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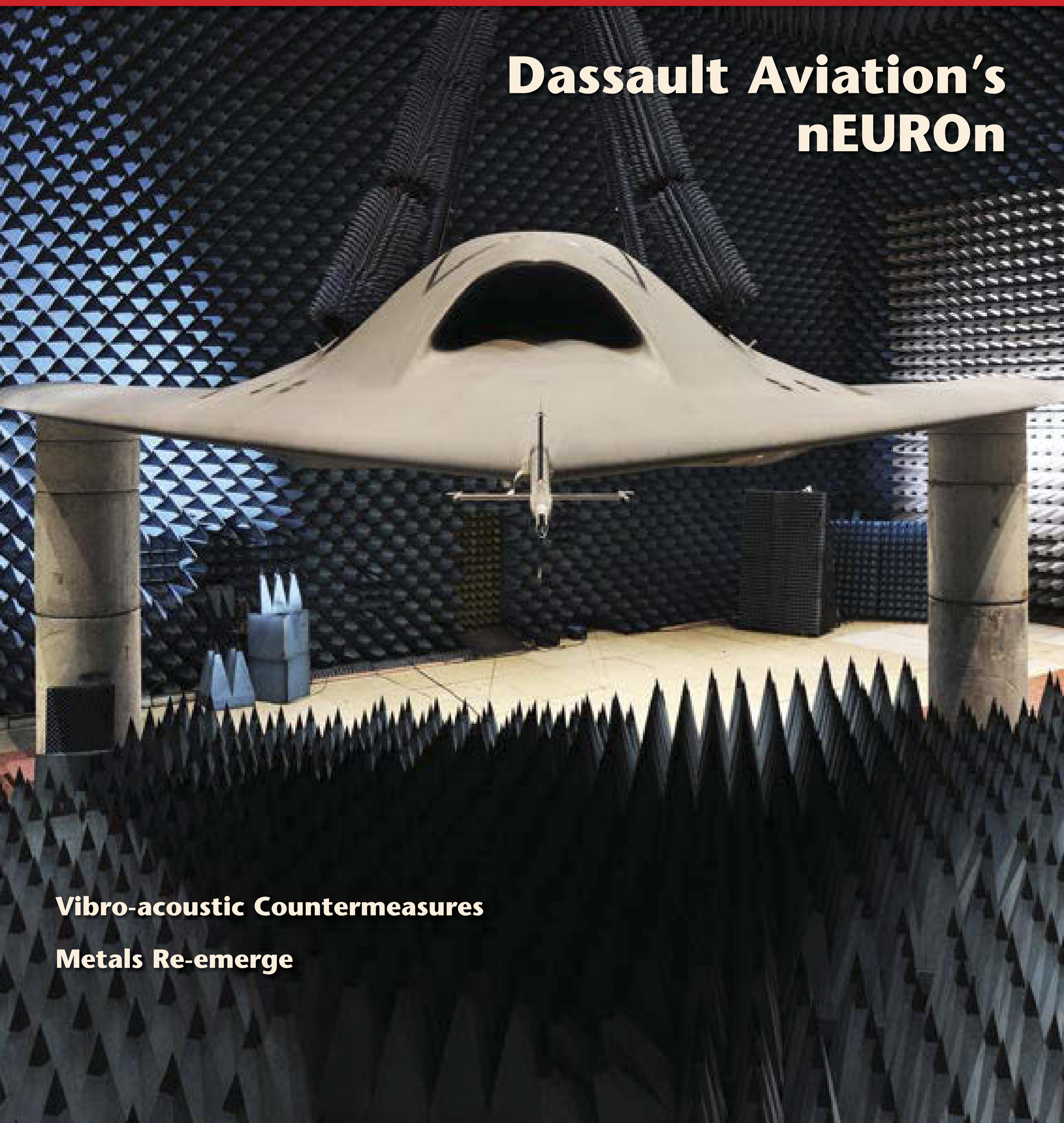
AEROSPACE ENGINEERING



Dassault Aviation's nEUROn

Vibro-acoustic Countermeasures

Metals Re-emerge

What's Online

Top Products

Adjustable retraction for cable guidance

Triflex RSP cable-guidance systems from igus feature an adjustable retraction system; they are designed for secure cable guidance on large robot arms or for robots programmed to perform complex movements. The force at which the unit retracts can be adjusted by changing the pressure inside its pneumatic cylinder. The system can be attached to various robot models quickly and easily via compact mounting brackets. Read more at ***www.sae.org/mags/aem/12008***.

Capacitor charging power supplies

UltraVolt Inc.'s high-power 8C-30C series capacitor charger modules feature an output power of 250W, which is a 100% increase compared to the previous offering of 125W. The modules were designed for applications including pulsed power, cap-charger, pulse generators, Q-switch and Pockell cell drivers, lasers, and TDR (time domain reflectometer) test equipment. Read more at ***www.sae.org/mags/aem/12006***.

Filters for industrial gas sampling

Mott Corp.'s all-metal inertial gas sampling filters allow the collection of particle-free samples from virtually any gas stream, including those that are heavily contaminated and run at extreme temperatures. Typical applications include gas sampling in stack testing, lime or cement kilns, fluid catalytic crackers, coking oven off-gas atmospheres, and general process control and emission control monitoring. Read more at ***www.sae.org/mags/aem/12005***.

Eddy current tester

The portable four-frequency eddy current instrument from UniWest offers single- and multi-frequency eddy current inspection, good signal-to-noise ratio, frequency mixing capabilities, USB and Ethernet data storage, digital strip chart data collection, and a color display. The device's strong signal-to-noise and filtering capabilities allow for inspection in applications normally outside of the scope of portable eddy current equipment. Read more at ***www.sae.org/mags/aem/12004***.

Excimer laser mirrors

Newport Corp.'s long-lived, deep ultraviolet (UV) excimer laser mirrors have projected lifetimes greater than 30 billion pulses when used in the proper photocontamination-controlled environment. The mirrors feature all-dielectric, high-reflector coatings to minimize absorption and maximize reflected energy at 193 nm. Read more at ***www.sae.org/mags/aem/12003***.

