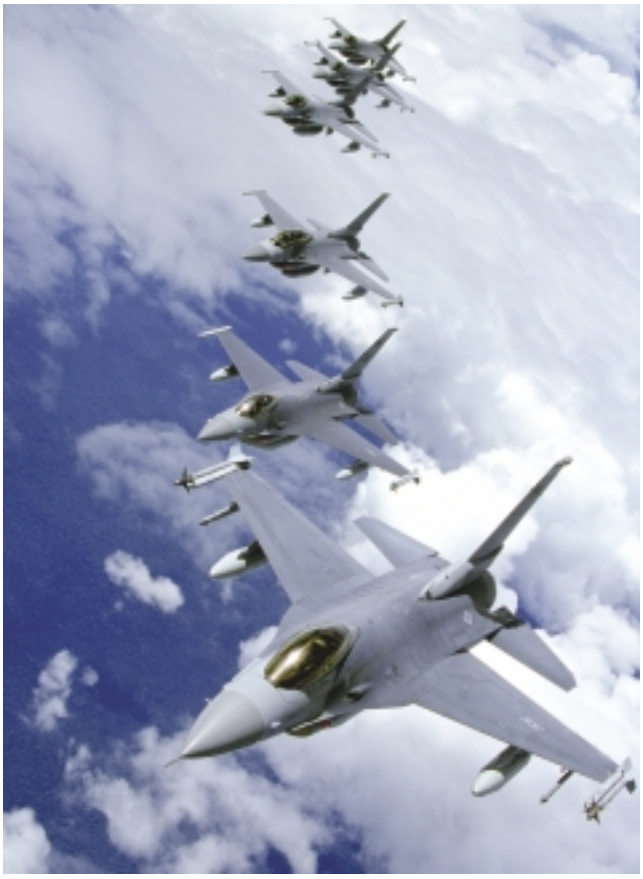
Technology update

Next phase of F-16

The first Phase IA version of **Lockheed Martin**'s F-16 has completed its Common Configuration Implementation Program (CCIP) and been delivered to Nellis Air Force Base for follow-on operational test and evaluation. **Lockheed Martin Aeronautics** Co. is providing the modification kits and field support for the CCIP effort at the **U.S. Air Force** (USAF) Ogden Air Logistics Center in Utah, the prime depot for the F-16. The F-16 CCIP provides a common, robust upgrade to the USAF fleet of approximately 650 Block 40/42/50/52 F-16s. Development efforts began in 1998.

The program is being completed in phases, with Phase I deliveries beginning in January of last year. That phase included a color multifunctional display set and the modular mission computer.



Mountain Home Air Force Base in Idaho will be the first operational squadron to convert its F-16 fleet to Phase IA configurations.

The Phase IA configuration incorporates the APX-113 air-to-air interrogator, which provides the F-16 pilot with increased situational awareness and the ability to autonomously identify targets. This feature provides the beyond-visual-range intercept capability using the AIM-120 advanced medium-range air-to-air missile. The configuration also includes two new electronics units for diplays and data entry, which use commercial components that provide increased throughput, reliability, and supportability, according to Lockheed Martin.

A corresponding software change allows the aircraft to operate either the high-speed anti-radiation missile targeting system pod or a FLIR targeting pod—including the new Sniper XR advanced targeting pod—from the right inlet chin station. The latter is new to the Block 50/52 aircraft and provides a capability to destroy ground targets using laser-guided bombs. A software upgrade made two years ago enabled the use of employing GPS-guided weapons.

Phase II will be fielded this July and will also incorporate the NATO-standard Link 16 data link, the Joint Helmet-Mounted Cueing System, and an electronic horizontal situation monitor. The Phase I/IA Block 50/52 aircraft will go back to Ogden to receive the additional changes. Phase III of the program involves the Block 40/42 aircraft, which will receive the entire modification all at one time, beginning in 2005.

Jean L. Broge

Training for Eurofighter

A five year project to allow the Luftwaffe to independently maintain and operate its Eurofighter aircraft is now getting under way. Training specialist **Objektum** has been appointed by **EADS** (European Aeronautic Defense and Space Co.) to provide a series of intensive training courses and workshops. Training is to focus both on subsystems and the engineering skills needed to develop the aircraft's software, including CORE, HOOD, and Ada. The Luftwaffe will use a National Support Center for the aircraft, where the first crews of Eurofighter system engineers are being trained.

