great effect on ditching characteristics. These features are represented and attached at scale strength where necessary to simulate the effect of such damage as closely as possible.

> "A team of three test engineers is usually required to launch, film and recover the model post-ditching"

Test environment

A typical basin for fixed wing ditch testing, where models of 15-50kg are launched into calm water and developed sea states up to a full-scale equivalent of 9m+, is 80 x 30m and around 1m deep. The launching equipment (or catapult) comprises a crane-like boom approximately 15m long, which can be adjusted in elevation to simulate various rates of descent prior to water entry. The ballasted and instrumented model is preset for actual pitch, roll, and yaw, underslung on the carrier and accelerated via cable, which is in turn powered by falling weights. The mass of the weights controls the forward speed of the model. Once up to desired velocity, the model is released for a short flight onto the surface of the water.

Sea conditions, including the compulsory head and beam test criteria, are generated by hydraulically operated and portable wave generators. These can be programmed to provide regular seas for repeatable testing or random seas, representative of various sea/ocean conditions for subsequent flotation assessment.

A team of three test engineers is usually required to launch, film and recover the model post-ditching. Following 'dry off', data from the onboard loggers (which record live event data from pressure transducers, accelerometers, rate gyroscopes, and fuselage bending measurement) is downloaded for future analysis and report purposes. Film coverage includes high-speed digital video and still photography. Various means of model tracking, including infrared and GPS, can be incorporated if required.

Instrumentation expansion

Accelerations sustained normal to the aircraft's horizontal datum during each landing are measured by miniature piezoresistive type transducers, and are housed in the nose, tail and close to the CG. Another, also mounted near the CG, measures deflection parallel to the horizontal datum, and a fifth, if required, can be similarly located to measure deflection transverse to the aircraft's longitudinal datum.

The attitude (or pitch angle) of the aircraft, taken as the angle between the fuselage horizontal datum and the water surface, and roll, taken as the angle between the fuselage lateral datum and the water surface, can be measured

Under the skin

A scenario that will eventually be proved but which has been subject of much internal debate is the potential benefit to safe entry that may have been afforded by lower fuselage skin deformation and rupture. Although not physically tested and certified on a similarity claim with supporting CFD data, it is believed the Airbus A320 carries a recommended water approach pitch attitude of +11°. Where possible, analysis of the grainy Hudson riverside CCTV video suggests the aircraft entered the water at a much lower pitch angle (approximately +6°), which tests may indicate would be likely to result in less favorable ditching characteristics.

It must again be stated, however, that without any engine power, the pilot was masterful in maintaining positive pitch. Without positive pitch the aircraft could have been prone to a high-speed dive with frightening consequences, or conversely conditions may have arisen where a rapid positive pitch rotation was followed by secondary high-level impact.

Our theory, which was borne out by small modifications to the lower fuselage to 'spoil' the skin-to-water interface in tests on the similar airframe, may have been substituted by skin roughness or water ingress caused by the deformation due to touchdown pressures during water impact, and probable failure of the rear cargo door. This, together with the failure of the wing and fuselage fairings, would also account for the rapid deceleration and flooding, but fortuitously coupled to improve the overall ditching characteristics of the aircraft and thus, as an outcome, enhanced safety and overall survivability.

For further information on TRaC's aerospace testing capabilities, contact test@tracglobal.com or visit www.tracglobal.com

"There remain dedicated British ditch testing engineers who will follow events with enormous interest"

For fixed-wing aircraft ditching, a large diameter tank is required to launch dynamic scaled models into the water by a gravity-powered catapult at a speed of up to 30m/sec

throughout each landing by incorporation of an electronic rate gyro in the model.

Miniature piezoresistive gauge transducers populate the entire underside of the fuselage to map and measure the pressure footprint. Specific numbers and positioning are determined from experience and customer requirement. However, devices can be added or relocated as testing progresses.

All the signals are fed into sealed onboard data loggers, which at the end of each test are downloaded to enable detailed analysis, comprehensive reporting, and recommendations.

Physical versus CFD

Although there is much to be admired and many claims made about computational fluid dynamics (CFD) with regard to simulation of fixed-wing aircraft ditching and prediction of subsequent flotation performance, there are many complex and interactive factors that influence airframe strength and deformation criteria, and loads on the occupants. The g force can rapidly exceed that which the human body can withstand as the aircraft impacts a medium (water) 800 times the density of that in which it is intended to operate (air). Equally, the design features that enable an aerodynamically refined and relatively lightweight machine do not necessarily perform well in, or withstand, hydrodynamic buffeting and loads. Many features that would be desirable from a water entry standpoint are simply not feasible for incorporation into modern jet aircraft.

For example, there are many theories about the effects of flow separation and cavitation on ditching aircraft, which can be further explored through physical test means. A twin commercial jet aircraft initially performed poorly on contact during a recent exhaustive test program, but small deployable modifications were made that dramatically improved ditching performance and resultant loads on the passengers and crew.

Further theories were also evolved to study performance of the fuselage itself on a 'freeze frame' basis by stripping the model of wings and all other appendages, and testing it in a high-speed towing tank. This would enable fully repeatable testing aimed at comparing ditch enhancement techniques, which could include passive V-shaped wedges, vortex generating fins, and deployable spoilers.

This type of study should complement current study and CFD where, despite immense capacity, parameters are not just many, but also extremely complex.

Crew involvement

Witnessing a test program can be revealing and informative to a flight crew who, one day, could be facing an emergency landing on water. Test pilots have occasionally visited the facilities dedicated to this work, and seldom fail to be mesmerized by an accurate 3m-long model of their aircraft coping with touchdown on a developed sea. Questions are many and event analysis becomes very detailed.

Pilots' notes on pre-ditching procedures, aircraft trim, and orientation are prepared on a case-by-case basis. All test work is carried out in accordance with relevant civil airworthiness requirements, and many of the directives contained in BCARs, FARs, and JARs were compiled from data sourced during UK hydrodynamic testing. It is believed that the facility is globally unique as similar research units, once operational in France and the USA, were of limited success and have ceased this line of testing.

Time, black box records and publication of the crash investigation team findings will ultimately reveal more about the event itself and the condition of the A320 airframe following what appeared to be an impeccable ditching in the Hudson River. There remain dedicated British ditch testing engineers who will follow events with enormous interest, with conviction that actual data will bear out long-held theories and belief.

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David George and David Eldridge are semi-retired. Prior to leaving full-time employment David Eldridge was fixed and rotary wing ditching group leader, and Dave George was manager of GKN Test Facilities

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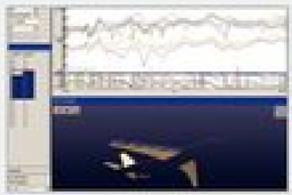

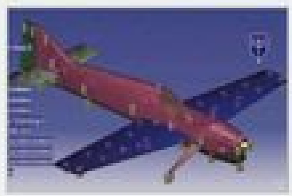

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Wind beneath my wings

GLIDER PILOT JOCHEN EWALD DESCRIBES HIS FIRST FLIGHT TEST OF THE SCHEMPP-HIRTH DUO DISCUS X GLIDER

BY JOCHEN EWALD

In 2005, when Schempp-Hirth presented the Duo Discus X as the successor to its best-selling 20m unflapped two-seater sailplane, it increased its maximum all-up-weight (AUW) from 700kg to 750kg. It also introduced a new small flap at the wing's trailing edge. This feature permitted easier and slower approaches with this well-loved and successful glider. Since then, the engineers have completed a great deal of successful 'fine-tuning'. I know this as I tested the latest glider, the Duo Discus XLT, which was fitted with a small retractable sustainer engine, at the Hahnweide airfield about 30 miles east of Stuttgart on a warm day in 2008.

It was quickly evident on the wingtip during rigging that each XL wing was now about 5kg lighter than the older Duo model, mainly at the outer end, due to the complete change to carbon-fiber structure on the outer sections of the wings. Ailerons and airbrakes are connected automatically via Hänle links when the wings are inserted into the fuselage with their main spar ends. After the main bolt is inserted and secured by swinging it behind its snap-in lock, the rigging handles at the outer end are replaced by the really lightweight wingtips, equipped with Maughmer winglets. These lock automatically by means of spring-loaded bolts on their spar tongues. The tip aileron sections only move upward together with the inner ailerons, which remain in a neutral position when these move downward. The tailplane is fixed to the fuselage using the Hänle system with automatic control connection.

The flap-combined Schempp-Hirth airbrake

The German connection

Between the first flight in a machine, developed by Sir George Cayley, and performed by his coachman in 1853, and the escapades of the Wright brothers, the development of aviation mainly involved gliders or sailplanes.

However, the sport of gliding only emerged after World War I as a result of the Treaty of Versailles, which imposed great restrictions on the manufacture and use of single-seat powered aircraft in Germany. Therefore, in the 1920s and 1930s, while aviators and aircraft makers in the rest of the world were working to improve the performance of powered aircraft, the Germans were designing, developing, and flying ever more efficient gliders, and were discovering ways of using the natural forces in the atmosphere to make them fly further and faster. In fact, nearly all of today's major glider manufacturers and designers are based in, or near, Germany.

The active support of the German government during this period ensured a steady stream of experienced aviators ready to be trained in conflict when the treaty was denied in preparation for World War II by the Third Reich – although for most of the participants, their sport had no military overtones.

system used with the 'X' four years ago has been modified to produce even more drag. The two-bladed airbrakes themselves are now placed 6cm further forward on the wing, and they extend 1.5cm further upward. To compensate for the loss of lift, the extended flaps connect through gas pressure struts to the airbrake pushrods. When flying at higher speed (above 170km/h), these gas pressure struts enable the flaps to retract automatically to protect the wing from high torsional loads. The sealing of the aileron and flap gaps has also been improved.

The main difference between the X and the XL can be found in the cockpit area of the fuselage. It has been extended by 10cm in between the two seats. The cockpit interior has also been completely redesigned. During this optimizing process to obtain best comfort and ergonomy in both seats, nearly all the employees of Schempp-Hirth were asked to 'try, and comment', and the result was a cockpit that I dare to say comes as close to the optimal as it can be. With its visible inner carbon-aramide fiber shell structure, it is not only very safe in the event of a crash, but also looks nice! The fully covered front instrument 'mushroom' can now be swung up for easy access and emergency exit. Everything is in easy reach. The front seat pan has an adjustable backrest at the top and bottom with an integrated headrest, and there are no longer 'steps' in the seat pan curve to accommodate old, thick parachutes – nearly all of today's modern parachutes are designed to be used on seats with smooth curves and without steps. The pedals of both seats can be adjusted over a wide range, and only very small pilots will need a seat cushion (also offered) to reach their best seating position. Schempp-Hirth has recently decided to deliver all its gliders equipped with shock-absorbing cushions from now on – a wise decision.

"Schempp-Hirth has decided to deliver its gliders equipped with shock-absorbing cushions from now on – a wise decision"

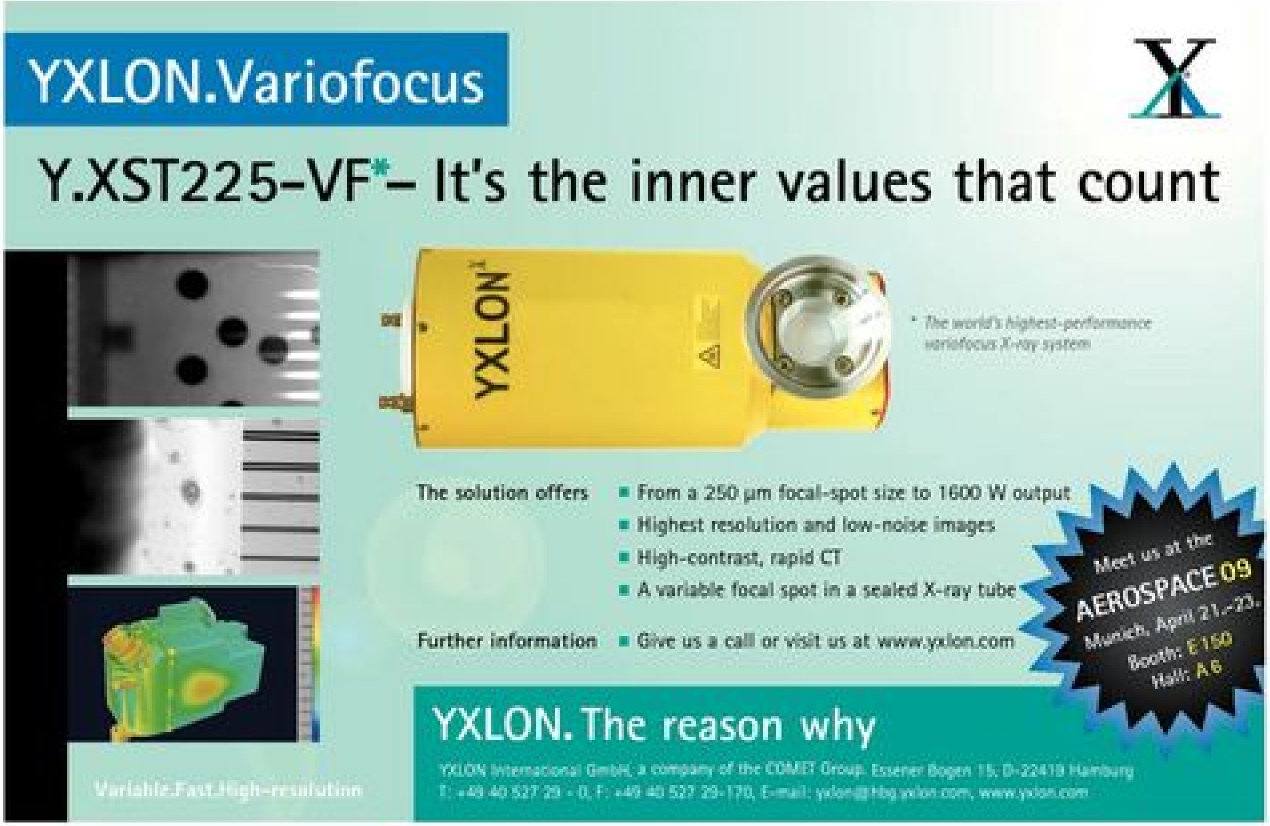
The sustainer engine is the well tried and tested 22kW two-cylinder, two-stroke Solo 2350D, driving a five-blade Oehler system folding propeller. The engine bay doors close again once the engine is fully extracted. The engine can be removed easily; its removal or reinstallation takes about 30-40 minutes. With the new, stronger wings, the Duo Discus XLT is also certified as 'semi-aerobatic' if the AUW is below 630kg. The new TB06 engine control unit makes operation simple. To start the engine in flight, simply swing the ignition switch to 'on'. Then the engine extracts and, as soon as it is fully out, the display asks you to pull the decompression valve left at the cockpit wall. As soon as this display disappears, let go of the handle and the engine starts its work. To get back to the 'gliding modus', simply switch off the ignition, the engine then swings back a bit until the propeller stops completely, and then it stows itself back into the fuselage. Of course, 'manual overriding' this automatic system remains possible following the scheme used with previous Schempp-Hirth sustainer installations. A protected switch in the front instrument panel socket permits the pilot to hand over full engine control to the TB06 instrument installed in the rear panel.