Top Articles

Phil Zulueta, Chairman of the SAE G-19 Committee.

SAE G-19 Committee making progress on counterfeit parts standards

SAE International's G-19 Counterfeit Electronic Components Committee, chartered to address the different aspects of preventing, detecting, responding to, and counteracting the threat of counterfeit electronic components, provides a status report on the activities of the committee and its subcommittees. Read more at ***www.sae.org/mags/aem/12100***.

Battery safety starts in the factory

At an April 2013 NTSB forum on batteries, a Saft representative said the company tests every one of the cells it produces — something not all cell makers can say. Read more at ***www.sae.org/mags/aem/12113***.

Pratt & Whitney moves additive manufacturing into production

Pratt & Whitney is quickly ramping up its capabilities for additive manufacturing, using parts made with additive processes on an engine that is being tested on a new Bombardier jet. The engine manufacturer also christened a new laboratory that will focus on this rapidly emerging manufacturing technique. Read more at ***www.sae.org/mags/aem/12061***.

Boeing and FAA confident in 787 battery fix (video)

U.S. National Transportation Safety Board on April 23-24 will hold a hearing focusing on the design and certification of the 787's battery system. Read more at ***www.sae.org/mags/aem/12040***.

Diesel aircraft coming soon to an airport near you?

The recent development of diesel technology has made the two-stroke, compression ignition engine an interesting option for light aircraft manufacturers, seeking power units of 100-300 hp, preferably not heavier than existing SI powerplants. Read more at ***www.sae.org/mags/aem/11241***.

Webcasts

The following webcasts are available for free on-demand viewing at www.sae.org/webcasts:

Gulfstream's IVHM-enabled G650 business jet.

- "Taking Data to New Heights: How Airlines, Plane Manufacturers, and Suppliers Are Shaping the Future of Integrated Vehicle Health Management" explores IVHM from three different perspectives. The IVHM Centre, Cranfield University, offers an academic view of the subject including educational offerings and research; UTC Aerospace Systems gives a supplier's perspective of utilizing IVHM to improve field service and supply chain management for components of major aircraft systems; and Gulfstream discusses the subject of an airplane manufacturer that has IVHM-enabled its latest business jet, the G650.

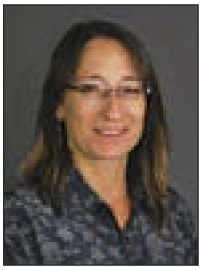
- "Battery Design Innovation: It's All About the Mathematics" demonstrates, through the use of examples and case studies, advanced symbolic mathematics techniques for developing high-fidelity physical models of batteries. Speakers include Dr. Ralph White, Department of Chemical Engineering, University of South Carolina; and Dr. Sam Dao, Application Engineer, Maplesoft. Sponsor: Maplesoft

- "Safety Trends for the Off-Highway Industry" examines a range of safety topics for the off-highway industry, from smart cylinders that allow operators to safely and precisely control equipment to electrohydraulic braking systems. Speakers include Manfred Maiers, MICO; Haubold "Hub" vom Berg, MTS Systems Corp., Sensors Division; and Gary Heydinger, Ph.D., P.E., S-E-A. Sponsor: S-E-A

- "PCA Engineers Limited Accelerates the Evolution of Turbochargers via Numerical Optimization and Advanced Simulation Techniques" looks at turbocharging internal-combustion engines and illustrates the implementation of a design-by-analysis approach, with examples of compressor and turbine designs for small gasoline engines. Speakers include Chris Robinson, Ph.D., PCA Engineers Ltd.; and Brad Hutchinson, Ph.D., ANSYS Canada Ltd. Sponsor: ANSYS

Editorial

Maintaining the high



The word "cyclical" does not have an unpleasant sound to it. And some good is implied in the word. The bad part about cyclical, though, is that sometimes you find yourself in the part of that sine wave that leaves you looking up at the x-axis.

In terms of the commercial aircraft industry, the good news is that it seems to currently be looking down at the x-axis.

In the lead-up to the Paris Air Show this year, fleets from around the world were again able to fly Boeing 787s, and production on that aircraft was set to ramp up; Airbus was continually teasing about the imminence of the first flight of the A350; and Bombardier was about to take the first flight of its new CSeries commercial jet, which is expected to be just one new aircraft program from around the globe with the realistic goal of contributing to the breakup of the duopoly that Boeing and Airbus have in the 100- to 149-seat market.

According to the recent Global Aerospace & Defense Industry Outlook put out by AlixPartners, "the commercial aerospace sector accounted for 52% of the overall industry profit pool [in A&D] last year, and all signs point to continued robust growth in the coming years."

As optimistic as things look right now, history and some fundamental knowledge about sine waves tells us that the high that the commercial aerospace industry is on right now simply will not last.

That fact was kind of hard to tell, however, when in mid-June Boeing released its annual Current Market Outlook. Between now and 2032, Boeing forecasts the demand for 35,280 new aircraft, worth about $4.8 trillion, essentially doubling the 20,310 fleet in service today when taking into account retired aircraft.

At the very least, Boeing knows something of which it speaks, and it would seem that even if the current high cannot be maintained, the move in the opposite direction over the next 20 years should not be too extreme.

In fact, AlixPartners provided some suggestions in its Outlook to avoid wide swings between highs and lows; specifically, "to survive and thrive in the current industry cycle, companies in the A&D industry must become more efficient, especially in the face of challenging commercial-aircraft ramp-ups."

Efficiency will be the key as all aircraft makers pump up production to fill already bulging backlogs, not just in terms of the efficiency of the actual aircraft and all its components, but in terms of manufacture and production. Randy Tinseth, Vice President of Marketing, Boeing Commercial Airplanes, was way above the x-axis when he said during the CMO announcement that "this forecast gives us confidence as we increase our production rates and invest in new products like the 777X and 787-10X."