Stuart Birch

PEEKing at seats

Seats in aircraft manufactured by companies such as **Airbus**, **Eurocopter**, and **Mirage** are complex assemblies that must be comfortable to passengers and crew while providing long-term functional safety and passenger safety.

"An aircraft seat consists of numerous components that have traditionally been made from a magnesium alloy," said Kevin Jennings, General Manager for **Victrex North America**. "However, crash tests have revealed that this material does not consistently ensure optimum elasticity. The lumbar support adjuster, for example, can show a permanent deflection after an impact without springing back as required." Victrex is the sole manufacturer and supplier of PEEK, its trademarked name for polyaryletherketone.

Feronyl is a Belgium-based manufacturer of seats for both commercial and military aircraft. The company chose to replace a magnesium alloy in a variety of seat components primarily because the PEEK polymer allows for enhanced "mechanical strength and low flammability/low-toxicity requirements in fire situations while delivering lower part weights than metal," said Jennings.

For long-term strength as well as creep and fatigue resistance, Feronyl chose a carbon-fiber-reinforced PEEK polymer to mold both the lumbar support adjustor and the headrest. Because neither the headrest holder nor the seatbelt guides require the same high level of mechanical strength and stiffness, Feronyl opted for a glass-reinforced grade of the polymer.

Victrex claims its PEEK polyaryletherketone polymer is an inherently pure material, which results in low smoke and toxic gas emissions in fire situation.

The PEEK polymer has a UL-94 V-O flammability rating to satisfy the industry's fire, smoke, and toxicity requirements for crash performance standards.

Jean L. Broge

CompAir compresses manufacturing costs

Aerospace engineering is an industry sharply focused on advanced technology and its applications, but sometimes traditional manufacturing systems are overlooked in terms of enhancing production and operating efficiency. Compressed air systems are used extensively in the industry, but according to international supplier, **CompAir**, that use can be highly inefficient.

In almost any compressed air installation in use across the aerospace industry, annual energy cost savings of up to 30% can be achieved. The company claims that traditional single-speed compressors operate at their optimum efficiency when delivering 100% capacity. But typical compressors in the 50- to 150-kW range operate at an average of only 50 to 70% of full capacity load for 4000 h a year. CompAir estimates that for a typical oil lubricated rotary screw compressor operating at 70% load, energy use accounts for 82% of the cost of ownership.

Ironically, one of the contributory reasons for this expense is the robustness and resultant longevity of the reliably functioning 20 years or more. However, during that time, the efficiency of screw compressors has improved "by an average 1% per annum," according to CompAir, while energy costs have risen markedly in that period. When not working at full capacity load, the conventional method of controlling output is to load and unload between upper and lower pressure set points. That is, the motor stops when the upper limit is reached and starts again when it falls to the lower level, which is inefficient for compressors fitted with a standard induction motor.

An alternative is to offload the compressor, which can involve opening the outlet of the compressor while continuing to turn the drive motor. However, a conventional single-speed compressor will still use between 25 and 40% of full load power even if it is producing no compressed air at all. The problem is to effectively regulate output to minimize energy wastage but still match fluctuating output demand, according to CompAir.

Although compressor technology industry in general as an advancing science, significant advances have been made, notably a speed-regulated drive that can regulate air output "to exactly match the system requirements, which means that the energy consumed is only that directly needed to produce precise air needs," says CompAir. It claims that in almost any compressed air installation annual energy cost savings of up to 30% can be achieved. Compressor configuration, individual compressor control modes, the number of compressors used to meet demand, overall system control, and downstream air treatment including the use of dryers and filters may also contribute to cost savings. The cost savings can be assessed by intelligent data logging that typically records the system's performance over a week, running in normal working conditions, and then extrapolating that data over a year. The representation of annual power usage this data capture provides enables a more efficient compressor configuration to be modeled against real demands, according to CompAir.