Take to the sky

Now let's take flight in the Duo Discus XLT, with sales manager Bernd Weber in the rear seat. The one we flew was the PH-1408. This glider was extremely well equipped with a good set of instruments, including a transponder, four 7.2Ah batteries (two in the tailfin and two under the seat), and one 18Ah underneath the 'baggage bag' in the front of the rear cockpit. This increased the basic empty weight from about 465kg to 485kg, and with our 150kg and 10kg of fuel, we reached a take-off weight of 645kg.

I felt immediately comfortable in the cockpit, as all the controls and levers were perfectly placed for me. And, when operating the airbrakes or (later in the air) the undercarriage, my elbows no longer hit the foot tips of my co-pilot because the seat shells were completely closed, separating the two seats up to canopy frame level. The redesigned positioning of the levers as well as the shape of the side consoles permitted free movement of my arms. The only things I disliked were the relatively high forces needed to unlock the trim button (it is a bit sharp-cornered and has to be swung inward to unlock) and the fact that the open canopy, with the left wing down on slightly sloped ground, is quite close to the point where it might be blown over even by a light gust. But the S-H engineers intend to modify the curve of the rear canopy frame, so that it can be opened a bit wider without the risk of the rear frame touching the wing's leading edge.

In terms of the general flying characteristics, the new XLT does not differ much from its predecessor, X. I tried both aerotow and winch launch, and found the glider very easy and safe



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to handle with both launching methods. This also makes it perfectly suitable for basic training. Visibility and fresh air supply in the cockpit through the front and the adjustable side nozzles appeared to be perfect, and the new canopy sealing reduced cockpit noise to 'light whispering'. The undercarriage retracted easily and locked safely by swinging the lever toward the cockpit wall. After releasing, I immediately felt that this new Duo with its lightweight outer wings appeared much more 'handy' than the older versions. This impression was not only caused by the perfectly working control system with low friction and control forces, but also by the reduced weight of the outer wing sections. My stopwatch confirmed the improvement. At 100km/h, I measured a 45° roll rate of slightly below four seconds, combined with a perfect control harmony. Four seconds – that is a typical value for a 'normal' 15m or a 'fast' 18m single seater. The result? Thermaling the XLT gives its pilot as much fun and success as flying in a single seater. In smooth thermals, it can be flown at 85km/h and climb like a lightweight single seater, and in rough weather with 45° bank, 95km/h is a sensible speed. The longitudinal stability is very good, even nervous pupils will not overreact. There was only one thing that troubled me. The elevator trim spring is relatively stiff (probably caused by the latest certification requirements concerning the longitudinal stability seen from the stick force side). This results in the need to adjust the trim setting quite often if you want to avoid permanent high stick forces. And the trim lever operation itself, as mentioned before, was practically the only thing I disliked during my check on the ground.

The stall behavior is very gentle; at about 70km/h IAS warning by buffeting begins. Pulling the stick further back resulted in the nose rising and the speed indication dropping down to 55km/h (this indication is, of course, not realistic, but is caused by the wing root turbulences hitting the tailfin pitot tube). Then the XLT entered a very stable, buffeting stall. I found precisely the same speeds and behavior when approaching the stall with the airbrakes open – they simply brake, and cause no trim speed change, only the nose points down a bit more, giving better overview to the landing field from both seats. A fantastic system! Abrupt airbrake position changes do not have any influence on flying. Also, at high speeds, the Duo Discus XLT flies in a stable and comfortable manner, but to set the trim to speeds above 150km/h, I needed to push the trim lever forward hard.

Engine operation

Operating the engine was easy. At a flying speed of about 100km/h the ignition was switched on, and soon there was a little bang in the rear, and of course the TB06 instrument's display reported that the main doors were closed again, and the engine was firm in the working position. The display said 'decompression', and I pulled the lever until the message disappeared – and the engine started running. There is no throttle, it always runs 'full power'. I found the best climb rate at about 85km/h (the engine revving with 6,100rpm). The turbulent air permitted us to climb at an estimated rate of just a little above 1m/s. For powered flight, the pitot and static supply is switched from the tailfin probes (which are then in the propeller stream) to the nose pitot and fuselage static openings.

When approaching stall speed in powered flight, the turbulences from the stalling wing root hit the propeller. This made an awful sound – an excellent warning – and the stall behavior was as gentle as in soaring flight. The possible maximum horizontal cruise speed is 120km/h, above which a yellow light in the control

Extensive computer simulations during planning and innumerable people of different sizes were necessary to place a seat in the cockpit

An adapted Duo Discus was used in the 1999 version of the film The Thomas Crown Affair

instrument reminds you that you're coming close to the engine's maximum of 6,600rpm. At 125km/h, we reached this limit, a red light appeared, and the ignition switched off automatically until rpm decreased. Using 'saw teeth flight' (climbing at the speed of best climb rate, then switching the engine off and gliding), the 16 liters of two-stroke mix in the tank give an extra 200km range in case the thermals fail. To stop the engine, I switched the ignition off. The engine bay doors opened automatically, and the mast swung back a bit. In this position, flying at about 85km/h, the engine soon stopped revving, and retraction continued automatically until the upward folding propeller blades disappeared completely underneath the closing engine bay doors. With the engine retraction manually stopped after switching the ignition off, I found the performance of this 'worst case' flight still very acceptable. The sink rate remained below 1.5m/s, and the handling of the glider was not affected. So, in the event that the engine neither starts nor retracts, there is no problem landing the Duo Discus XLT safely on a landing field (which is an option you should always keep open when flying).

Acrobatic capacity

Another new feature of the sailplane is its ability to do semi-aerobatics with the Duo Discus XLT. It loops and stall-turns nicely from an entering speed of about 200km/h (the minimum speed required for this maneuver is around 180km/h).

> **"To stop the spin I used the standard method of kicking opposite rudder, then eased the stick forward until rotation stopped"**

The lightweight wingtips make stall turns easier and more precise than with other gliders of this span. Spinning is also possible and permitted, an important feature to declare a glider suitable for training. Flying at stall speed, the stick is taken fully back and full rudder is applied. The XLT then drops a wing and starts rotating with the nose pointing sharply downward. During the first turn, the glider buffets and its nose comes up a bit (but remains far below an angle that might make you fear that a flat spin might develop) and then goes down again. After about one turn, the 'full and stable' spin is established with a fairly steep attitude, moderate roll rate, and comfortably low centrifugal g forces.

To stop the spin, I used the standard method of kicking opposite rudder, then eased the stick forward until rotation stopped, which happened after about a quarter turn only. Correctly easing the big glider out of the dive, I lost only 100m height. This approach is ideal for spin training.

Landing the Duo Discus XLT was as easy as you expect in a basic trainer. With the stall speed remaining unchanged when the airbrakes were opened, a basic approach speed of 90km/h (plus half windspeed) was sufficient for the approach. The large airbrakes, combined with the flaps' baking effect, permit steep approaches, and the visibility on the landing field, especially also from the rear seat, has really been improved over that of the old Duo Discus. A nice safety feature is that the force used to pull the airbrakes out is always positive, so they do not open by themselves if the pilot forgets to lock them before take-off. Sideslipping is also possible, easy, stable, and very effective, and the slight tendency to accelerate when the airbrakes are extended during sideslip can easily be compensated for with the elevator.

Fully held off (against some force of the spring trim), the Duo Discus XLT touches down in perfect two-point attitude, and the new disc brake Beringer main wheel in combination with the nose wheel (which only touches the ground when braking very hard) allows very short ground runs, if needed.

The retractable Turbo propulsion system is primarily intended to overcome dead air conditions and to avoid off-field landings

The glider has winglets to improve thermal flying and a sprung and lower retractable undercarriage

The new Duo Discus XL is a wonderful glider, a two-seater offering the fun of flying as in a single seater, but with a performance equal to that of the best open-class gliders of the early 1980s. Although it has easy, safe, and gentle flying and landing characteristics, it is also perfectly suitable as a basic trainer for club use, and could be used to teach spin and basic aerobatic training.

The sustainer version XLT, with its renowned drive system and simplified engine operation, is a sensible option for all those who want to make sure that their glider comes back from failed cross-country attempts without problems, and to introduce pilots to the handling of sustainer engines. The craftsmanship is excellent, as to be expected from a factory known to excel in giving customer satisfaction. ∎

Jochen Ewald is a journalist and glider pilot

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FORMING AN AEROBATIC GLIDER TEAM, COORDINATING A TRAINING PROGRAM, AND MAINTAINING THE AIRPLANE ARE SOME OF THE TASKS FACED BY DUTCH GLIDER AEROBATIC TEAM COORDINATOR ERIK HOUTMAN

"We practiced a great deal and took the sailplane to the edge of what was possible"

BY ERIK HOUTMAN

It was in 1990 when a few Dutch glider pilots from several clubs became interested in glider aerobatics. The pilots discussed the possibilities and the group grew to include about 20 pilots. Then in 1991 the decision was made to buy a Swiss-made Pilatus B4, a fully metal glider. This allowed us to perform glider aerobatics on a simple but agile glider. To finance it, money was needed and an account was opened. Almost instantly the group shrank to six pilots, but we found our B4 – a standard B4 that needed only two modifications to become fully aerobatic. We practiced a great deal and took the sailplane to the edge of what was possible.

The first challenge came in 1993 with the World Championship Glider Aerobatics (WGAC) in the Netherlands. We had to take part in that. But how should we conduct the training? What were the rules? We talked to the renowned Dutch aerobatic pilot and Red Bull air racer Frank Versteegh, who advised us and did some training with us, but when the contest finally took place, only one member of the team was good enough to take part.

The following year, two of the team went to Italy for the European Championships, and there it became clear that glider aerobatics had changed. The B4 was suddenly no longer compatible because of the introduction of the Fox and Swift gliders in 1993. These were a completely different class of aerobatic gliders and, if we wanted to compete, we needed a Fox or Swift. So in 1995 we visited the Marganski Aircraft factory in Poland, where the Fox is built.

Once more there was a large group of interested pilots, but because of financial commitment, again just six brought it together. The Fox arrived in the Netherlands in 1996, and a lot of technical effort was needed to comply with Dutch registration rules.

The Fox is a two-seater glider designed for aerobatics. Until 1993 there were only single-seat aerobatic gliders. The Fox is made of glass fiber with epoxy resin. It has a wingspan of

14m, which is quite short for a two-seater, but is needed for maneuverability. The maximum speed is 285km/h, and the allowed forces are from -6g to +9g. It is great to fly because the Fox does exactly what the pilot orders, but it is not easy to fly and one has to respect its limits. If the wing stalls, all the lift disappears immediately. Glider wings usually have a twist to maintain stability with decreasing speed for as long as possible, but on the Fox there is no twist.

Maintenance

The Fox was built in 1996 according to JAR-22, making it easier to obtain registration in other countries. The Dutch team's Fox is maintained every year during the winter according to a checklist that has to be accepted by the authorities. Checks include: measurement of the rudder deflections; measurement of the resonance of the wings; and a leak test on all the instruments. Every five years the position of the center-of-gravity has to be checked because it is of great importance for the stability of the glider.

This year the new rules of European Aviation Safety Agency (EASA) will take effect. For the Fox this means that the maintenance book will have to be rewritten.

Competition

In 1997, two members of the team went to Poland for training and to compete, and then went on to Turkey for the WGAC. It was a good lesson, but the result was not great: they finished in the last two places in the rankings. However, on the way home we met Hungarian Sandor Katona, a very experienced aerobatic pilot who lives in France and has flown all of his life. We took the Fox to him for training weeks for several years, and this helped a lot. At the next event the team scored better and reached the middle of the rankings. Over the following years the team took four pilots to the World and European Championships.

An aerobatic flight starts at 1,200m (4,000ft) above ground and ends at 200m (650ft). The whole flight has to be conducted in a cubic kilometer. During a contest the projected square kilometer is laid out on the airfield with white markers, and the pilots are watched by line judges and scored. The pilots have to fly 'Known', 'Unknown' and 'Free' programs. The Known program is approved in the year before the contest in order to give everyone the opportunity to practice. The Free program is usually created by each pilot and handed in at the start of the competition. The Unknown program cannot be rehearsed, and is only put together by an international jury from data handed in by the competing countries during the competition.

Several countries organize their own national competition. In the Netherlands, team member Sape Miedema worked out a structure for basic training for aerobatic flying, and since 2002 the team has organized the Dutch Gliding Aerobatic Championships in which pilots from Germany, Belgium, and the UK also take part.