But AlixPartners seems to suggest some caution may be in order. It expects that commercial aircraft programs will have "ramped up by 45%" by 2017 "to include a significant surge in big, new programs."

However, reality is close by as it stressed "new programs will introduce new technologies, both for airframe and engine companies, aimed at improving aircraft operating efficiency by up to 20%, which will further increase the complexity of the supply chain and the risk of delays."

There must be drastic measures at all levels of the aircraft manufacturing and engineering experience to enable the ramp-up to happen, and be successful, with minimal delays. As AlixPartners suggests, "The commercial-aerospace supply chain is just not ready to handle a simultaneous increase in volume and complexity — it's going to overheat, especially among lower-tier suppliers."

There is no alternative. We must be ready. And we must recruit brilliant young, old, and otherwise engineers to participate in this challenge at all levels of the aerospace engineering experience. And make aerospace engineering their high.

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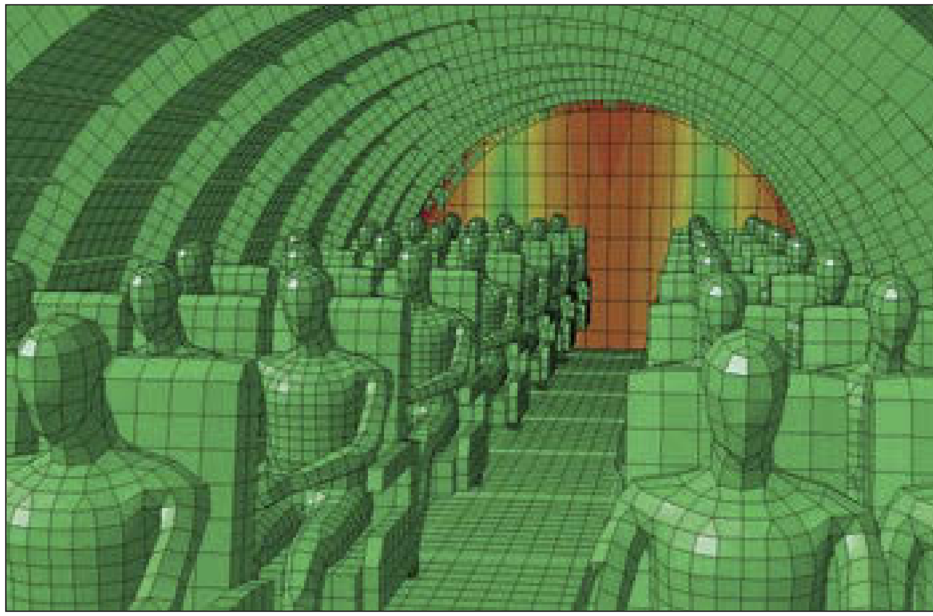
Fine-Tuning Vibro-Acoustic Countermeasures in a Turboprop Aircraft



SENER used LMS Virtual.Lab to predict the cabin interior noise due to the fuselage vibration.

Turboprop engines are becoming more and more popular because they offer up to 30% reduction in fuel consumption compared to turbofan engines. But turboprop engines are also known for generating substantial noise, so reducing cabin noise to ensure passenger comfort is an important engineering challenge.

"Propeller noise is largely dominated by tonal components associated with the propeller blade passing frequency and its harmonics," said Pierre Huguenet, noise and vibration engineer at SENER, an engineering company that specializes in solving vibro-acoustic problems.

Propeller noise can be divided into several categories. Thickness noise is generated by the volume of air displaced by each propeller blade, and its level is strongly dependent on the helical tip speed and the blade geometry. Blade loading noise can be either steady or unsteady. Steady blade loading depends on the propeller net thrust and torque. Periodic blade loading is caused by oscillations in the blade effective angle of attack that generate acoustic tones. Blade loading noise depends on the blade surface pressure. Finally, quadrupole and nonlinear noise sources are only relevant for propellers operating in transonic and supersonic regimes like high-speed propellers and prop fans. These sources can normally be ignored for a general aviation turboprop aircraft.