Stuart Birch

Dunlop intakes no ice

The NH90 is a twin-engine, 10-t helicopter that will be produced in two versions, TTH (Tactical Transport Helicopter) for land-based use and the NFH (NATO Frigate Helicopter). The TTH was primarily conceived as a tactical transport for up to 20 personnel, more than 2500 kg of cargo, heliborne operations, and SAR. The NFH was designed principally for autonomous anti-submarine warfare and anti-surface unit operations.

The NH90 program has been designed and developed by **NH Industries**, formed in 1992 by **Augusta** (Italy), **Eurocopter** (France), Eurocopter Deutschland (Germany), and **Fokker** (The Netherlands). Construction work is shared between the partner companies, and together they chose **Dunlop Aerospace** Ice Protection and Composites (DAIPC) for the design, development, and production of anti-iced engine air intakes for the NH90 helicopters. The first development units of the intakes will be ready for flight testing before the end of this year, and serial production will begin next year.

NH90 helicopters from NH Industries will be fitted with anti-iced engine intakes designed and manufactured by Dunlop Aerospace Ice Protection and Composites.

A shipset of the DAIPC equipment consists of two engine intakes, each formed from two high-integrity composite moldings with integral foil heaters. The design incorporates glass reinforcement for electrical insulation and carbon fiber for lightness, strength, and fire protection.

NH expects to build more than 1000 NH90 aircraft with over three hundred firm orders and many options already sold for Germany, France, Italy, the Netherlands, Portugal, Finland, Sweden, and Norway. The NH90 is offered with the choice of either a **Rolls-Royce/Turbomeca** RTM 322-01/9 and the **General Electric** GE T700-T6E powerplant.

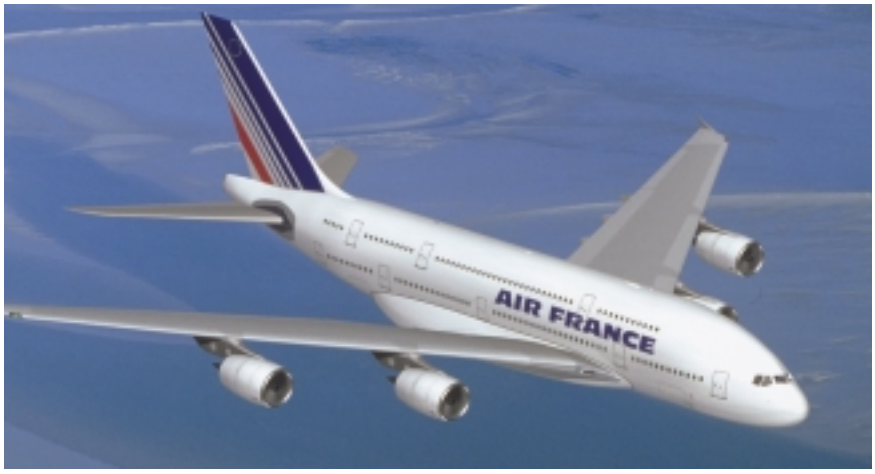
Jean L. Broge

A380 gets Michelin NZG technology

Michelin's NZG (Near Zero Growth) radial tire design fitted to the Concorde (See "Top Technologies for 2002" in *Aerospace Engineering*, December 2002) for its return to service after being withdrawn following the Paris crash of an aircraft operated by **Air France**, will be used for the 555-seat **Airbus** A380. Making the announcement, Michelin said that the tire is suitable for all current and future wide-bodied airliners and is also scheduled for the Airbus A340-600.

It is three years since Michelin started tire development using a "new high modulus reinforcement material" that offered higher damage resistance together with what the company terms "substantial" weight gains. Until now, the only way to reinforce the tires used on heavy aircraft was to increase thickness. However, this increases tire weight and heightens problems of friction and overheating, thereby wiping out the advantages of the "standard" radial tire. According to Michelin, limiting carcass growth when the tire is inflated (less than 3% compared to 6% or more for a radial tire), the tread rubber works under less tension and is much less vulnerable to shocks and damage. As the structure is more abrasion resistant, the tire has a longer service life. The NZG radial halves the number of layers in the tire, thereby reducing weight by 20% compared to a Michelin bias-ply tire.