When the pilot of the glider is ready for the slack to be removed from the towline, a 'thumbs-up' signal is given by the pilot to indicate 'Pilot ready, level wings'

The Fox is largely taken from the S-1 Swift (same NACA wing section), which itself was an evolution of the 1964 designed Polish SZD-21-2B Kobuz 3

Costly game

The downside of glider aerobatics is the price. The aerotow to the starting height costs an average of €40 (US$52) per tow. Every pilot wants to cut training costs, and towplanes such as the Super Dimona, like motorgliders, are cheaper to operate.

There was an experiment with long winch cables four years ago. Most gliding clubs use a winch to launch the gliders, and mostly steel cables are used. The site is about 1,000m (3,300ft) long, which is about the maximum length possible because of the weight of the 5mm strong steel cable.

A new cable made of Dyneema, a very light superstrong polyethylene fiber, is already being used by several clubs in Europe. The overall conclusion is that the release heights are increased, giving the possibility of high-altitude winch launches. Experiments started in Germany, and cables with a length of 3,000m (9,800ft) were used, reaching release heights up to 1,600m (5,200ft). In the Netherlands in 2007 the record was set with the Glider winch, which had a cable length of 3,050m (10,000ft), and achieved a release height of 1,720m (5,650ft).

Launch prices vary between €15 (US$19) and €25 (US$32) depending on the winch and the airfield, and there is considerable organization involved to make this possible, in addition to obtaining the necessary permissions. For two years a glider aerobatic training week has been held in Germany, where winch is the main method of launch, and in 2007 at the German National Glider Aerobatics Championship, the first beginners competition was organized using winch launching.

Glider aerobatics is very demanding from a flying perspective and financially. However, it gives the pilot a better understanding of how aerodynamics work and ways of coping with difficult situations in normal gliding. ■

Erik Houtman is a member of the Dutch aerobatic team and a member of CIVA (Commission Internationale de Voltige Aerienne), which is responsible for the administration of aerobatic competitions worldwide under the auspices of the FAI (Fédération Aéronautique Internationale, the World Air Sports Federation)


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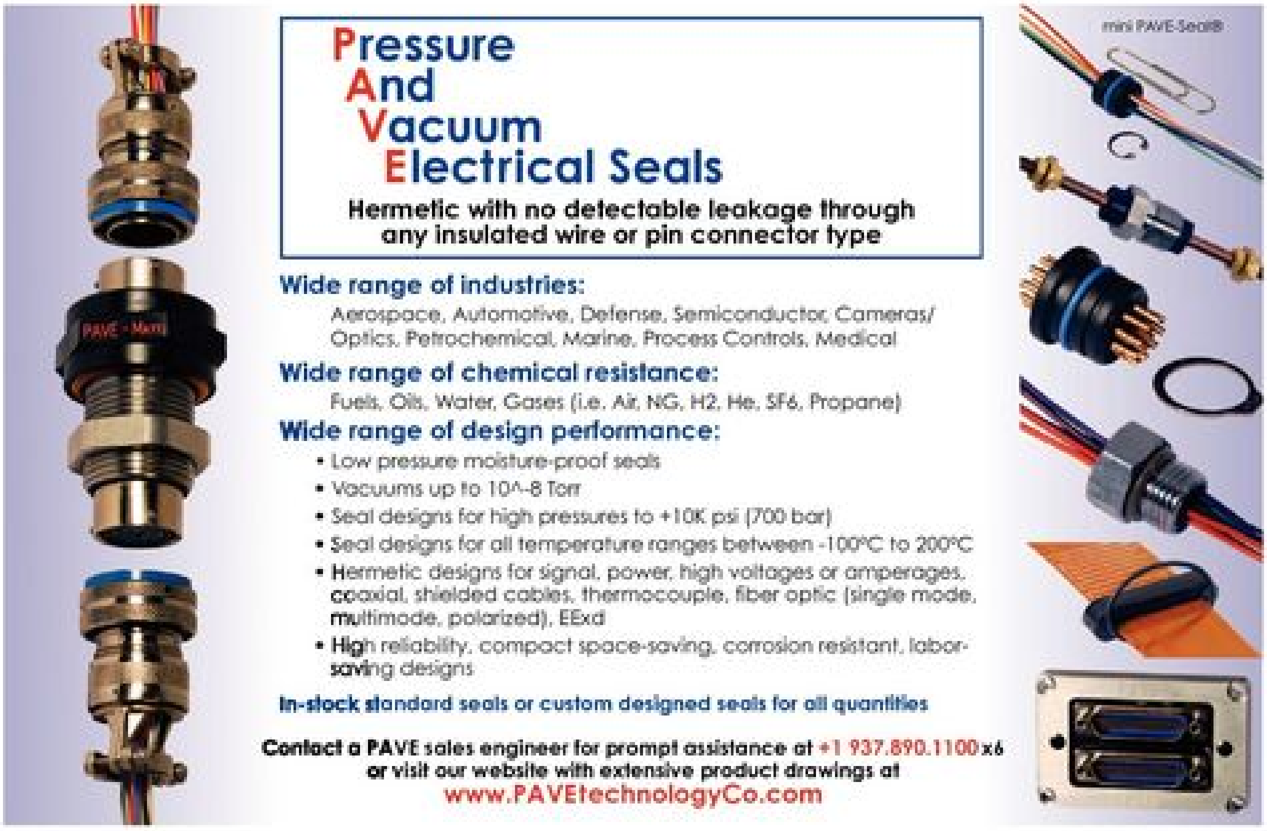
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Second only in number

PEOPLE TALK ABOUT MSN 001'S RESULTS IN THE STATIC TEST A400M, BUT THAT WASN'T THE FIRST AIRCRAFT PRODUCED FOR THIS JOB. MSN 5000 WAS, AND USED 7,000 STRAIN GAUGES TO VERIFY PERFORMANCE UNDER SIMULATED CONDITIONS

BY DOUG MACLENNAN

Much attention is focused on the status of A400M Manufacturer's Serial Number (MSN) 001, the first flight test aircraft of the €20 billion (US$30 billion) program, and Europe's largest ever collaborative defense project.

The very first complete A400M airframe to be produced was, in fact, MSN 5000, the static test specimen assembled and now installed at the EADS-MTA facility in Getafe, near Madrid. The airframe was fully commissioned in February 2008 following fine-tuning of equipment and test systems. A spokesman for the structural test team at the facility says, "Working closely with our test system partners and suppliers ensured we were ready to start testing when we needed to be."

Testing began in March 2008 and the process essentially simulated the loads, temperatures and pressures the aircraft will experience during operational use. Actuators apply mechanical loads to the airframe wing and fuselage, and engine and propeller torque loads are simulated by applying appropriate forces to dummy engines and pylons. It is envisaged that some 40 load cases will be studied and tested, first to what is called 'limit load', then to 'ultimate load', then beyond these limits, possibly to destruction. By applying mechanical loads exceeding those the aircraft will experience in service, the validation process ensures maximum structural integrity and reliability prior to certification.

Data from more than 7,000 strain gauges, distributed strategically around MSN 5000, are monitored, captured and measured by HBM's Data Acquisition (DAQ) System, comprising the MGC-plus DAQ system combined with the distributed strain gauge amplifier system known as CAN-HEAD. This DAQ system, is designed to provide high-quality measurement data that can also greatly reduce the cost and burden of cabling that, in the case of MSN 5000, requires more than 21km of wiring, weighing up to 8,000kg. A member of the testing team at EADS CASA (MTAD) comments, "We have always experienced superior service and quality from HBM and are confident we can rely on the Data Acquisition System for dependable data."

Digitally acquiring the measurement data from the load, strain (stress) and displacement signals is an important part of the test program. It validates stress calculation methods by comparing measurements obtained from the test specimen with predictions from mathematical models. Engineers can then verify the performance of the airframe under simulated operational conditions by putting design theory into practice.

Structural testing of the airframe will continue at MTAD and will incorporate tests of the fuselage pressurized to twice nominal cabin pressure, fatigue testing of airframe CFRP parts (ES wing), tests on the cargo doors, tests on the refueling probe, and a separate static and fatigue test of the horizontal tail plane (HTP). The entire test program is expected to be completed by mid-2010.

Although MSN 5000 will never actually fly (that privilege is left to MSN 001), it is crucial to the A400M development program. ∎

Doug MacLennan is global business development manager – Aerospace at HBM

The CASA test installation near Madrid, Spain. (Pictures courtesy: EADS CASA)

Final approach

NOW IN ITS SEVENTH YEAR, AEROSPACE TESTING, DESIGN & MANUFACTURING IS THE GLOBAL MEETING PLACE FOR THE AEROSPACE ENGINEERING DEVELOPMENT COMMUNITY

Aviation engineers are taking a long-term view of the current difficult economic climate and are upbeat about future investments, according to Reed Exhibitions, organizer of the forthcoming Aerospace Testing, Design & Manufacturing expo. The company is confident of strong support for April's exhibition, which returns to Munich with a focus on innovation, maximizing efficiency, and careers.

Reed carried out research in November 2008 with a sample of 100 visitors with direct responsibility or influence on purchasing products in aero testing, design, and manufacture. More than 50% of them said that they expected their gross sales and revenue to increase over the next six months, and over 80% believed their number of supply chain partners would either increase or remain the same over that period. Approximately 70% said with regard to future projects that they expected increased activity, or to maintain the status quo. Most importantly, more than 60% said they would be investing in the fields of aerospace testing, design, and manufacture within the next 12 months.

"These findings very much underline that Aerospace Testing, Design & Manufacturing expo should be the number one priority for the sector this year," says exhibition director Jonathan Heastie. "It is a key opportunity for small companies to share their technology with larger players who are always looking for niche capabilities."

Now in its seventh year, engineers have come to regard this show, the exhibits, live demonstrations, and its technical seminars as must-attend events. It is the premier networking event for the aerospace engineering development community. During days one and two, more than 70 seminars will reveal the latest developments in topical issues within the areas of avionics, testing software, telemetry and data acquisition, metrology and quality assurance, NDT, engine testing, materials and composites testing, design and pre-production, as well as a full-day run by The Society of Flight Test Engineers and, new this year, a panel session on green initiatives. The last day of the free education program will be determined by the engineers themselves. They have the opportunity to vote on the show website for the top 12 presentations they would like to hear on day 3, creating their own conference.

Young aerospace engineer of the year award

Following the success of the event's student program, Aerospace Testing, Design & Manufacturing has this year joined with EUCASS to present The Young Aerospace Engineer of the Year Awards, sponsored by MTS, to recognize excellence in tomorrow's engineers. There will be two prizes. The Scientific Prize will recognize the most innovative project in aerospace research, and The Technology & Innovation prize will go to the best project in aeronautical and space testing, design, and manufacture. Further details are available at www.aerospace-testing.com/yey.

Aerospace Testing, Design & Manufacturing is looking forward to welcoming some 3,500 attendees this year. Spain, Canada, and India in particular will be sending strong delegations of engineers.

"The show has become the global marketplace for the aerospace engineering development community operating outside the USA. Visitors, speakers and companies participating this year include Airbus, BAE Systems, Boeing, Eurocopter, EADS, GE, Honeywell, Beta Air, MTU Aerospace, and RUAG," confirms Heastie.

The next generation of aerospace engineers will be invited guests

CREATE A CONFERENCE

The last day of the free education program will be exclusively designed by the aerospace engineers themselves.

From a selection of presentations available on the website, online visitors have voted for the top 12 presentations they'd like to hear, creating their own conference.

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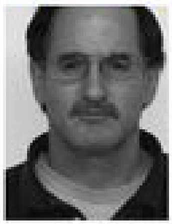
Conference high points

AGEING HELICOPTER COMPONENTS



Robert S. Skillen is the president and chief engineer and Ajit D. Kelkar is the director of VX Aerospace Corporation, USA. In recent years, US civil and defense aerospace industries have faced the challenging problems of aging metal components. Their presentation discusses these components that are typically made out of structural aluminum. They cover the development of several helicopter components based upon basic principles of re-engineering design and manufacturing procedures for aging metal components. Special emphasis is placed on the use of lightweight, high-strength fiberglass and carbon composites. They demonstrate innovative out-of-autoclave manufacturing methodologies that were developed in conjunction with the use of hybrid woven composites to meet the required strength and design criteria.

Day 2: 15.00 – 15.30hrs

MOBILE A350 TOOL SUITE

Nicolas Lesellier has worked for 10 years as a software system engineer specializing in simulation and data-loading products for TechSAT GmbH, Germany. His discussion focuses on the complete tool suite being offered to AFDX testers for the A350 program, based around a standard laptop with no additional hardware required. The tool suite provides a mobile and cost-saving solution that covers the whole lifecycle, including development, production, and maintenance.

Day 1: 10.00 – 10.30hrs

A complex array of the latest test devices and applications will be demonstrated in Munich in April

ENGINE ELECTROSTATIC MONITORING

Dmitry Golentsov, who is head of sector at CIAM in Russia, deals with problems connected with diagnostics of ignition systems, application of electro-gas-dynamic effects to aviation engine monitoring, and metrological certification of test benches. By analyzing the signals of the electric fields generated by the engine jet, it's possible to get information about engine operation and abnormalities, including the destruction of the engine elements.

Day 2: 11.00 – 11.30hrs

BLADE VIBRATION

Non-contact blade vibration and a tip clearance measurement system for axial compressor application is the subject being discussed by Michael Zielinski, consultant for advanced measurement techniques in turbomachinery with MTU Aero Engines. The presentation deals with BSSM, the non-contact blade vibration and tip clearance measurement system of MTU Aero Engines. Originally exclusively developed for vibration measurements on rotor blades of axial compressors, the system has in recent years used capacitive probes instead of the former optical probes, because their signals can simultaneously be used also for blade tip clearance measurements.