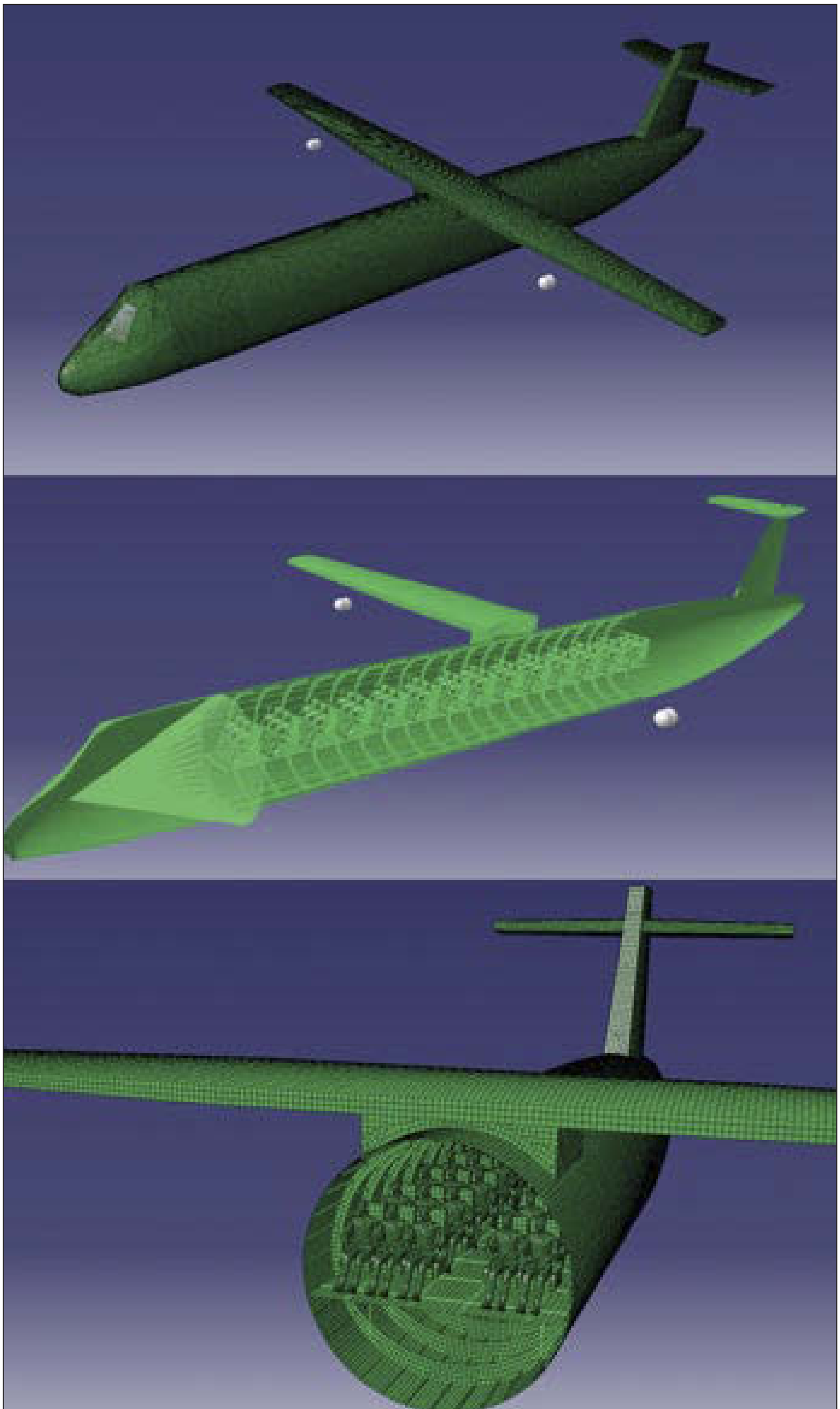
Propeller noise can be transmitted to the cabin through the air — the airborne path — and through the structure — the structure-borne path. "The energy from the acoustic waves is coupled with the structure, which in turn is coupled with the interior cabin," Huguenet said. "This means that we have to deal with an external and an internal acoustic field. Optimizing the cabin noise requires a fully coupled vibro-acoustic numerical model of the aircraft cabin and structure. Depending on the location of the noise source, sometimes the coupled zone can be reduced to a critical or 'wetted surface' area with the largest contribution to the global interior noise."

A variety of noise countermeasures can be considered such as isolation materials and structural modifications. "If the noise problem is localized, then a possible solution is to make a local structural change to the aircraft panel such as changing its thickness or adding rivets or an attached weight. For a global noise problem, you need to consider modifying the main structure. You might also look at local changes such as adding dynamic vibration absorbers (DVAs), damping materials, or viscoelastic materials. Making structural changes and adding isolation materials can reduce the perceived cabin noise level by up to 15 dB," Huguenet said. "Active control techniques interacting with the noise source can provide further noise reductions, but these methods are rather complex and can also be expensive."

The simulation process needs to encompass both the acoustic field and the structural response at the frequencies of interest to solve coupled vibro-acoustic problems. "In our most recent project on a turboprop aircraft, the model included a detailed finite-element model [FEM] of the fuselage structure and a representation of the interior and exterior acoustic domains using boundary elements [BEM]," Huguenet said. "Coupled vibro-acoustic simulations were performed with LMS Virtual.Lab, focusing on the first blade passing frequency (BPF)."

In the case of a turboprop aircraft, SENER focuses on BPF tones generated by the turboprop engine covering the low- and mid-frequency range, the harmonics of the BPF tone, and possible false harmonics. Low frequencies for a turboprop aircraft range from 10 to 200-250 Hz, and mid-frequencies from 250 to 400-500 Hz. A statistical approach such as Statistical Energy Analysis is used to study frequencies higher than 500 Hz.

"Vibro-acoustic problems are solved by using FEM for the structure and either a FEM or a BEM for the acoustic domain. The choice between FEM/FEM and FEM/BEM depends on the size and complexity of the model and whether the problem is interior or exterior. FEM/FEM models require a full mesh, yet the matrices are sparse so large mod-



Examples of different meshes used in LMS Virtual.Lab to optimize noise countermeasures.

els can be efficiently solved. A coupled FEM/FEM model is usually preferred for interior problems. FEM/BEM models, on the other hand, have less elements in the BEM mesh so the model creation and modification are much faster."

SENER has developed a specific methodology to perform a two-step sensitivity analysis, which provides a greater understanding of the vibroacoustic countermeasures, optimization of the countermeasure distribution, and a more efficient solution for weight reduction.

"LMS Virtual.Lab includes a number of analysis tools and toolboxes that are very useful for this type of analysis," Huguenet said. "We have used LMS Virtual.Lab concurrently with Nastran SOL 200 to perform a sensitivity analysis of the baseline configuration. Sensitivity analyses help to determine which countermeasures are effective and which are not.

"The goal of the optimization is always to minimize the amount of countermeasures without compromising the amount of noise reduction," Huguenet said. "When you increase the stiffness of 10 panels, it will reduce the local noise level. This can be a good solution, but it may not be the best one. Maybe increasing the thickness of only nine panels would be only 0.01 dB noisier yet 20 kg lighter. Sensitivity analysis helps us optimize these trade-offs.

"Given the demand for more economical aircraft, the ability to optimize countermeasures is important," Huguenet said. "We use a hybrid approach with a brute force mathematical optimization as a first step, and a second more subtle optimization step to fine-tune the solution without losing too much sound reduction capabilities. When you are able to remove 10 kg of DVAs with only a 0.2 dB loss, that's nearly always a good trade-off."

This article was written by Jennifer Schlegel, Senior Editor, LMS International, Leuven, Belgium.