It was in 1981 that Michelin introduced a new radial tire design to a market that, it says, was dominated by bias-ply technology. The new radial offered enhanced grip, added comfort due to lower inflation pressures, and had lower rolling resistance. It also saved weight. Pioneered by Michelin, radial tire technology was introduced initially to the auto industry in 1946, and its "X" range was used on a wide variety of cars from the two-cylinder **Citroën** 2CV to high-performance models. In 1981, the Michelin Air X was initially fitted to the French Mirage III fighter and subsequently to 100-plus seat airliners, and to freighters. The belted crown of the tire is designed to spread loads evenly while reducing wear. The current version of the Air X is fitted as original equipment to all versions of the Airbus, and it equips the most recent **Boeing** airliners, plus fighters including the F-15E, Mirage 2000, Rafale, Eurofighter, and F-22. There are 45 different sizes, the smallest has a mass of 4 kg, the largest—for the Airbus A340—125 kg.



Michelin announced that Airbus will be using its Near Zero Growth radial tires—first approved for use on the Concorde—on its new A380.

Bias-ply tires are still widely used, notably on commercial aircraft with less than 100 seats and on large, earlier generation aircraft. Michelin has updated bias technology and some 63% of Michelin's aircraft tire production is of bias technology, including those used for the **NASA** Space Shuttle. With the company's Orion technology, the tire crown is reinforced in the zone where it comes into contact with the ground, increasing tire strength, ensuring more even wear, and "substantially" prolonging tire service life.

Michelin has detailed some of the extreme loads that aircraft tires need to absorb when fitted to types ranging from fighters to very large airliners, to the unique Concorde. These include an ability to withstand loads up to 266 times the tire's own mass: The tire of an Airbus A320, which has a mass of 75 kg, bears a weight of almost 18 t. These extreme loads cause significant deformation, 32-35% deflection, compared to 20% for a car tire. Temperature variation can also be extreme. During let-down and landing, tire temperature may rise from -50 to +100°C with as much as 150°C at its crown. Aircraft tires are also subject to extreme acceleration including zero to 360 km/h during the take-off run in less than one minute and acceleration from zero to 250 km/h in one second on touch-down.

Stuart Birch

Materials for safety from Amann

A new range of "extreme" category technical sewing threads for aerospace applications has been launched by **Donisthorpe** & Co. and its international parent, **Amann & Soehne** GmbH. They are for use in space vehicle applications, fire resistant upholstery and lap belts, parachutes and hot air balloons. Called tech$_x$ and developed in Germany and France, the range comprises "a number" of technical threads each designed to meet the specific functional and safety requirements of seams.

"The new range is the result of many years' research, development, and cooperation between Amann, research institutes, and our customers," said Axel Pyper, Product Manager at Amann. "The threads are technical components specifically designed to add to the performance characteristics of safety-critical products. Lives literally depend on their performance."

At what the company describes as an "extreme end" of the tech$_x$ range are C-tech 80 and K^c-tech 11 and 22 threads, which can be used in composite-based applications within the Space Shuttle body and wing structures to help absorb and disperse "extreme heat and noise" generated on reentry into the Earth's atmosphere. C-tech 80 is described as a conductive thread produced from continuous filament polyester and a fine carbon fiber yarn. K^c-tech 11 and 22 are constructed of heat-resistant, para-aramid continuous filament fibers. "These threads can be used to sew together different layers of composite materials before they are soaked with resin, to produce a lightweight, almost seamless barrier," said Pyper.

Amann is cooperating with research institutes and with sewing machine specialists to develop a further range of tech$_x$ threads based on carbon, PEEK (polytheretherceton), or para-aramid fibers specifically to meet the sewing performance requirements of composite materials. However, a more general application of tech$_x$ involves aircraft upholstery using N-tech 40 and N^c-tech 40. These threads are produced from meta-aramid fibers and can retain their tensile strength even after prolonged exposure to temperatures up to 200°C and will char and decompose—but not melt—after exposure to temperatures of more than 370°C. "N-tech 40 is constructed of long fiber-spun, meta-aramid fibers, producing threads with a traditional textile form," said Pyper, adding that they "look good," have enhance sewing characteristics, and offer improved heat resistance.