Day 2: 15.00 – 15.30hrs

Unmanned Air Vehicle development will be a specific highlight at the show

NEXT PROTOCOL

Niels-Jørgen Jacobsen joined Brüel & Kjær as DSP software developer on analyzer systems. He is now a product manager, designing a general-purpose, high-quality noise and vibration data-acquisition system. A number of divergent requirements must be fulfilled, and experience and innovation needs to play an important role in achieving this challenging objective. Jacobsen's presentation will highlight some of the technologies used in LAN-XI, including Precision Time Protocol (PTP), Power over Ethernet (PoE), Dyn-X, REq-X, and TEDS.

Day 1: 14.00 – 14.30hrs

THE BLACK ARTS

Pietro Cervellera holds a PhD in aerospace engineering from Italy's Università di Padova, and is now business development manager of aerospace industry at Altair Engineering in Germany. His presentation covers composite materials, increasingly adopted in the design of aerospace structures due to its many attractive properties, most importantly its low weight. Composite laminates offer engineers ultimate design freedom, enabling tailoring of the structural properties to meet design requirements. This design freedom is typically, but not fully exploited (black metal approach), mainly due to the complexity of the system.

Day 1: 14.00 – 14.30hrs

FOAM CORE MATERIALS

Martin Rinker is a research associate from the Fraunhofer Institute for Mechanics of Materials in Germany. He will talk about sandwich structures with carbon-fiber-reinforced polymers for the face sheets in combination with lightweight core materials. These qualify for aircraft applications because they offer a good ratio of bending stiffness and strength to weight. Processing time and manufacturing costs can be decreased by using closed cell rigid foams as core material.

Day 2: 12.00 – 12.30hrs

ACOUSTIC ANALYSIS IN AIRBUS

At 29 years old Nicolas Verbeke has youth on his side, but as an engineer with ORME in France he also possesses a great deal of aerospace wisdom. ASAM-ODS is a well-known standard in data management in the automotive industry, but it is now also beginning to be used in aeronautics. Airbus France has chosen this for its acoustic test and simulation data management. ORME has developed for Airbus France a whole software application including acoustic data processing, data management using ASAM ODS, and web services.

Day 1: 15.30 – 16.00hrs

UNMANNED SYSTEM AT NEAT

Sten Hedlin is the marketing director for NEAT in Sweden. Unmanned systems have been flown over NEAT for more than 50 years, originally in the form of target drones for air-to-air and surface-to-air missiles. Hedlin says that in recent decades, armed forces and manufacturers have used the range for test and evaluation of existing and new systems. The location of the range in an unpopulated part of Europe makes it possible to fly new, untried systems easily, and the size of the range provides opportunities for long-range endurance tests. Flying overland gives the added bonus of being able to test sensor systems on realistic targets.

Day 2: 12.30 – 13.00hrs

Pick of the bunch

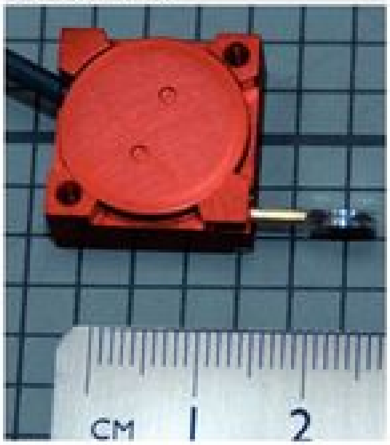
A TASTE OF THE NEW PRODUCTS AND SERVICES BEING UNVEILED AT AEROSPACE TESTING, DESIGN & MANUFACTURING 2009

HARDWARE PLATFORM

The VibPilot is m+p international's new compact 4/8/16-channel hardware platform tailored to meet the requirements of today's vibration testing and dynamic-signal analysis. Being demonstrated at the show, the system is based on the latest generation of IC technology, resulting in high-precision measurement ability and impressive real-time performance in signal analysis. With 24bit sigma-delta A/D converters and up to 102.4kHz sampling rate, VibPilot allows for alias-protected measurements in a frequency range up to 40kHz and more than 120dB spurious-free dynamic range. Rugged and dust-proof, VibPilot can be operated indoors and outdoors. The fanless, noise-free operation enables acoustic measurements requiring a low noise environment.

MINIATURE CABLE TRANSDUCER

Variohm Eurosensor will be launching the new 150 series miniature cable transducer. Designed with the requirements of testing in mind, this 19 x 19 x 10mm transducer fits in space-critical applications. Offering a 38mm measurement range and a linearity of 0.25%, the 150 series gives the perfect measurement solution where linear parallel alignment and other mounting constraints may be a problem. With the aerospace, automobile and instrumentation markets in mind, the unit has also been approved across a temperature range from -50°C to +100°C.



NEW STRING TO THE BOW

MTU Aero Engines and MTU Maintenance are brands whose names stand for top-notch, high-tech engineering and quality in the engine world. Now Germany's leading engine manufacturer has announced a third brand, MTU Aero Solutions, which markets and sells the company's world-class technologies and services individually.

"Globally, MTU boasts great expertise in engineering, testing, parts manufacturing, and surface technology. We're now going to sell it to other industries as well as aviation," reveals Dr Anton Binder, senior vice president of commercial programs at MTU. The new brand can draw on the many years of engine expertise of its parent company, which has been in the business for decades. "MTU provides top-notch products and services in all essential domains of engine manufacturing, and, under MTU Aero Solutions, can fold these into integrated solutions," says Dr Sorina Seitz, who heads the new MTU activities.

SPIKE FOR A400M & A350

Variable frequency generators are driving new test requirements for the A400M and A350XWB. Airbus specification AMD-24C addresses voltage spike testing on AC and DC power interfaces. Being demonstrated at the show, EMC Partner's Fx-AMD24C is a plug-and-play extension to the already popular MIG2000-6 test system which enables 2/10us, 2/50us, 2/100us, 2/200us, and 2/400us impulses from a single unit. The 2/10us impulse can also be used for RTCA/DO160 section 17 and EUROCAE ED14 voltage spike tests. Impulses are superimposed simultaneously onto all power lines.

HIGH-SPEED CAMERA

Demonstrated by AOS, the digital high-speed camera X-EMA with its 1.3 megapixel resolution and framing rates up to 32,000fps is specifically made for airborne and other applications with challenging environments. It is tested and certified according to MIL-STD 461 and 810.

With its ultra-compact footprint, X-EMA fits into any given compartment, and can be mounted on either side. It has just two wires for power (24-36VDC) and trigger, making integration easy. The X-EMA's built-in PowerPC enables configuration of the camera so that it behaves in a similar way to film cameras, with the result of just minimal modifications on the airplane as well as on the test procedure. Existing handshake routines can be duplicated by a number of programmable status lines.

MULTI PRESSURE SCANNER

Being launched at the show, the Kulite Multi Pressure Scanner (KMPS) offers a high-performance acquisition unit for multiple pressure measurements of non-corrosive gases. Ideally suited to the aerospace market, applications include wind tunnels, aircraft engines, gas turbines, aircraft ground and flight testing, and aerospace research.

The unit integrates up to 32 Kulite miniature pressure transducers in a compact and rugged box. Pressure-sensing technology is based on Kulite's piezoresistive technology using dielectrically isolated, silicon-on-silicon devices with high natural frequency, low hysteresis, and superior thermal characteristics. Pressure transducers can be individually replaced in the field.

Operational modes include absolute or differential measurement with auto-zero capability. Differential mode uses an integrated purge.

VARIABLE FOCAL SPOT SIZE

YXLON International is presenting its Variofocus x-ray system Y.XST225-VF with new focal-spot technology, a product that offers extraordinarily small, in-performance variable focal spot.

Y.XST225-VF closes the gap between microfocus and conventional x-ray tubes in digital radiography and computed tomography. Variofocus is especially useful for x-ray application in the automotive, aviation and aerospace industries. The Variofocus focal spot is less than half the size of conventional x-ray tubes, and much more symmetrical. These two key parameters lead to higher spatial resolution, and consequently, optimal detail recognition.

ALL IN THE PIXEL

According to exhibitor PCO AG, new CMOS high-speed camera pco.dimax achieves an unrivaled high frame rate of 1,100fps at a resolution of 2,016 x 21,026 pixels. If the area of interest is reduced to 1,032 x 1,024 pixels, the frame rate is increased to 4,000fps, and all this at 12bit dynamics.

The 12bit CMOS camera system represents advanced CMOS technology. The custom-designed CMOS image sensor with a diagonal of 31.4mm has 11µm pixel size, a quantum efficiency greater than 44%, and is available in monochrome and color. The pco.dimax has a 32GB primary image memory (camRAM) integrated and various trigger operational modes built in to fulfill the range of needs and demands by the automotive and aerospace industries for crash tests and component tests.

RADIO SENSOR TELEMETRY

Exhibitor Manner Sensortelemetrie GmbH has developed a new multi-channel radio sensor telemetry system especially for airborne test applications of helicopters or turbo-prop aircraft.

A receiver, designed as a small box (100 x 120 x 30mm) with a digital interface, is the main feature. This interface can be chosen as USB or TCP/IP and allows a direct connection to the acquisition PC without any analog signals. An advantage is that no additional parts are needed. The transmitter possesses direct sensor interfaces, supplies all sensors, and all channels are separately configurable.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Fighting fatigue

FATIGUE TESTING IS BECOMING INCREASINGLY IMPORTANT, PARTICULARLY WITH MODERNIZATION PROGRAMS AND AVIONICS UPGRADES EXTENDING THE WORKING LIVES OF AIRCRAFT. HOWEVER, IMPLEMENTATION IS NOT WITHOUT ITS CHALLENGES

BY ANDREW CHILTON

Fatigue testing is more important than ever, as air companies tighten their belts and extend the lives of aircraft. Implementing fatigue testing comes with its engineering challenges. As well as upgrades and modernization, there is the practical issue of determining the validity of the tests. What makes for reasonable loading and cycling? What permutations should be considered? Where do the tests come from? Where, when and how should data be collected? And how are the results to be used?

These questions can be answered by considering a number of fatigue testing programs currently underway at Marshall Aerospace Test Services, part of Marshall Aerospace and located in a 21,500ft2 purpose-built hangar on the outskirts of Cambridge, UK. Of the hangar space, 5,400ft2 is 'hard floor', given over to the testing of airframe parts and sub-assemblies. One of the programs running is to underwrite the safe life of the current RAF C-130K aircraft. For this, a ground-based test rig was built in 2004 to underwrite the continued safe flying of the C-130K to its out-of-service date of 2012. Some 31 actuators are connected between the fuselage and floor, and either push or pull depending on the static and/or dynamic forces being simulated, and the fuselage reaction loads are monitored through six fixed load cells around the undercarriage. Some of the forces exerted are point loads, others are transient or shear. The loads may be applied to spreader beams or yokes so that a single actuator can apply pressure at multiple points simultaneously.

Each actuator has its own dual-bridge load cell that forms part of a closed-loop control circuit for that actuator, which itself is part of a system-level closed loop. Any test must provide instruction to all 31 actuators and the six reaction load cells. Travel is recorded at each actuator too, and if unexpected travel is experienced on any actuator, the test will initiate a

Nose around

Uk-based Marshall Aerospace Test Services is also undertaking, under contract with Messier-Dowty, extended fatigue tests on the front nose landing gear of the Airbus A340 500/600 aircraft.

The rig was originally sited at a Messier-Dowty facility in Gloucester, UK, but was transported and rebuilt in a modified form at Marshall's facility in 2007.

The nose gear is suspended within the rig in much the same way that it attaches to the aircraft. All forces applied are therefore relative to the mounting. Some 14 actuators are employed, which are fitted with load cells from which all load measurements are taken. Simulated loads include side, drag, landing, retraction, skid, and tow.

Tank-busting record

Marshall Aerospace worked with Boeing to set the world record for the longest distance travelled non-stop by a commercial aircraft. A B777-200LR departed from Hong Kong International Airport at 22.30 local time on November 9, 2005, and flew into London Heathrow at approximately 13.30 GMT on November 10th. The aircraft flew 11,664 nautical miles (21,601km) – effectively more than halfway round the world – in 22 hours and 42 minutes.

The long-range (LR) variant of the B777 employs a fuel tank designed, manufactured and tested by Marshall Aerospace. It was developed to fit in the cargo hold of the aircraft, and the testing included pressure fatigue cycling between -4psi and +3psi.

The fatigue test tank, on-site in Cambridge, UK, is in support of the certification program and it has already undergone 30,000 flights, the equivalent of two lives. It is tested for leaks during inspections every 3,500 flights, and will now be subject to typical operator damage and repairs using standard repair schemes. The tank will then undergo a further 30,000 flight tests to ensure that there is no structural degradation as a result of the repairs.

When being tested, the tank is typically filled with polystyrene to occupy the majority of its volume, and to reduce the amount of time it takes to pressurize the vessel.

Top: The fatigue test tank has undergone 30,000 flights

Above: Enclosed in its pen, the RAF C-130K fuselage undergoes a range of structural and pressure fatigue tests

controlled abort.

Approximately 400 strain gauges, which experience a change in resistance that is proportional to strain, have been bonded to the fuselage in strategic locations. Each gauge has a unique reference number, which corresponds to a data logger channel, and is typically sampled at 10Hz – so about 4,000 readings are taken per second.

As for where and why measurements on the rig should be taken, and where and why forces should be applied, that intelligence is derived from the operational load measurement (OLM) program. These are in-service aircraft that have been fully instrumented and calibrated. There are currently three OLM aircraft flying – two UK Royal Air Force (RAF) and one Royal Australian Air Force (RAAF) – which are J model C-130s, and between them they have been collecting data over the past three years.

With typical payloads, data recordings have been made during taxi, take-off and landing, and many other flight conditions. Around 190 strain gauges per aircraft are employed together with on-board data-acquisition systems.

Data from the OLMs has been used to define realistic tests at Marshall's facility in Cambridge. The tests are controlled using a graphical user interface and apply certain loads for varying durations. For example, aerodynamic loads may be applied for several hours. Simulated landings, on the other hand, are executed by briefly pulsing the actuators down (including those simulating the cargo load), while reacting against the fuselage at the undercarriage load points.