Metals Make a Comeback

A look at how new metallic and hybrid materials are competing with carbon composites for a continuing role in aerospace manufacturing.

by Richard Gardner, European Editor

The Boeing 777 assembly line in Seattle shows plenty of evidence of conventional metal structural components dominating the scene. (Richard Gardner)

The past two decades in the aerospace sector have seen a steady trend toward the ever-increasing use of carbon fiber reinforced polymer (CFRP) composite materials beyond weight-saving components for aircraft into major primary structures on a scale that was unimaginable a few years ago.

While general aviation aircraft and sport gliders represented an easy starting point in expanding the use of composites, the adoption of large CFRP structures came about in stages. Obvious items such as fuselage/wing fairings and tail assemblies provided much scope for saving weight while creating awkward aerodynamic shapes in a single piece through a relatively easy molding process, using human labor to lay down composite sheets, and requiring modest-size autoclaves.

As manufacturing experience and composite technologies improved, with more automation and investment in new manufacturing facilities allowing larger structures to be assembled, the use of CFRP components has boomed.

Closeup of a 787 fuselage panel showing the composite structure with metal fasteners and strengtheners. (Richard Gardner)

Moving up from adoption on GA types through business jets into regional passenger aircraft, the "plastic aircraft" was soon featured as a key must-have catalog item in the product lines of the sector's biggest manufacturers, Airbus and Boeing. This was also the case in the military aerospace sector where new manned and unmanned airframes saw large-scale use of composites for structural use.

Controversially, Boeing's adoption of composite structural components for almost the whole of the 787's airframe seemed to signal the beginning of the end for traditional metal structural manufacturing. Even the giant Airbus A380 featured a huge dependency on composite fuselage and wing components. But interestingly, the latest Airbus widebody addition to its portfolio, the A350XWB, is not quite as committed to plastics, and retains a mix of advanced metallic components and composite materials.

Another factor is also emerging. Over the next 20-30 years, it is estimated that the world will require over 30,000 new large commercial transport aircraft to meet expanding traffic needs as well as replacements for aging aircraft.

With production rates ramping up to reduce order backlogs and maintain reasonable delivery requirements, this increasing demand for new aircraft is likely to present a real challenge to the composite materials supply chain. This coincides with new advances in metallic materials that are re-introducing greater competition. The latest metallic products and processes are certainly becoming far more competitive, and the signs are that they are likely to make a real comeback, especially on the emerging next-generation airframes that are shaping up on the CAD/CAM screens of the major manufacturers.

Aluminum in the Air

A market leader in the supply of advanced metallic materials for the aerospace sector is Constellium (formerly Alcan Engineered Products), which has invested in a range of new Airware products tailored to meet today's demanding needs for performance (strength, stiffness, and damage tolerance), ease of manufacture, and competitive costs.

An important factor, and one seen by Constellium as an aspect that benefits from the use of metallic components, is the increasing environmental concern over the need to recycle structural materials. Constellium provides a close focus on how waste material is recovered and re-used, right through the supply chain manufacturing process up to the time when the airframe is eventually dismantled after a lifetime of service use. This approach minimizes material losses and enables a very positive outcome, long term, in environmental benefits.

In this respect, it scores higher than within the composite manufacturing and recycling supply chain, and uses less environmentally harmful contents. Airware is 100% recyclable. These lightweight, high-performance materials give overall hybrid structural solutions that offer a more sustainable future, with a reduced carbon footprint.

The unique Airware technology features a much lower density, a higher stiffness, and better damage tolerance. Combined with advanced welding and redesign of aircraft aerostructures, it is claimed to achieve up to a 25% reduction in structural weight.

Higher corrosion resistance and greater fatigue resistance increase the structural durability, and this in turn guarantees longer intervals between heavy maintenance periods out of service. These advantages are encouraging aerospace manufacturers to use advanced aluminum solutions rather than composites for more high-tech structures.

Airbus has adopted Airware structural components for the latest A350XWB (internal wing structures and fuselage), and Bombardier has also chosen it for the fuselage of the new 130-seat C Series super-size regional jet. Both new aircraft are due to make their first flights soon.

Airware products are available in three innovative forms. Airware I-Gauge is the thickest low-density alloy plate (165-mm thick), and offers OEMs better performance while minimizing weight

and simplifying manufacturing and assembly of complex monolithic shapes. It is 46% more corrosion resistant and 25% more fatigue resistant.

Airware I-Form is a highly formable product and comes in sheet form, allowing the design of complex 3D curvature shapes with no loss of mechanical properties and a reduction in manufacturing steps. Highly formable, it is 3% lighter, 47% tougher, and 40% more corrosion resistant, and reduces the number of manufacturing steps from four to two. It is best suited for fuselage nose and tail structures, as on the Bombardier C Series.

Airware I-Core is 21% stronger and is a high-strength extruded product that comes in a low-density alloy. It is optimized for a hybrid structure environment with the best crashworthiness ratio. Its ability to absorb energy reduces the risks of structural damage in a crash or emergency landing, and also makes it an ideal solution for cargo floor beams.

In March, Constellium opened a new casthouse in Issoire, France, dedicated to low-density alloys. The industrialization of the new technology has involved the reinvention of some of the manufacturing processes, with an open view on innovation. Some €52 million was spent on the new project, which included a pilot phase that took place in the company's R&D center at Voreppe, France.

Constellium is integrating its manufacturing capacity, which now comprises facilities in France, Switzerland, and the U.S. at Ravenswood, WV. These plants work closely with customers in close partnership to exploit the gains that can be made from

At its Issoire recycling casthouse, Constellium has demonstrated the recyclability of A300 wings and cockpit parts with a recovery yield of over 90%, resulting in new aluminum ready for use in future aircraft.

using advanced materials. A good example is the way in which the company has worked with Lockheed Martin on the F-35.

"To meet a critical need for very large monolithic components for the F-35, we needed to produce very large plates of previously unheard-of dimensions," said Kyle Lorentzen, CEO of Constellium's Ravenswood facility. "This was achieved by combining a unique manufacturing capability with a tailored product range."