N^c-tech 40 is described as a non-melting, self-extinguishing thread produced from continuous filament meta-aramid fibers, suitable for upholstery seams. Both N-tech 40 and its finer versions, N-tech 70, are suitable for producing heat-resistant Space Shuttle suits, said Pyper. For safety-relevant, high-stress aircraft upholstery, Amann has developed Strongfil 40, which uses tear and abrasion resistant polyamide 6.6 continuous-filament fibers. Polyester continuous filaments are used for Serafil lap belt threads, providing very-high breaking strength (and high thermal-breaking resistance) and abrasion resistance.

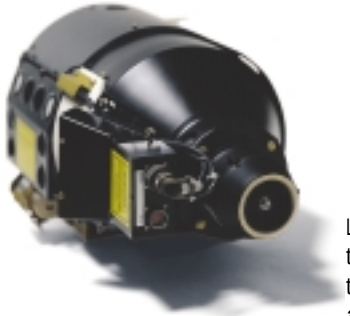
Ultraviolet, weather, and pollution resistant Tenara M 1000 sewing thread is used by Amann. It was pioneered by the company's brand development partner **W.L. Gore & Associates**, for use on **NASA** spacesuits. It is constructed of high-strength, abrasion-resistant 100% ePTFE (expanded polytetraflourthylene). According to Amann, it was important to ensure that long-term exposure to the elements and frequent handling, including folding and packing, would not reduce seam quality.

Stuart Birch

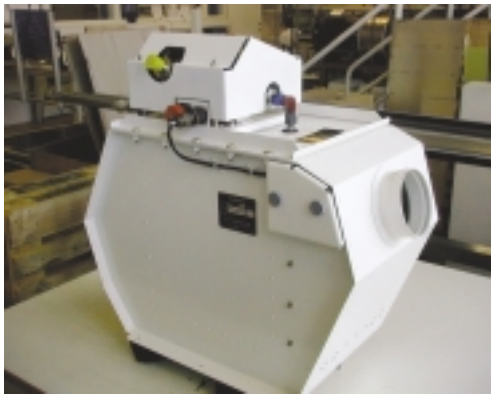
CTT finds safety and comfort zone

A few years ago **CTT Systems** introduced the Zonal Drying System, which combats condensation in the thermal and acoustic insulation of passenger aircraft. According to the company, during air travel a **Boeing** 767 can accumulate about half a ton of extra water from condensation, initially in the form of ice build-up, which later melts and accumulates in the insulation blankets or as puddles in various places of the aircraft. The extra water can cause electrical wiring failures, drip into the cabin, freeze exit doors, or corrode the aircraft skin. As a preventive measure to reduce the maintenance costs the above problems could cause, the company's Zonal Drying System has been used by customers that include **Jet Aviation, Airbus, Raytheon Systems** Co., and **KLM** to maintain a dry environment between the cabin and the aircraft skin.

The company is now offering a system that deals not only in condensation, but also with humidity via the Zonal Comfort System. The system consists of CTT's Zonal Drying System and one or more specially designed humidifier units. Water from existing supplies (usually from the aircraft's regular onboard supply) is fed into the humidifier, transformed into vapor by an evaporative pad, and released into the onboard environment. CTT cites that most crew members and passengers feel best in a relative humidity of 50%, though the fresh air that enters into executive jets and commercial aircraft can cause the cabin humidity to dip below 5% relative humidity, or 2-3 times drier than Phoeni, AZ.



CTT Systems claims its Zonal Drying System contributes to increased aircraft safety as well as cuts non-revenue ballast through the elimination of accumulated condensation.



The technology used in the Zonal Comfort System is based on the principle of evaporation from a free water surface, similar to water evaporating from a lake.

The contact media in the humidifier can absorb up to 100 L/m^2 of water. The humidifying process is self-regulating, while the lack of aerosols in the process stops bacteria from being transferred to the humidified air. Salt and other pollutants accumulate as residues on the pad. The effect of the humidifier units is determined by the size of the pad, the flow of water, and the temperature of the air fed into the unit. A long-haul plane usually requires two humidifier units, with each humidified using about 7 L of water per hour. Water consumption averages 100-150 L or water per 10 h flight, says CTT.