In addition to the structural load tests, the fuselage is also pressure cycled, and the internal pressure can be increased by 7.5psi in addition to approximate ground-level pressure simulating the forces exerted on the fuselage when above an altitude of approximately 17,500ft. The pressure can be increased within 90 seconds using two large air pumps. The fuselage is filled with several large foam blocks, which are all purpose-built and fit together like 3D jigsaw pieces, and occupy the majority of the volume within the fuselage. This is primarily for safety, but also aids in the pressurization speed.

The fuselage is situated within a mesh and Perspex pen measuring 43m long x 14m wide x 4.5m high, which acts as a safety guard should anything be ejected from the fuselage.

In addition to the C-130K fuselage tests, Marshall is conducting wing tests for the C-130J. The tests are being conducted for the RAF and the RAAF with a view to providing a cleared fatigue life equivalent to 30,000 hours, and also to make use of the data recorded on the OLMs.

Unlike the fuselage rig, which sees all loads applied relative to the floor, the wing rig is more of a framework in which the wing is suspended and was built in the 1980s for a similar test on a C-130K wing. Here some 42 actuators and around 300 strain gauges are used, and test control and data acquisition are as for the fuselage tests. The loading tests include aerodynamic loading during flight, twisting resulting from turbulence, and reaction to engine torque, plus take-off and landing loading.

Due to the limitations of the wing specimen, the pressure cycle is applied using an airbag that is inflated beneath the center wing box, within the fuselage, while the fuselage's side-walls are pulled. This simulates expansion of the fuselage and wing-box at altitude.

Both tests are at different stages of their programs. Specifically, the C-130K fuselage is currently undergoing a major service, and the C-130J wing test rig is in the final stages of commissioning, awaiting final project board sign-off by the RAF and RAAF.

Data collected from both the fuselage and wing tests is being fed back to the respective customers for their analysis and interpretation. This has resulted in the gathering of a large amount of information relevant to future fleet maintenance. ■

Andrew Chilton is business development manager at Marshall Aerospace Test Services

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Silence of the lamb-wave

A REPORT FROM POLYTEC LOOKS AT HEALTH MONITORING OF AEROSPACE STRUCTURES WITH LASER VIBROMETRY FOR DAMAGE DETECTION USING LAMB WAVES

BY W. J. STASZEWSKI

Lamb wave inspection uses guided ultrasonic waves to detect damage within structures. Its commercial exploitation has been limited by drawbacks in current detection techniques. Using a new detection technology known as 3D Scanning Laser Vibrometry, structural damage is clearly identified by locally increased in-plane and out-of-plane vibrations. The method is simple, fast, and reliable, eliminating complex lamb wave propagation studies, baseline measurements, and signal post-processing.

Aircraft designers, manufacturers, and operators face many test and measurement challenges. New, large-capacity civil airframes that make greater use of composite materials are being developed and will be more widely used. At the same time, new military structures exhibit improved performance by relying on greater structural complexity. End users of these new aerospace structures demand reduced lifecycle costs and high operational availability. These goals can be achieved with the application of new materials and wider use of damage-tolerant design concepts that result in lighter structures and better performance.

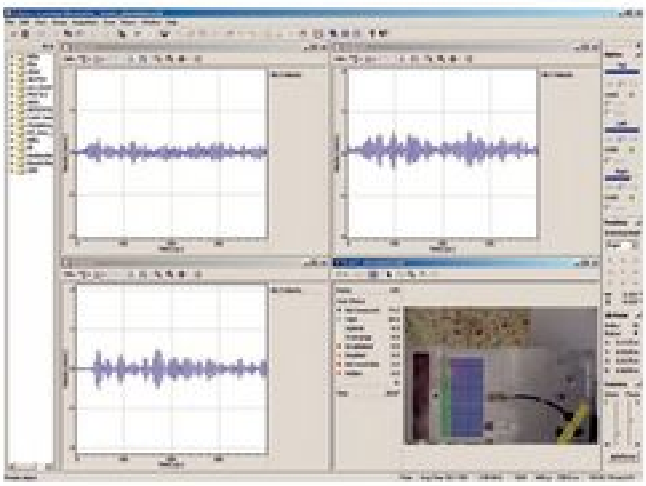
While these new aircraft are being developed, the existing fleet is aging and must be maintained. A number of life-extension programs have been considered and performed in recent years; civil structures are being converted from passenger aircraft to freighters and military aircraft are re-designed to add new weapon capabilities. These developments are a major challenge to existing aircraft structure inspection and maintenance methods.

Aging aircraft structures require considerable maintenance effort. The application of new materials and damage-tolerant concepts in next-generation aircraft also requires enhanced and reliable structural-health monitoring, with regular periodic inspections, to assure a safe and an extended operational life.

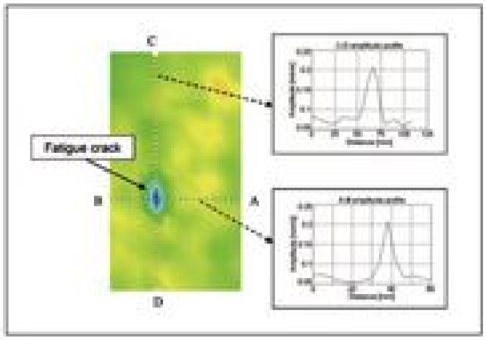
Damage detection with lamb waves

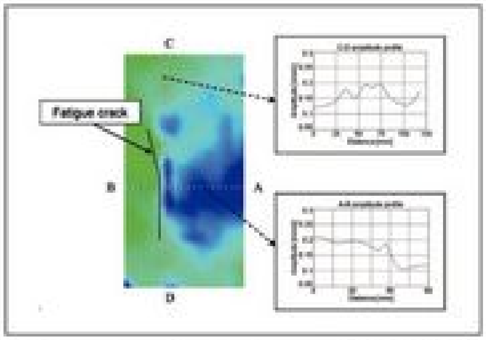
A number of new technologies have been developed with the potential for automatic damage detection in aerospace structures. One promising

Experimental arrangements for lamb wave damage detection using 3D laser vibrometry as a receiver

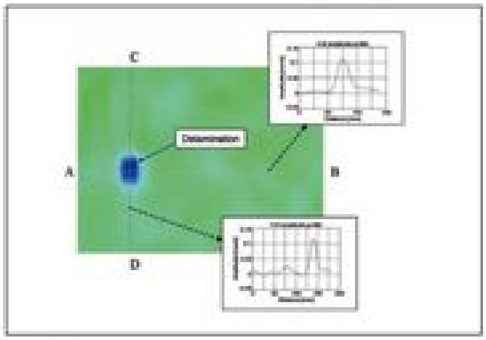


In-plane and out-of-plane lamb wave responses plotted using Polytec's PSV Software





Fatigue crack detection in metallic structures using lamb waves. RMS amplitude contour maps show amplitude profiles across fatigue cracks for 75kHz in-plane vibration (far left) and 325kHz out-of-plane vibration (near left)



Impact damage detection in composite structures with Lamb waves. Amplitude contour map shows amplitude profiles across delamination for 100kHz in-plane vibration

technology is lamb wave inspection, the most widely used damage detection technique based on guided ultrasonic waves. These are ultrasonic wave packets propagating in bounded media. Although several lamb wave applications have been tried over the last 20 years, to date the practical commercial exploitation of ultrasonic-guided waves has been very limited. There are three major drawbacks associated with current lamb wave damage detection techniques. First, a number of actuator/sensor transducers are required for monitoring large structures. This is labor intensive, slow and costly. From the logistical point-of-view, it is not practical to cover an aircraft with many thousands of bonded or embedded transducers.

Second, lamb wave monitoring strategies, often associated with complex data interpretation, require highly qualified NDT technicians for point-by-point field measurements. Consequently, broad deployment is restricted by higher costs and lack of properly trained technicians.

Finally, current signal processing and interpretation techniques used for damage detection use signal parameters that reference baseline data representing the 'no damage' condition. These parameters can be affected by effects other than structural damage, such as changes in temperature or bad coupling between the transducer and the structure.

3D scanning laser vibrometry

Laser vibrometers can overcome many difficulties associated with lamb wave damage detection techniques. In the top figure on opposite page, the application of a non-contact, multipoint scanning laser vibrometer to structural damage detection is illustrated. Lamb waves from a piezoceramic transducer are sensed using the Polytec PSV-400-3D scanning vibrometer. The 3D scanning vibrometer covers the complete optically accessible surface with a high density of sample points. At each sample point, the vibration vector is measured including both in-plane and out-of-plane components.

These measurements are assembled into an intuitive 3D animated deflection shape. These results show that structural damage can be identified clearly by locally increased in-plane vibration amplitude such as fatigue crack and delamination, and by attenuation of out-of-plane vibration amplitude.

Scanning laser vibrometry can reveal structural damage and its severity such as crack length and delamination area. Simple contour maps and profiles of lamb wave amplitude across the structure are sufficient to see the damaged areas and do not involve studies of complex lamb wave propagation in the structures, baseline reference measurements in undamaged structures, or signal post-processing to extract damage-related features. The method is straight forward, fast, reliable and immune to environmental effects.

From W. J. Staszewski, C. Boller and G. R. Tomlinson's study: Health Monitoring of Aerospace Structures, John Wiley & Sons

Control panel

A NEW GENERATION OF MULTIPURPOSE DIGITAL CONTROLLERS AND AUTOMATED DESIGN-OPTIMIZATION TOOLS FOR HIGH-PERFORMANCE CONTROL OF MECHANICAL SYSTEMS WITH SERVOHYDRAULIC ACTUATORS ARE AVAILABLE FROM CONTROLLERSOLUTION GMBH

BY DR MAXIMILIAN SCHLEMMER

In test engineering, typical applications of multipurpose controllers range from low-frequency engineering applications such as large-scale aircraft-structure fatigue testing, right up to higher frequency control engineering applications such as vibration tests, automotive and structural-component testing. Typically, this involves a test rig driven by servo-hydraulic actuators and requires appropriate control engineering methods to achieve maximum tracking speeds at low tracking error levels or to achieve maximum tracking accuracy coupled with high control-loop stability.

Controllersolution GmbH supplies model-based multipurpose digital-control and monitoring systems for mechanical systems driven by servo-hydraulic actuators. The company manufactures and delivers control and monitoring systems either in standard modularized field-structure cases or in custom-made compact cabinets.

The company also offers an 'open solution' that allows customers to purchase all the hardware directly from the hardware manufacturer through a worldwide-supplier and support network, helping to make control-and-monitoring systems available at prices far below the market prices of our competitors. An added advantage is that customers are able to purchase standardized hardware that better matches the requirements of their specific control-engineering applications.

The controller systems is designed specifically for complex multichannel control engineering applications. Different types of control, including force, position, velocity and acceleration controls, or even mixed controls, can be efficiently implemented. The highly automated level of the control and monitoring system is met by a close connection to the model generation and system-simulation environment. System simulation is used to automatically calculate a preliminary optimization of the controller, to automatically generate the time-optimized command-signal profile as well as to analyze and design actuator and oil-supply systems.

Efficient operability

An easy-to-tune and sophisticated feedback control algorithm specifically designed for servo-hydraulic control engineering applications as well as model-based control engineering methods such as 'feed forward' control, inertia and vibration compensation and gain boost ensure the high performance of our controllers. For higher-frequency control-engineering applications, we provide an additional preliminary filter technique (inverse control) and standard RPC (remote parameter control), which are both based on the plant's identified inverse transfer matrix.

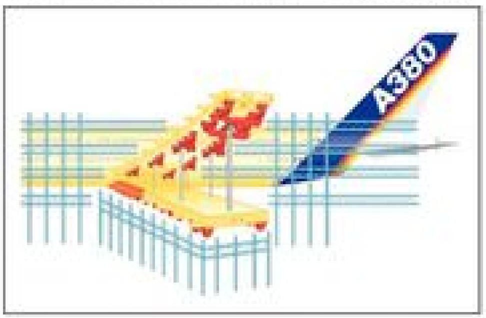
Efficient operability is achieved by an application-tailored system scalability, especially of the controller's operation and configuration environment, as well as by multiproject application efficiency at the operation level. Features such as monitoring, activation and shutdown procedures, on figurable error monitoring up to 300 channels, slow-motion, measurement and static/dynamic operation modes, which are implemented in a real-time system, ensure a maximum degree of system automation. Potentially unstable and error-prone 'scripting' is not needed.

The controller is designed for efficient multiproject application administration. Further, an automated protocol for event display and logging during operation provide a traceable history of all states and occurrences of relevance to the system and application. Offline-and-online visualization tools enable efficient data analysis and fine tuning of controller parameters. Manual controller operation and some basic visualizations can be provided as options in the field by means of touch panels. In this case, each controller is allocated a touch panel, enabling the user to operate the controller locally in the vicinity of the control-engineering application without needing a PC.

The controller-system structure consists of the basic unit, the measurement unit and control units. These units are interconnected by a real-time communication system. The measurement unit executes tasks such as data acquisition, post-mortem analysis and communications to the touch panel.

The controller, which is modularly extendable up to 200 channels, consists of individual control units, therefore allowing the configuration of almost arbitrarily extendable

Model-based optimal control of the test rig for the Airbus A380 large-scale fatigue test



A380 fatigue tests involved 47,500 flight simulations spread over 26 months. That corresponded to around 25 years of operational use

linear or star-like topologies. This makes it especially suitable for highly distributed control engineering applications in the field. For instance, control units can be located in the vicinity of the corresponding sensors and actuators. Therefore, its real-time communication system, which is also the fieldbus, reduces cabling effort to a minimum. Additional control units can be efficiently connected by 'plug-and-play'. As an alternative to the standard modular field structure, control and monitoring systems can be supplied in custom-made compact cabinets.

System simulation

In the easy-to-use FE model generation environment, the physical model of the plant is generated from a library of pre-defined model classes and is automatically identified by the optimization-based modeler. The result is a non-linear physical-plant model that can easily be assigned multiple parameters, allowing it to be employed efficiently in the corresponding control-engineering application.