On the F-35, Constellium's 7050 and 7140 alloys have been used, which give strength and lightness and importantly, greater corrosion resistance. But legacy military aircraft, including the F-16 and F-18, have also received replacement materials in their bulkheads, skins, and other key structural components using Airware 2297 and 2098 alloys.

Airware from Constellium enables aircraft designers and manufacturers to meet demands for a new generation of lighter, more efficient, and greener aircraft.

Manufacturing Methods

Lithium has been in the headlines as a result of the long-running Boeing battle to cure its battery problems on the 787, but combined with aluminum, lithium can produce a range of alloys that offer the best of both worlds — the strength and lightness of CFRP materials with the more environmentally friendly ease of manufacture and flexibility of aluminum structures.

These "superalloys" are winning over many engineers and decision-makers in the main aircraft supplier companies. But the situation is subject to much change at present as the plastic vs. metal debate is very dynamic. This results from an almost continuous flow of new innovation and processes that are changing how aircraft are put together.

The F-35 is the most modern combat plane in production and uses both composite structure and metal components in the fuselage and wing. (BAE Systems)

Many current production aircraft such as the 787 and A380, for example, have to incorporate additional metal strengthening components such as brackets and support struts, in addition to using very large composite panels with molded-in strengtheners. The new-generation aluminum lithium components can be machined with great accuracy in complex forms, saving the extra complication of combining different types of structural material that adds to the assembly effort. There can be no escaping the fact that composite materials involve the use of unfriendly resins, and waste disposal is an issue. In operational terms, using advanced metallics in vulnerable parts of the structure, such as where vehicle strikes might be expected, can offer an easier permanent repair solution and better overall resilience.

Some years ago, Airbus announced at one of its Toulouse technical briefings that it was experimenting with new materials that would offer superior performance and keep weight down. This became GLARE, or Glass Laminate Aluminum Reinforced Epoxy. It turned out to resemble a multi-layer sandwich comprising many very thin layers of aluminum between layers of CFRP, all bonded together with epoxy.

The innovative aspect of the technology at that time was that the pre-pregnated composite layers could be

AM technology being developed by GKN Aerospace creates complex metallic shapes that reduce material waste, saves weight, are extremely strong, and show the way forward for future exploitation in aerospace component manufacture.

laid down in different directions to cater for specific stress conditions (similar to what is now common on many composite components). This meant that the resulting panels were extremely strong, yet light.

As the GLARE sheets are bonded together, they can be handled in the manufacturing process like sheets of aluminum, using conventional techniques. Compared to conventional aluminum, GLARE panels are more resilient, have greater corrosion and fire resistance, and are lighter. They require less inspection and maintenance, and have a long lifetime. Major structural panel sections on the A380 have GLARE panels.

But the pace of the metallics revival is quickening. The re-emergence of metallic solutions as alternatives to future wing structures, for example, is an area that is being actively developed by GKN Aerospace, a global Tier One supplier that has a very sizable stake in both metallic and composite structural manufacturing for all the major aerospace constructors.

The company believes that additive manufacturing (AM) presents a massive opportunity to create complex shapes, some of which would be impossible to manufacture using conventional methods, with higher functionality and different materials. Using AM techniques, materials can be fused to form objects from 3D models, building up structures iteratively instead of taking forgings and then machining material away. AM can produce highly complicated, near-net-shape geometries with a good surface finish, and, by almost eliminating the machining process, can make great savings in cost and carbon emissions.

GKN has invested heavily in exploring many different associated technologies, but is presently focusing on processes such as electron beam melting, selective laser melting, and direct metal deposition techniques. It believes the potential for advanced welding and joining processes, such as laser welding, linear friction welding (LFW), and friction stir welding, is very applicable for future wing structures.

Laser welding techniques developed by GKN have been used on the European Ariane rocket nozzle and are now being applied to critical engine structures on the latest Rolls-Royce Trent XWB. They are being studied for new aerostructure applications. LFW joins two items of material by rubbing them together until the surface gets hot enough to become plastic. A load then forces them together, forming the joint. The technique can form near-net-shape engineered blanks, considerably reducing build costs. This has been developed to reduce the amount of waste material that can emerge from a forging (up to 90%).