Jean L. Broge

KVH miniaturizes FOG

KVH Industries is using its new digital signal processing (DSP)-based fiber optic gyros (FOG) to create a high-performance inertial measurement unit (IMU) for defense-related applications under a contract to **L-3 Communications** Corp. According to Martin Kits van Heyningen, KVH President and CEO, accurate IMUs are "a vital" component in a variety of military applications, including drone and unmanned aerial vehicle navigation, as well as missile and smart munitions guidance. "By minimizing our DSP-based FOGs, we are making significant progress in our development of a three-axis package for precision IMUs that will meet both the operational and budgetry needs of emerging defense applications (such as counter-terrorism operations)."

The three-axis inertial measurement unit (IMU) KVH is developing, under a contract for L-3 Communications, combines the company's proprietary polarization-maintaining optical fiber and fiber components with integrated digital signal processing.

KVH's proposed IMUs will be suitable for missile and smart munitions guidance systems like those used on JDAM-based smart bombs.

The initial model of KVH's DSP-based FOG accepts data input as fast as 500°/s. Future DSP systems could have input rates of 1000°/s or more with no reduction in accuracy or stability. The gyros combine the company's proprietary polarization-maintaining optical fiber and fiber components with integrated DSP. The result, claims KVH, is a low-cost, tactical grade rate gyro with improved bias stability, low noise, high bandwidth, and accuracy approaching 0.05%. The proposed IMU will use DSP gyros and accelerometers to measure both angular rate and linear acceleration in three dimensions and provide this data to onboard systems to control precise navigation.

Jean L. Broge

Batteries from Airbus to Antares

Onboard power for engine starting and electrical systems back-up for the **Airbus** A380 will come from **Saft** ULM (ultra-low maintenance) rechargeable nickel-cadmium batteries. The type is a 50 A•h and Saft claims that a key element of its design is the use of a plastic bonded negative electrode that "dramatically" lowers battery water consumption by reducing the current drawn during overcharge. The non-sintered negative plate weighs less, provides better energy density, and allows for an increased reserve of electrolyte, says Saft. The design also features an enhanced sintered positive electrode combined with a "special" electrolyte said to be optimized to increase charge efficiency. The company claims the batteries' design features combine to double the interval between maintenance checks.

Antares can now reach 3000 m in powered flight using Saft lithium-ion batteries, as opposed to 1890 m when it used a Ni-MH system.

At the opposite end of the size spectrum, the German Antares self-launching sailplane will use Saft's high-energy rechargeable lithium-ion batteries, which will allow it to achieve 3000 m. Antares has a retractable electric motor and propeller. Saft claims the use of lithium-ion batteries has improved its ceiling by some 1100 m over the height reached by the prototype using metal-hydride batteries.

Developed by **Lange Flugzeugbau** GmbH, the Antares has what is described as an almost silent, environmentally friendly propulsion system, comprising a brushless 42-kW electric motor with external rotor, power electronics, rechargeable batteries, and a slow speed pusher propeller with a 2 m diameter. For take-off and powered flight, motor and propeller are extended above the wing. To retract them into the fuselage, the pilot pulls a lever and the aircraft is then in a suitable aerodynamic configuration for effective soaring.

According to Safe, the Antares was designed around the Ni-MH system that facilitated a climb to about 1890 m. However, in the quest for even greater performance, the design team decided to switch to Saft's VL lithium-ion calls, which were originally developed for hybrid and electric vehicle applications to pack as much power as possible into a lightweight and space-efficient package. The cells have a nominal capacity of 39 A•h and a nominal voltage of 3.6 V and are "significantly" lighter in weight. The Antares battery system comprises 72 VL 41 M cells in series, providing a nominal voltage of 260 V. Total mass of the battery is about 76 kg, representing some 13% of Antares' maximum all-up weight including pilot, parachute, and water ballast of about 600 kg.

With a maximum take-off power setting of 42 kW, its typical climb rate is 4.3 m/s, with 1000 m reached in 4 min. At maximum power the battery can provide about 13 min of duration, good for a 3000-m climb. In zero lift conditions, the aircraft has a glide-back-to-ground time of 100 min.

The lithium-ion battery system is fitted with an electronic-control-management system for the monitoring of charge and discharge voltages, as well as temperature, and takes 8 h to charge at 220 V. An onboard charger is carried on Antares to facilitate cross-country flights. According to Saft, the VL cells are capable of up to 1500 charge/discharge cycles, and in the Antares application are expected to have a service life of around 11 years.

Stuart Birch