Apart from this, the physical model is already available at early project phases, far before the plant itself has been assembled. This permits the actuator and oil supply-system layouts to be optimized well in advance. Parameters are assigned to the model intuitively through a graphical user interface, whereby the user has to specify fundamental model parameters such as the geometric data and dimensions of the mechanical system and the positions of actuators and bearings. After the model parameters have been defined, automated model identification is carried out. This involves the user-describing characteristic mechanical properties such as deflection bending lines, masses and, where available, natural frequencies and inertia tensors.

The appropriate physical model adjustments are then made automatically with the aid of the modeler's numeric-parameter optimization function. For higher-frequency control-engineering applications such as vibration tests, test-rigs for automotive road-tracking profile simulation and structural-component testing, the physical model will generally become inaccurate. In such cases, the plant's transfer matrix is derived automatically by appropriate excitation-measurement campaigns.

The main features of the system simulation environment are: automated closed-loop system design optimization; the trajectory optimization method and the analysis tool for calculating the capacities of the servo-hydraulic actuator, and the oil supply system. The closed-loop system design-optimization tool automatically calculates conservative controller parameter settings for a ready-to-start control and monitoring system configuration. Safe operation of complex or large-scale closed-loop mechanical systems at maximum tracking speed requires an optimized-command signal profile. The trajectory-optimization tool automatically calculates the minimum-time command signals and generates such profiles on the basis of a set-point file, such as a loading program, and takes into account all the given technical constraints. For higher-frequency control-engineering applications, standard RPC is applied instead of the trajectory-optimization method. ∎

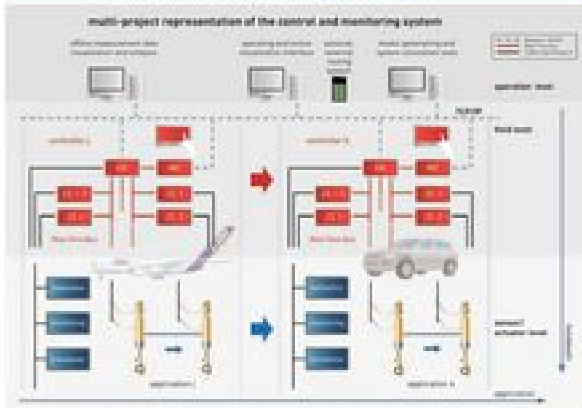
Dr Maximilian Schlemmer, was a control and measurement-technology engineer at IABG, with special responsibility for the development of simulation and control techniques for fatigue testing of the Airbus A340-600 and the Airbus A380

CONTROLLER SOLUTION

A Novel Multi-Purpose Controller and Automated Model Generation and Design-Optimization Tool for High-Performance Control of Mechanical Systems with Servo-Hydraulic Actuators

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 structure fatigue testing right up to higher-frequency control-engineering applications such as vibration tests, automotive road tracking profiles and structural component testing.



Features of our product

- The control- and monitoring system is designed for efficient multi-project applications administration
- Modularly extendable up to 200 controller channels and up to 300 configurable monitoring channels
- High automation level of our control and monitoring system by a close connection to the model generation and system simulation
- Fast setup by easy-to-use system simulation tools: trajectory generation of optimal command signal or by RPC, automatic closed-loop system design-optimization
- Easy-to-use model generation environment for FEM and optimization-based system identification, high-frequency response identification by plant excitements
- High performance by proven model-based control engineering methods and easy-to-tune feedback controller.
- Minimum cabling effort in field by use of Real-Time Ethernet
- our company offers an 'open solution', which allows customers to purchase all the hardware directly from our hardware manufacturer through a worldwide supplier and support network.
- our control and monitoring systems available at prices far below the market prices of our competitors.

FOTO: MARTIN SPURNY, SEAN GLADWELL, KEITH NAYLOR, FOTOLIA.COM

CONTROLLER SOLUTION

Controllersolution GmbH
email: info@controllersolution.de | web: www.controllersolution.com

Pump up the fuel

One of the most experienced companies specializing in ground-support and test equipment (AGE/GSE) for the aviation and space industries is Test-Fuchs.

Soon, the company will complete one of the largest fuel projects seen in the aviation marketplace for many years. This is the exciting EADS test stand that provides a total fleet solution for fuel pumps and components.

EADS required a test stand for testing about 50 different fuel components, such as electrically driven fuel pumps, driven fuel pumps and control units, fuel valves with or without actuators. The development has also been carried out in accordance with the new explosion protection directive (ATEX).

Two years from formal design agreement, including the manufacturing and testing times, Test-Fuchs has accomplished the task of building one test bench for all the required components. To provide a single solution, it was essential to separate the test bench into three stations.

Station 1 is a pump-test station. Here it is possible to test fuel pumps with a maximum of 750 liters-per-minute (lpm) and a maximum rotating speed of 15,000rpm. Two major components from the Tornado aircraft can be tested on this station.

Station 2 is a swivelling tank. All components that are directly mounted in a fuel tank such as fuel pumps, flow divider or refueling valves can be tested under fuel level. From the Tornado and Eurofighter 10 separate components can be tested on this station.

Station 3, the largest station, is the universal test chamber, where the rest of the components from the Tornado, Eurofighter and also from the Phantom can be tested. Supply outlets are for low pressure (max 8 bar/1,000 lpm), medium pressure (max 50 bar/120 lpm), high pressure (max 120 bar/50 lpm) and static high pressure (max 250 bar). Measuring circuits from 0.16 lpm up to 1,200 lpm are also available on this station.

Every station has integrated pressure, temperature, flow sensors and also free connectable pressure and measurement sensors for a more precise measure point. All three stations have the same fuel supply module, that is located one level below the testing stations, to prevent a high noise level. Additionally all doors have sound isolation.

The large number of different components requires rapid adaptation of the test rig to reduce the set-up time and the testing costs. Therefore major design criteria were the optimization of the handling process and the minimisation of the use of hand tools. This task has been achieved by using quick-clamp adaptors. Apart from the time saving quick-clamp adaptors, the test rig offers ample work space and excellent access for maintenance.

The test stand is designed in compliance with ergonomic requirements for easy use of operation. The operation is carried out by an industrial-standard PC on a color monitor with fuel resistant mouse and keyboard, mounted on a moveable tray to enable quick changes from one station to another.

The TFSW2000 software used for operation and control of the test bench is an in-house development from Test-Fuchs. The software guides the operator through all necessary steps of an entire functional check of the desired component. This starts with selection of the test sequence, a combination of list and pictures with several views of the correct assembling of the desired component to the test bench. The operator can choose between different modes of the software (complete run/step-by-step/manual).

This test bench is fully equipped with an integrated self-test process and the system assists the operator in confirming the serviceability of the test station.

The modular design concept enables the fuel test systems to be combined with other applications such as pneumatics

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Ready for the chase

Digital high-speed cameras are replacing their analog predecessors not only in applications such as car safety testing or scientific research, but also in many kinds of airborne applications. The advantages, such as immediate playback, easy image data management and advanced functionality, are obvious.

Fixed-positioned digital high-speed cameras are widely used nowadays to record test sequences like payload dropping and missile liberation. One specific use was, until recently, in the hands of analog film cameras: flight chasing. Cameras like the one pictured use double-edge perforated 16mm film, which has become scarce as major film manufacturers have phased-out, or drastically reduced their range of this type of film product. A replacement of those film cameras has now become a major headache since a digital high-speed camera was simply not available to be used in a cockpit.

AOS Technologies, the Swiss high-speed camera manufacturer known for reliable, compact and simple-to-use cameras, has now launched its X-CHASE camera, the first system to replace film cameras in all test flight chase applications.

Based on the company's modular camera platform, the camera is specifically configured for flight chase applications and comes in form of a 'super 8' hand-held camera system. Weighing less than 2.5kg (4.5 lb), it can be single-handedly operated in tight cockpits. The X-CHASE has a built-in PowerPC to control and manage all operating conditions, so the camera features one single push button to start recording. No 'control PC', 'camera controller' is necessary to operate the camera. There is also no cable of any kind connected in the cockpit, so in case of an emergency exit the camera can simply be dropped and will not interfere with the ejection routine.

A built-in, explosion and spontaneous-ignition proof NiMH-battery offers autonomous operation of three hours in all operating conditions. The X-CHASE camera has 5.2GB image memory, which could be used for one single sequence (about 45 seconds at 800 x 600/250fps) or to be split in a number of sub-sequences, each capable to capture a single event. Once the image memory is fully recorded, the image data gets automatically downloaded to the built-in flash memory card. Once completely downloaded, the camera returns automatically to recording mode, waiting for the exposure button to be pressed.

An 800 x 600 image resolution is very similar to 16mm film format, so existing lenses can be re-used and will provide a similar perspective. However, for high-resolution images the camera offers 1,280 x 1,024 image pixels to capture the finest details.

Frame rates are selectable by the operator and offer typically up to 1,000fps at 800 x 600 pixels or 500fps at 1,280 x 1,024 pixels. Maximum frame rate is 32,000fps.

Camera status is indicated with sunlight-readable LED's at the back of the camera. Since LCD displays are bulky and difficult to read in sunlight, the X-CHASE offers a simple 'sports viewfinder' consisting of a transparent screen and an adjustable bead sight. The screen is collapsible and will fold down in case the camera hits the canopy or the instruments panel during flight maneuvers. Depending on the lenses being used, the field-of-view can easily be marked with self-sticking dots on the screen or a felt-tip marker.

Once the mission is completed, the image data can be played back or securely archived on any Windows-based file server. The camera offers a standard Gigabit Ethernet interface to download the image data from the camera; alternatively, the Flash memory card can be extracted from the camera and inserted to a card reader on a PC.

A flat black finish on camera, handgrip and viewfinder reduces unwanted reflections to a bare minimum.

Finally, like all AOS high-speed cameras, the X-CHASE is more a platform than a final product. Customers can choose not only different viewfinders, and boresights, but also from different image memory and battery capacities, handgrips and finishes. The camera control software can be parameterized so the camera performs application-specific, virtually duplicating the replaced film camera without the need to re-write the testing and operation manuals.

Approvals: The X-CHASE camera system is tested and approved against MIL-STD 461 and 810.

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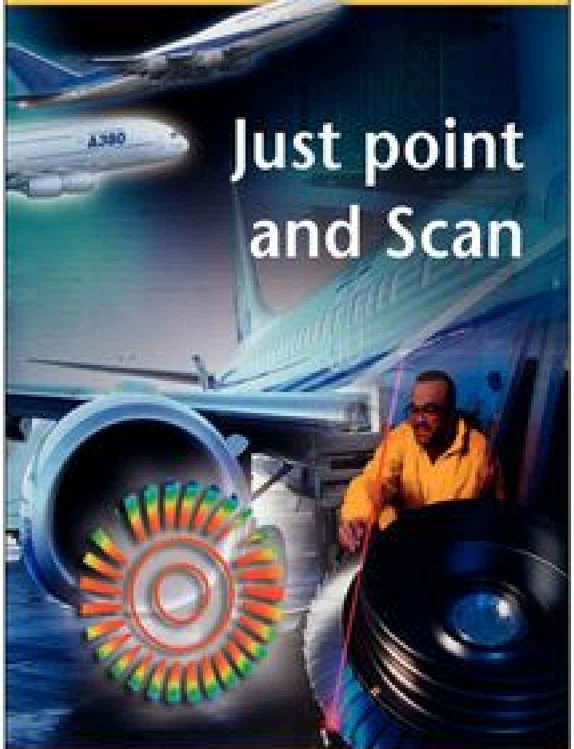
Go to online reader enquiry number 102

Polytec



The PSV-400 family of scanning laser vibrometers: Where light is the Vibration Sensor

If you're doing experimental modal and structural analysis, wouldn't it be nice if you could easily acquire and visualize vibration data without a lot of time-consuming transducer mounting, wiring and signal conditioning? Now you can!

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Taking a stand

A general consolidation process in the European aerospace and defense industries has taken place recently. The aerospace industry has always worked in cycles, and since the commercial opening of the European market, important competitive and innovative systems are now a major priority. The development of new product generations leads to the increase in partnerships and alliances between European companies.

Big players and subcontractors work in a more complicated world with shrinking defense budgets and the current economic situation affecting airlines and space activities. To preserve new growth opportunities, companies must secure operational experience for project management using relevant partners to find the best solutions for price and innovation.

ABC is one those partners for developing innovation and keeping the prices 'right' for development. ABC provides high quality tailor-made test stand solutions for aerospace systems. A test stand is a result of combined engineering, technology and experience for the qualification of a system. For aerospace companies, a test stand is an important tool to validate and to certify the reliability and the quality of their products. Today the company ABC uses a digital-simulation software system to design test-stand solutions.

By analyzing the performance of aerospace systems during the design phase, the company reduces the time for development and the time needed for adjustments to test stands. Mechanics, hydraulics, electronics, thermal, electrics technologies can be integrated and tested. The results of these preliminary analyses improve technical choices and give dedicated solutions for validating future innovative aircraft solutions. ABC provides its expertise to aerospace systems manufacturers through this technology.

Simulation does not give all the answers but gives a better understanding of system behavior before the results are confirmed by later, real tests. These simulated outcomes, on many occasions lead to the adjustment of some parameters of the test stand, or of the system to be tested. Many projects confirm the efficiency of the simulation by the correspondence of the simulated and expected results and the real answers of systems. The goal is to anticipate the reaction of the system and to improve its use.

The simulation described is applied on an ABC project to test bearings on a space application. To qualify a critical mechanical piece which supports propellers, the company needed to ensure the best test bench to guarantee the performances of the bearing – a launcher can only be fired once. For this project ABC provided a complete installation with hydraulic power packs to supply the required power to several servo-actuators that operate at a specific high pressure and frequency. A mechanical structure is provided, designed to accept extreme loads of up to 400 tons, the high frequency and all the test parameters.