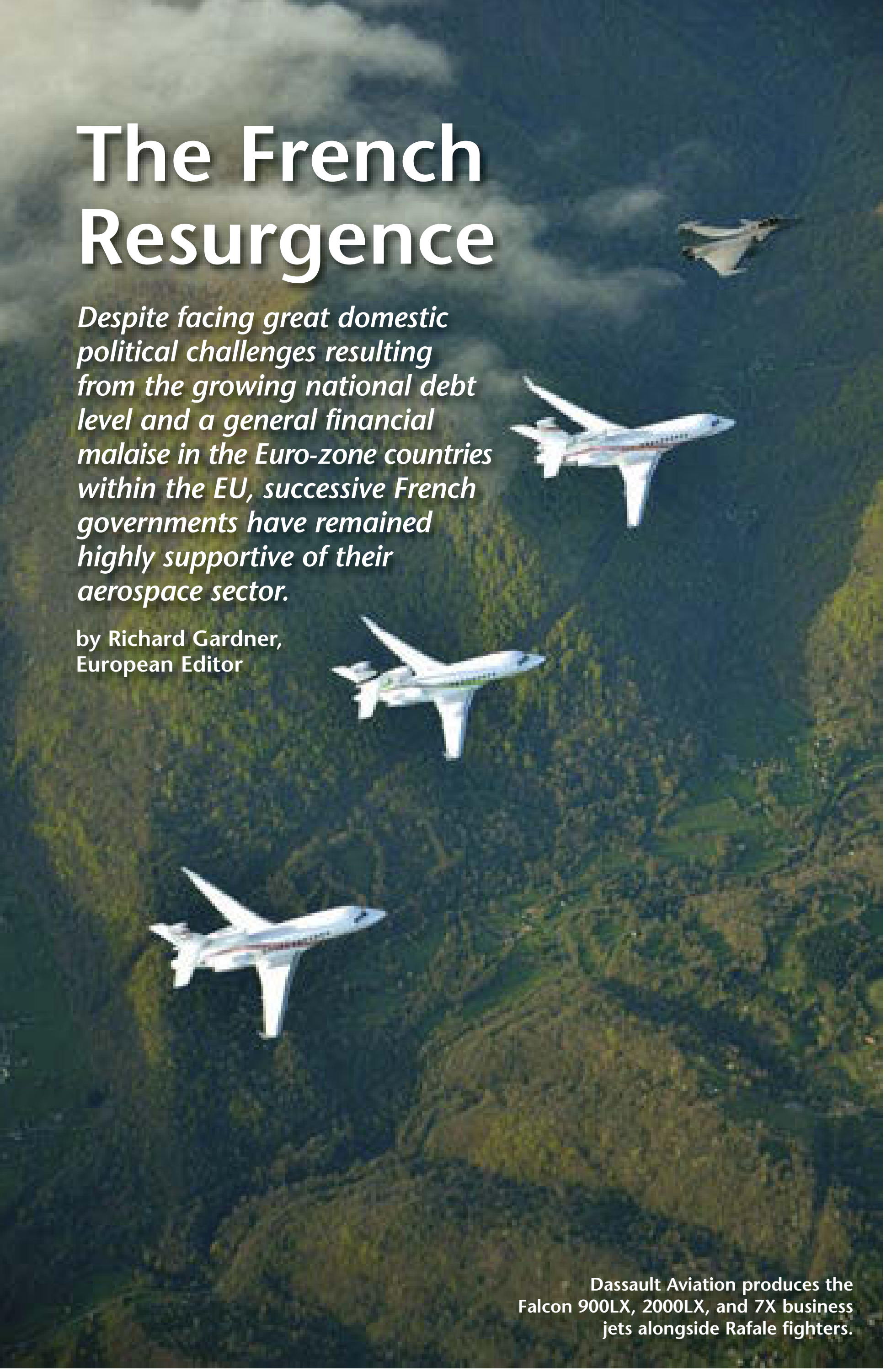
The company is also looking closely at using LFW with titanium as well as dissimilar materials and alloys. It believes friction stir welding could replace today's bolted and riveted metallic joints with large panels. This solid-state jointing process forces together parts under load with a rotating tool, heating and stirring the plasticized metal to bond the components.

The benefits are many and include reducing component weight, improving fatigue performance, reducing the parts count, lowering design and assembly costs, and easier maintenance. Little wonder that at the front line of aerospace structural manufacturing, metallics are well positioned for a significant comeback.

The French Resurgence

Despite facing great domestic political challenges resulting from the growing national debt level and a general financial malaise in the Euro-zone countries within the EU, successive French governments have remained highly supportive of their aerospace sector.

by Richard Gardner, European Editor



Dassault Aviation produces the Falcon 900LX, 2000LX, and 7X business jets alongside Rafale fighters.

The first of five development aircraft in the Airbus widebody A350XWB flight test fleet rolled out of the paint shop this past May following its completion and successful integration of all systems and engines, with ground tests well underway. Whether this aircraft makes it into the air in time to put in an appearance at the Paris Air Show in June was unclear at press time, but with advance orders for 617 aircraft for 35 customers already signed up, it was sure to be a major topic of interest at the show.

The host nation, France, remains a world leader in advanced aerospace and defense products; though, as with most other major European players in this market, much activity is now conducted within international partnerships. Although France is a major shareholder in EADS, which includes Airbus, Airbus Military, MBDA, Astrium, and Eurocopter, it also retains national champions in the shape of Dassault, Arianespace, and companies that have also become multinational, such as the Safran and Thales Groups.

Military Backgrounder

Even though state financial budgets are under extreme pressure, it is unlikely that there will be any significant rollback in aerospace investment. France has always taken a long-term view regarding this area of industrial activity as a precious national asset that annually generates irreplaceable levels of export revenue, thanks largely to the success of Airbus, the Snecma engine group, and the country's booming space sector.

Last year, France's aerospace and defense revenues grew by 16% to €42.5 billion. Exports rose 20% to €26.98 billion, representing 75% of turnover, and orders in 2012 reached €49.7 billion. Including indirect as well as direct jobs in the aerospace/defense sector, France employs an estimated 310,000 people.

A large portion of the 74% that were civil sales came from Airbus activity, but France is also building large numbers of Dassault Falcon business jets and its share of ATR regional airliners, as well as being a 50% partner in CFM's CFM56 engine program, the world's biggest-selling civil jet engine, which is aboard the Boeing 737 and Airbus A320 families. The CFM-56's successor engine, the LEAP development, is the sole offering on the new 737 MAX.

In late April, the French government published its policy document on defense and national security, outlining plans leading up to 2020. The intention is to try and retain as much front-line capability as possible. However, there will be some defense cuts in the French Services, which will be made in training and second-line support areas, rather than in existing or planned national capability.

The revised program for 2020 includes: 140 reconnaissance and attack helicopters, 30 army-operated UAVs, 115 utility helicopters, 225 multirole fighters, 50 tactical transports, seven AEW&C detection and surveillance aircraft, 12 air tankers, and 12 surveillance UAVs. This total front-line fleet is slightly reduced in comparison to today's fleets, but some areas where the French military planners wanted action have not yet been addressed. This includes the future development of UAVs and a new anti-ship missile system.

Focus on Dassault

The most important French military air program is undoubtedly the Dassault Rafale, which has been selected by the Indian Air Force for a new medium multi-role combat aircraft. Despite negotiations throughout last year, which were due to conclude at the end of March 2013 with a confirmation of the order for up to 126 aircraft, the talks have become protracted, as is often the case with Indian military procurement.

Dassault remains in competitive mode as it continues to offer the Rafale worldwide against the Eurofighter Typhoon and U.S. fighters, including the F-35 and F/A-18E/F Super Hornet. Brazil is a key export target for Dassault, and the country once announced a Rafale selection to replace its French-supplied Mirage fighters, but the statement was later overruled by the Brazilian Air Force and no new fighter has yet been chosen, though a decision is still due. Dassault is also gaining valuable extra revenues from upgraded Mirage 2000 contracts that include major radar, avionics, and weapons replacement.