Shock absorber test rig with the internal element of a two systems hydraulic cart (below)

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Go to online reader enquiry number 103

Backtracing fuel leaks

A new system for locating leaks in aircraft fuel tanks using diluted hydrogen as the tracer gas has been developed by Swedish company Adixen Sensistor. One problem with an aging aircraft is that capillaries are formed in the sealant creating leak paths where the leak exit point on the outside of the skin may be far from the leak entry point inside the tank. Finding the origin of a leak faster, and being able to forecast the time required for repairs more accurately, are some of the important benefits of this new system.

The Adixen Sensistor solution is a complete leak-locating kit containing everything needed to pinpoint the leak origin and to verify repairs. The method used is backtracing the leaks by injecting a tracer gas from the leak exit point on the skin of the aircraft. This solution is based on a tracer gas consisting of 5% hydrogen in nitrogen, a standard gas which is non-flammable, non-corrosive, non-toxic and environmentally friendly.

On plain surfaces, the gas injection is done by using injection pads. These are applied using durable, kerosene-resistant adhesive that does not damage the surface on which they are applied. On smooth surfaces a typical application spot for the pads is over a visibly leaking joint, screw or rivet.

To be able to connect the gas onto leaks on uneven surfaces, an injection fix kit is recommended. This kit contains adaptable plastic pipes and plugs that can be modeled to fit to any surface. When injecting the tracer gas into the leak, the injection panel ensures the right pressure at the right time. The panel houses a pressure regulator, valve, manometer and reference leak, as well as ports for getting tracer gas in and out.

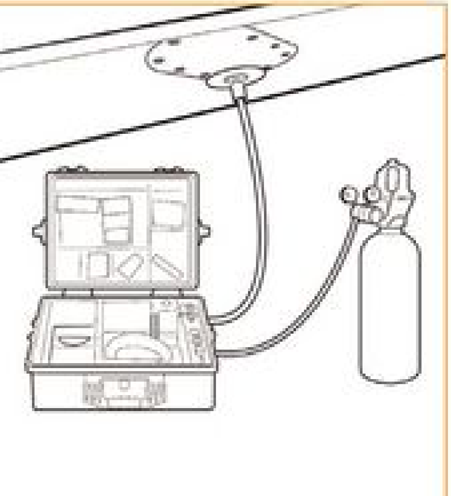
Once the tracer gas has moved from the leak exit point to the origin of the leak, it is easy to detect this position, to enable repair, by using the Hydrogen Leak Detector Extrima. This detector meets the requirements for use in zone 0 according to the ATEX directive as well as CSA, IECEx and NEPSI. Extrima can stand rough handling as well as all standard jet fuels and hydraulic fluids. It is also IP67 water proof.

After a leaking fuel tank has been emptied, ex-certified instruments are the fastest option when leak locating from the inside. There is no need for venting to a non-explosive level. Extrima is easy to use and easy to read, the higher the concentration, the higher the signal.

When the leaks have been repaired, the detector is also used to verify that there are no other leaks and that the repair will stay completely fuel tight. With this method and these tools, leak locating can be done by one person alone and the job can still be done in less than half the time compared to other methods.

Light touch

Hydrogen is actually the lightest element in the universe, and hydrogen gas is the lightest of all gases. Hydrogen molecules move with a much higher velocity than any other molecule and therefore escape through leaks quicker than other gases. Hydrogen gas also dissipates quicker than other gases thereby minimizing the risk of a build-up of background interference during leak testing.



The Complete Injection Kit contains everything needed to perform leak testing on aircraft fuel tanks

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Go to online reader enquiry number 104

Settle the motion

Faced with the boom in the inertial field, whether it be traditional applications in the aeronautics and defense sector or new applications in the automotive or medical sectors, there has been a great need for an innovative new offer on motion systems testing.

Since the 1990s, the automated testing field for electronic equipment and systems has developed an innovative, new offer to meet various objectives: vertical reuse, which is to have a common means for testing cards, equipment, subsystems and systems; and horizontal reuse, which is to have the same identical means throughout the product and system lifecycle (for testing in development, production and maintenance).

To this end, test suppliers have developed a modular offer. With software technologies this is using core time and multitasking, thereby making it possible to meet the needs of system integration benches (SIB), burn-in benches (HALT and HASS), and, of course, production and maintenance benches (ATE). Also, in generating and measuring instrument technologies using rackable modular generic resources, thereby making it possible to scale the test bench to meet the requirements of a card test as well as those of a system test.

All these technological developments can, unfortunately, only be applied to the electronic and software fields. However, systems testing involving motion were not concerned by these technological advances.

Consequently, the company IXMOTION has been developing over the past five years a range of hardware and software products to meet horizontal and vertical reuse objectives for the field of motion, and more particularly, for inertial systems. This product range, known as EVO and PROAXE, is modular and provides technological innovations that meet development, production and maintenance needs.

IXMOTION has developed a software application to control the axes that integrates the 'model-based' simulator's behavioral model into the real-time loop. This technological advantage offers innovative control-command functions, such as auto-adaptive sinus. This patent provides a function to increase the bandwidth in sinusoidal mode from 70Hz to 200Hz with 0dB loss. This standard test is increasingly used to test the limits of sensors and hardware in order to simulate constrained environments.

This patent provides for an auto-tuning function to adjust the system to be tested without having to reconfigure the simulator (no need to alter the machine's balance, or reset the equalizers), while still maintaining optimal performance.

This patent provides for systematic auto-correction, rejecting any perturbations observed in the spot speed and resulting from the simulator's internal components (engine, encoders).

This fault detection function detects any dysfunction of the table with regard to its behavioral model. This represents an additional safety barrier that acts well upstream of traditional detectors, making it possible to guarantee the safety of both equipment and people.

In the feedback loop, the possibility to control motion in real time using an outside command has been integrated, giving a real-time loop. This allows the user to control and receive data in real time from the simulator on the system integration bench.

Calls to simulators can be customized according to client needs; including the hardware abstraction layer, a wide range of communications interfaces are available (IEEE, Ethernet, RS232, RS422, etc); the software layer, any specific protocol can also be easily implanted thanks to the modular nature of our software architecture; and finally, integration of client instruments, when the controller allows for applications and instruments such as climate control and control of optical resources for simulator targets to be integrated into the simulator.

The electronic solution is based on the IXMotion multi-axis real-time controller with varying racks of different strengths. This versatile technical solution enables users to scale their configuration and the strength of their simulator according to their project. Moreover, because of our partnership with a manufacturer of slip rings, we can offer you, either by catalog or à la carte, all sorts and numbers of slip rings – all without having to modify the simulator.

Our mechanical solution is based on a range of simulators with from one to three axes (EVO series), each in a different size and offering different performances, all commanded by the same controller.

IXMOTION simulators are designed for inertial sensors, guidance and navigation systems

CONTACT

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Robotic Shearography NDT

As today's composite aerospace subassemblies become more complex, used NDT systems need to keep up and become more sophisticated. The composite materials have been optimized for weight saving, and the shapes incorporate advanced 3D curvatures. This forces the NDT inspection methods to become contactless in order to achieve high inspection quality and speed.

In 2008, Dantec Dynamics delivered a fully automatic robotic shearography system for 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 production environment, inside a vacuum chamber. It excites the production parts with vacuum and can also 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 being easy to operate and harmonize with a company's written practice standard, in accordance with SNT-TC-1A or corresponding. The robot system can also be equipped with a software integrated sound excitation mode for vibration shearography through a piezo shaker or loudspeaker.

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or go to online enquiry card 106

A350 cabin integration

TechSAT, an industry leader in real-time avionics test and integration systems, has been selected by Airbus Germany to provide the test facilities for the A350 cabin integration and verification. The approach for the test facility takes into account the strategic business process optimization adopted by Airbus for the A350 program. Compared to previous programs like the A380, the focus of integration testing has shifted from testing individual systems to testing complete aircraft functions. This implies a highly integrated test facility capable of testing individual aircraft systems and also complete functions by clustering individual test benches into larger compounds.

The solution is based on TechSAT's established ADS2 system, an integrated generic and scalable hardware/software platform for real-time test and simulation applications, and already used by Airbus Germany for the A380 test facilities. Due to its modular design and its simple yet powerful mechanisms, ADS2 provides the flexibility to be adapted to the new requirements for the A350 test facility. A key element to the new strategy is the ADS2 Cluster Manager, a central supported database, graphical configuration, a control and monitoring environment, which tackles the complexity of configuring multiple system integration benches with several hundred systems under test into an integrated cluster. The technology is optimized for test and integration systems, which need to support flexible switching between simulation and real equipment.

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Efficient vibration qualification

Vibration qualification for environmental testing can be a time-consuming process. Especially in military applications, rapid deployment of new components can be of vital importance. The GlyphWorks Accelerated Testing software from nCode provides a unique toolset for making time-critical judgments on the profile or need of vibration testing and relative systems.

Usage on helicopter applications has proven the system's ability to provide 'read-across' evidence from different aircraft types. For example, if a component has already been certified using a sine-on-random test from MIL-STD-810F for one helicopter, GlyphWorks enables the user to determine whether a testing profile for another helicopter will be less severe from a fatigue damage and shock perspective and therefore avoid costly re-tests. In addition to comparing testing profiles, GlyphWorks also enables measured test data to be compared with the severity of the testing profile, therefore enabling an assessment of whether components in service will be likely to survive the target service life. This known safety margin may help extend the life of aircraft parts in service or conversely avoid unexpected failures.

Another application of the GlyphWorks accelerated testing software is 'test tailoring' to create equivalent tests that can be run more quickly. Instead of lengthy sequential sine sweep and dwell tests, GlyphWorks enables the calculation of equivalent sine-on-random tests in accordance with MIL-STD-810F and RTCA-DO160E standards that can be run a fraction of the time. Real-world component test times have been reduced by over 80%, while maintaining equivalent shock levels and fatigue damage.

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One microphone suits all

Brüel & Kjær is introducing the world's first multi-field microphone Type 4961 – a high quality measuring microphone with uniform response in any sound field. Until now, acoustic engineers have been forced to make a choice between a microphone optimized for either free, diffuse or pressure field. This choice is often made without preceding knowledge of the sound field.

In real life many applications don't represent well-defined conditions. These unknown factors result in a potential risk of measuring errors, which may exceed 10dB at 20kHz. As a result of this, the uncertainty imposed by the microphone alone, may far exceed the system tolerances as specified for instance in IEC 61672.

But now, errors and uncertainty due to the microphone choice will no longer be a problem. The introduction of the multifield microphone will make the choice of microphone very simple. Now one microphone suits all tasks where 20kHz bandwidth is sufficient.

The multifield microphone Type 4961, which basically is a 0.25in measuring microphone with the sensitivity (50 mV/Pa) and noise floor of a 0.5in microphone. The 4961 features an integral DeltaTron preamplifier with SMB socket, and of course, it supports TEDS (Transducer Electronic Data Sheet).

The multifield microphone can be used for all applications where a high-quality measuring microphone with uniform response in any sound field is required.

For further information contact
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Web: www.bksv.com
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Ground vibration and modal survey

The aerospace industry is continuously under pressure to develop lighter components, systems and aircraft in shorter timeframes and at lower cost – without compromising quality and safety. On one hand, engineering teams need to ensure the structural integrity of the critical components. On the other hand, they must reduce testing time while increasing data quality and accuracy.

LMS offers a dedicated, integrated solution and advanced engineering services to help aerospace manufacturers meet tighter testing deadlines. The solution allows customers to: reduce test risk, shorten testing times, increase modal behavior observability and perform near real-time correlation and test quality validation.

LMS can offer a unique approach combining simulation and physical testing to accelerate and optimize the complete testing cycle – from test preparation and modal testing to analysis, numerical model correlation and model updating. LMS references include AgustaWestland, BAE Systems, Cessna, CIRA, CSA, DLR, EADS CASA Military Transport Aircraft Division, EADS Space Transportation, Lockheed Martin, National Aerospace Laboratory, NASA, Raytheon, RKK Energia, Saab Aircraft, Sikorsky, Tsagi and Tupolev.

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Compact signal conditioning module

Imagine a Compact PCI/PXI bridge signal-conditioning module with onboard analog to digital converters. KineticSystems' new CP246 module incorporates eight signal-conditioning channels and eight independent 16-bit ADCs as well as 16 multifunction digital I/O channels. The CP246 eliminates the need for complex field wiring, reduces noise, and increases data accuracy.

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 also minimized.

KineticSystems' goal is to provide users with powerful, flexible, and cost-effective data acquisition solutions such as that of the CP246 with combined bridge signal conditioning and ADC functionality in a single module, simplifying the user experience while directly reducing the total system cost. Applications include rocket motor testing, structural testing, wind tunnel testing, fatigue testing, RTD temperature measurements, vibration and torque measurements, compression and tension measurements, weigh scales, automotive test cells, industrial monitoring and control, automated test equipment and general-purpose digital control or monitoring.

For further information
regarding the CP246 cPCI/PXI ADC module from KineticSystems refer to the company's website:
http://www.kscorp.com/Products/pxi/analog_digital/CP246/index.htm
or go to online enquiry card 111

Chamber made

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, & JAA, DEF 5941, FAA AC20-136, EUROCEA/ED-14E, and SAE ARP5412/5416.

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Ruggedized Ethernet switch

In recent years there has been a shift from proprietary and closed solutions for FTI networks toward more open systems using Ethernet technology ACRA CONTROL has been developing airborne Ethernet technologies for many years and is now introducing the NET/SWI/001. This is a 100Mbps, PTP enabled ethernet switch designed for operating in harsh environments (-55°C (-67°F) to 105°C (221°F)). With this ruggedness, Ethernet switches can be located on or near aircraft engines and in wings, which has major implications for simplifying and reducing the FTI wiring requirements and opens up more flexible system architectures, further reducing the complexity of a distributed installation.

The NET/SWI/001 has a store-and-forward switching architecture, a negligible start up delay with ports to connect up to eight full-duplex Ethernet end nodes. The NET/SWI/001 transparently supports PTP, providing synchronization accuracy even under heavy network traffic conditions. When these factors are combined, the result is a switch that enables a robust distributed system with reduced design and wiring requirements, high bandwidth and near zero 'boot-up' delays – all with the flexibility Ethernet provides.

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High temperature and MEMS accelerometers

PCB Piezotronics is pleased to showcase the Health and Usage Monitoring Systems (HUMS), high temperature and MEMS accelerometers at Aerospace Testing Expo.

HUMS are gaining wide acceptance as an effective predictive maintenance strategy in helicopters and some fixed wing aircraft. Due to the large number of critical flight safety systems on aircraft, vibration monitoring technology is effective in detecting and thus preventing catastrophic mechanical failures. High temperature accelerometers are ideal for applications with temperatures up to 650°C (1,200°F), such as engine and exhaust testing. The charge output type accelerometers are hermetically sealed, electrically-isolated with Inconel housings.

MEMS Accelerometers are best suited for very low frequency acceleration (vibration) measurements and are typically used for flutter and load factor testing. The PCB family of MEMS sensors is robust, lightweight, and offers excellent performance characteristics.

Advanced design capabilities permit PCB to customize solutions specific to your requirements. Please inquire to learn which solution is right for your application. Visit us in Booth C105 at Aerospace Testing Expo on April 21-23.

For further information contact
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or go to online enquiry card 114

Supporting industry transition

All aerospace manufacturers must now comply with AS/EN/JISQ 9100 Rev. C, which is being released by the IAQG early in 2009. The scope of 9100 has expanded further to include aviation, space and defense and there will be greater emphasis on product and process improvement (such as risk management and customer satisfaction).

A poll carried out in January 2009 indicated that nearly two-thirds of aerospace industry respondents were not confident that they understood the changes to AS/EN/JISQ 9100. eQuaLearn has developed a detailed review of the changes in the revision AS/EN/JISQ 9100 and how to apply these new requirements with your company.

In 2008, eQuaLearn trained over 2,000 students in 12 countries and in seven languages on quality-related topics such as root cause corrective action, internal auditing, introduction to pyrometry and problem solving tools.

eQuaLearn is part of PRI's Customer Solutions and Support, which aims to identify and meet customer demand in all areas of business relating to quality.

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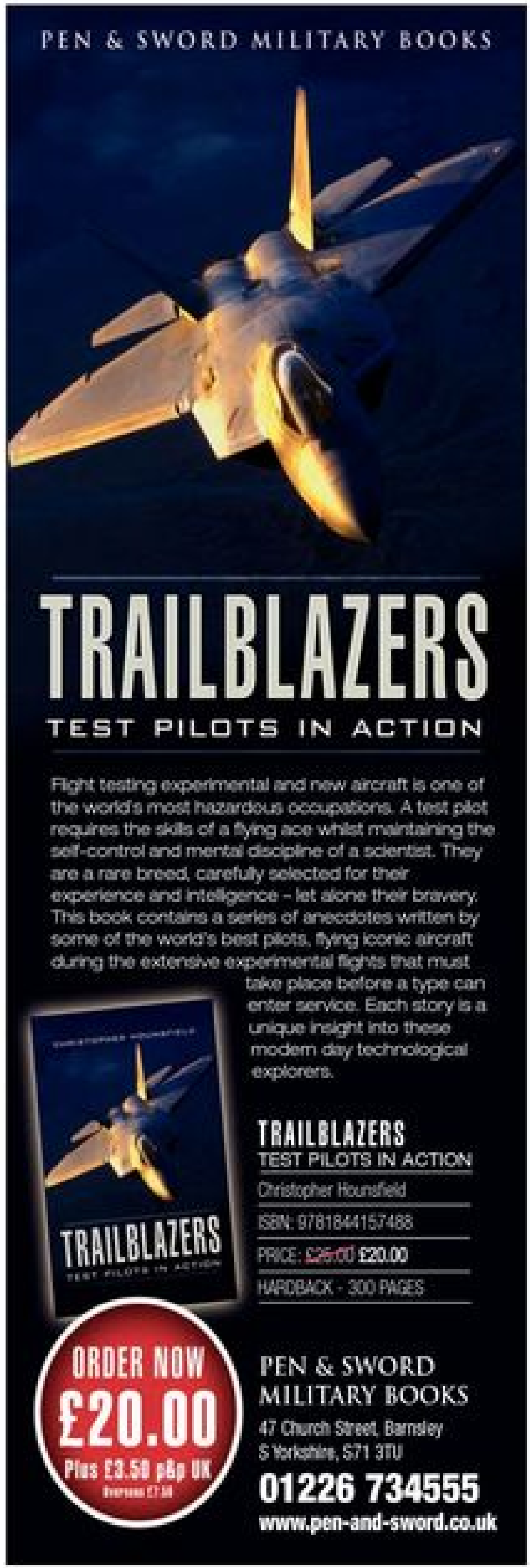
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FRENCH COMPANY SURVEY COPTER SPECIALIZES IN DESIGNING, DEVELOPING, AND PRODUCING REMOTE-CONTROLLED SYSTEMS OPERATING IN THE HOSTILE ENVIRONMENTS OF THE SEA, LAND, AND IN THE AIR

BY DAVID OLIVER

Based at a small airfield in France's Drôme region, 25km north of Orange, Survey Copter has carved out an impressive niche in the mini-UAV market. Along with its Swiss subsidiary weControl AG, the company produces airframes, powerplants, control systems, and sensor systems as well as data transmission and target-tracking devices. It also produces a range of rotary-wing and fixed-wing mini-UAVs and unmanned tethered or free-flight blimps.

Established in 1996, Survey Copter was revitalized in 2005 when it was taken over by Pierre Tantot, who had a background in developing gyro-stabilized cameras for television and underwater applications. Within two years, Tantot moved the company to a custom-built facility at Pierrelatte Aerodrome and increased the workforce from four to 20.

The company currently produces two rotary-wing mini-UAVs powered by 26cc single-cylinder two-stroke petrol engines capable of carrying 5-10kg payloads. The single-engine

Control Column

Copter 1, first flown in prototype form in 1997, has been replaced by the Copter 1B with improved altitude, range, and endurance performance. The twin-engine Copter 4 has a payload of 10kg, a flight endurance of 60 minutes, and a range of 8km.

Both airframes have a pod and boom configuration, are 2m in length, and have two-blade main and tail rotors and a skid landing gear. Their payloads can include CCD, zoom, IR or thermal imaging cameras, and pollution, temperature, radioactivity or mine detection sensors. The real-time video downlink is via an HF transmitter.

Some 70 Copters have been sold for civil and military applications in six countries. These include aerial photography and filming, agricultural and maritime survey, paramilitary surveillance, border patrol, public safety missions and military detection, reconnaissance, identification, and targeting. Guidance and control is fully autonomous with waypoint navigation, tracking by GPS with moving map display, and the two-way datalink provides information on speed, altitude, position, engine temperature, and rotor speed. The Copter's cruising speed is 40km/h with a ceiling of 1,500m.

> **"The Tracker is a hand-launched UAV of composite construction with a 3m wingspan and a 1.8kg payload capacity"**

In 2003, the giant French aerospace company EADS announced that it was to launch two rotary-wing mini-UAVs, the Scorpio 6 and Scorpio 30, based on the Copter air vehicle systems produced by Survey Copter. More than 50 have been sold to date for sea and coastal monitoring, border control, law enforcement, communications relay, and NBC sampling. The Scorpio has also been evaluated by the UK Joint UAV Experimentation Team and also the French Commandant des Opérations Spéciales.

Survey Copter, in cooperation with EADS, has also developed and is manufacturing a fixed-wing close-range surveillance mini-UAV, the Tracker, to fulfill the French Army's Drone de Reconnaissance Au Contact (DRAC) requirement. In 2005, the French MoD procurement agency (DGA) awarded EADS a contract for 25 DRAC systems, two air vehicles and a ground control unit per system, with deliveries beginning in December 2006 and have subsequently followed up with a second tranche of 35 systems ordered in July 2008 to be delivered in 2009. The French Army has a requirement for a total of 160 DRAC systems.

The image intelligence section of the intelligence brigade unit from the French 1st Marine Artillery Regiment undertook trials of 10 DRACs during an operational detachment in Kosovo, from July to September 2008, in the Multinational Task Force-North (MNTF-N). This was prior to the recent announcement that the French contingent serving with NATO's International Security Assistance Force (ISAF) in Afghanistan, would be equipped with the DRAC within the next few months.

Ten DRAC were used by an operational detachment in the Multinational Task Force in Kosovo, from July 2008

The Tracker is a hand-launched UAV of composite construction with a 3m wingspan and a 1.8kg payload capacity. Powered by two electric motors driving two-blade folding propellers, the Tracker has a cruising speed of 50km/h at a typical operating altitude of 300m, a two-hour endurance and a datalink range of 10km. The entire system can be carried in a backpack and operated by a crew of two.

Survey Copter is marketing a smaller single-engine version designated the DVF-2000 CARD. Both these fixed-wing UAVs have fully autonomous weControl GPS-based flight guidance and navigation systems, using laptop computers. Their mission payloads range from gyro-stabilized two or three-axis daylight, low-light or infrared turreted cameras (designed by Survey Copter) to laser designation and telemetry systems.

Survey Copter's range of innovative turrets are mechanical devices used as a support platform or to house a sensor payload with aiming, stabilization and data transmission functions. They can be integrated to any moving vehicle, a car, helicopter, aircraft, Blimp, boat or mini-UAV. The weControl range of wePilot family of integrated flight control systems are used by several other rotary-wing mini-UAV manufacturers worldwide.

In its range of systems that transfer data by an high frequency link, including video images, GPS positioning, flight plans, etc, Survey Copter uses various types of transmission systems that can be adapted to any requirements in terms of data type, bandwidth, dimensions and weight, and include a complete range of short-, medium- and long-range analog, digital OFDM or COFDM links and their specific antenna.

"Survey Copter is unusual in designing and manufacturing all the products in its various product ranges"

New products under development at Pierrelatte include several motorized unmanned Blimps that can be used for aerial photography and filming, long-duration day and night surveillance, and as radio relays. A larger version of the Copter 4 called the Helextro is powered by three electric motors and is currently undergoing flight trials.

Whether mass-produced or one-offs manufactured to customer specification, Survey Copter is unusual in designing and manufacturing all the products in its various product ranges. The company provides a complete follow-up service, supplying spare parts and performing the operational maintenance work defined in the user manuals, and scheduled maintenance as per the flight log for the UAVs.

Survey Copter provides the complete package in terms of supply and training, giving initial customer training in the use of the equipment, and refresher training or retraining in the event of products changing. Typically, the training for DVF-2000 operators is one week, comprising two days of software training, one day of flight training, and two days of support/maintenance training. On completion, participants are certified to operate the company's UAV systems. ∎

The first passenger jet

BY FRANK MILLARD

Ronald Eric Bishop (1903-1989) joined De Havilland in the UK in 1921 when he was 18 years old and worked his way through the metal, fitting, and engine workshops before entering the drawing office in 1923. The first aircraft-design project for which he was in full charge (from 1936) was the Flamingo twin-engine civil airliner, an all-metal airplane that was developed to compete with the US and German airliners of the period. He later headed up the design of the first commercial jet airliner, the De Havilland Comet.

The Comet featured four upgraded (slimmed-down) Ghost turbojet engines, designed by Frank Halford, each of which delivered 5,000 lb of thrust. Bishop had headed up the design of the incredible wooden Mosquito fighter-bomber during World War II and its successor the DH 100 Vampire. The third member of the team that built, tested, and flew the Mosquito, Vampire, and Comet was the aerodynamicist Richard Clarkson. The Ghost grew out of Halford's Goblin engine design, which had featured in the Gloster Meteor and the UK's other early jet aircraft. Rolls-Royce Avon engines, however, eventually replaced the Comet's Ghost. The aircraft fuselage was of all-metal construction and included a fully pressurized internal environment. The wings were swept back 20° (using German design technology revealed after the liberation of Europe), with the two pairs of engines bunched on either side of the fuselage.

The original Comet (1A), which first took to the skies on July 27, 1949, was the result of years of research as well as the concern of the British Government (Brabazon Committee proposals, 1943), while World War II was still raging, that the UK was in danger of lagging behind the USA in commercial aircraft design and sales in a post-war market unless work was started on new designs. As a result, in 1944 a jet-powered airliner was envisaged that promised to put clear blue sky between the British aircraft industry and its foreign competitors. Aerodynamicist and test engineer Tony Fairbrother, who was present on the flight deck of the prototype in 1949, later commented with a sense of history, "The world changed as our wheels left the ground." The chief test pilot on the Comet was wartime night-fighter ace Group Captain John (Cat's Eyes) Cunningham, OBE, DSO (two bars), DFC (and bar).

BOAC De Havilland Comet 1 G-ALYP leaving Heathrow for Johannesburg on the world's first jet service May 2, 1952

The Comet eventually went into commercial service early in 1952 and in May took off on the world's first all-jet flight with fare-paying passengers, from London to South Africa with BOAC (British Overseas Aircraft Corporation). From the very first year of commercial service, however, there were crashes involving Comets. Although initially put down to pilot error and adverse weather conditions, the frequency and severity of the crashes increased and something more structural began to be suspected.

In 1954, the aircraft was grounded and its airworthiness certificate revoked. After extensive testing it was decided that metal fatigue was responsible after cracks were seen to appear in the corners of the square passenger windows. Although the Comet 4 was introduced in 1958 with the first transatlantic jet airliner service, once all structural problems had been overcome and round windows had replaced the square ones, the faster and cheaper Boeing 707 and Douglas DC-8 had filled the gap that the Comet left in the market in the intervening period. The British aircraft was never to fully recover its early promise. ∎

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