In December of last year, Dassault announced that Europe's unmanned combat air vehicle, nEUROn, had successfully completed its maiden flight. This demonstrator program, launched in 2005, involves France, Italy, Sweden, Spain, Greece, and Switzerland, and is intended to evaluate the performance of an advanced stealthy combat air platform.

nEUROn features a 10-m-long fuselage, with a 12.5-m wingspan and a low radar signature. It also has an operating internal weapons bay. Flight tests will progress from flying trials in France to autonomous trials in Sweden starting in 2014. These trials will be followed by further weapons firing and stealth trials in Italy. The nEUROn is powered by a single Rolls-Royce Turbomeca Adour engine.

Dassault produces the Falcon 900LX, 2000LX, and 7X business jets alongside Rafale fighters, and these aircraft serve as government VIP transports and also as maritime patrol aircraft with many air forces, navies, and coastguard organizations, as well as hundreds of business customers worldwide.

The Falcon family has been considerably upgraded over the years, recently celebrating the 50th anniversary of the original Falcon 20. Since then, over 2,250 members of the jet family have been delivered. These business jets now feature advanced fly-by-wire flight controls, hi-tech glass cockpits, global communications through satellite links, and aerodynamic refinements such as winglets that enhance range.

A French Navy Rafale landing on a French aircraft carrier.

Snecma is a leading aerospace engine producer and many of its products are built in cooperation with other partners in Europe and the U.S.

Thales supplies all the cockpits and flight control systems for the Airbus family. This is ODICIS, a futuristic concept for a wrap-around display system incorporating the latest apps technology and maximum display flexibility.

Dassault's nEUROn made its first flight at the end of last year. Tests will continue in France until moving to Sweden in 2014.

Transport Futures

France is due to receive the first production A400M military transport this year. The order for 50 aircraft will replace existing fleets of Transall and C-130 Hercules tactical airlift aircraft with the French Air Force. Further deliveries to Germany, the UK, Spain, and Turkey will follow, and Airbus Military is promoting the A400M in global export markets.

This large transport can carry up to 116 paratroops and has a high-volume freight cabin accommodating two attack helicopters or three heavy armored vehicles, plus alternative engineering vehicles such as excavators and mobile cranes, making it very suitable for emergency relief support as well as strategic and tactical military airlift.

The A440M bridges the gap between the smaller U.S.-built Lockheed Martin C-130J and the larger Boeing C-17, and it can fly from France to the Gulf nonstop. The maximum payload is over 80,000 pounds, and the A400M can operate into short, rough surfaces as well as from conventional runways.

The design also has built-in provision for use as an air tanker, using removable under-wing flight refueling pods. Converting to the tanking role requires no internal modification and the cargo hold can still be used for freight or passengers. All A400Ms have a refueling probe.

Airbus Military has also had great sales success with its smaller military transport aircraft, which include the C212, CN235, and CN295 Transporter. The U.S. Coastguard uses the HC-235 for coastal surveillance and search and rescue.

Airbus is also leading the sales battle in the export market for large tanker transports with the A330 MRTT, which is now in service with the air forces of the UK, Australia, UAE, and Saudi Arabia, with India and France due to follow. Within the EADS/Eurocopter Group, the French aerospace industry has a big stake in all the major programs, including the EC725 Cougar and EC532 Super Puma, NH-90, Tiger UHT attack helicopter, and the Fennec family of light military helicopters in use with armies and navies for training, reconnaissance, and ship-to-shore light transport, as well as search and rescue.

In the Flight Plan

The success of the trans-European Airbus venture, now 40 years old, has transformed the global market for large commercial transport aircraft. With a huge product line covering passenger jets seating from 130 on the A319 up to 700 in the A380, the consortium has developed modern, highly competitive aircraft that now enjoy a firm delivery backlog of almost 5,000 aircraft, which will keep the final assembly lines flowing at maximum capacity for the next seven years. To date Airbus has sold more than 12,800 aircraft. Through May, nearly 500 new orders had been announced just this year.

The latest project to emerge from the sprawling Toulouse final assembly line (from a brand new assembly building) is the long-range A350XWB, which can seat from 270 to 350 passengers, using 25% less fuel than previous aircraft in this midsize widebody category. The development program is ramping up with a view to achieving entry into service in 2014.

The new Rolls-Royce Trent XWB has been certified for flight, and the initial rating for the A350-800 will be between 75,000-79,000 lb thrust. The A350-900 model, which has production priority, will have engines rated at 84,000-lb thrust.

Following into service in 2017 on the stretched A350-1000 will be the 97,000-lb thrust engine. The best-selling A320 is currently being rolled out of three final assembly lines, soon to be four, at a rate of 40 each month. This aircraft, like Boeing's 737, shows every sign of just running and running.

The Franco-Italian ATR twin turboprop regional airliner has been chosen by many customers for use as a VIP transport, coastguard patrol aircraft, and as a navy and air force maritime patrol aircraft. As well as sea search radar, the MPA version carries electro-optical and infrared sensors for day or night identification and tracking of surface targets and small vessels. Onboard display systems enable surveillance of large areas of coastline or open sea, with multiple tracking and datalinks to ships, shore bases, or other aircraft.

The Eurocopter is co-produced between France and Germany and has recently been upgraded with enhanced engines and avionics systems. (EADS)

The first Airbus A350XWB emerged from the paint shop in May.

MBDA has become the main European supplier for all types of short-, medium-, and long-range missiles. France is a major partner in the group, and a new generation of air-to-surface weapons is under development, while today's major programs include the ASRAAM and Mica short-range air-to-air missiles, the Meteor beyond-visual-horizon AAM, the Scalp-Storm Shadow stand-off attack missile, MARTE anti-ship missile, and the ASTER advanced ship- or land-based air defense/anti-missile systems.