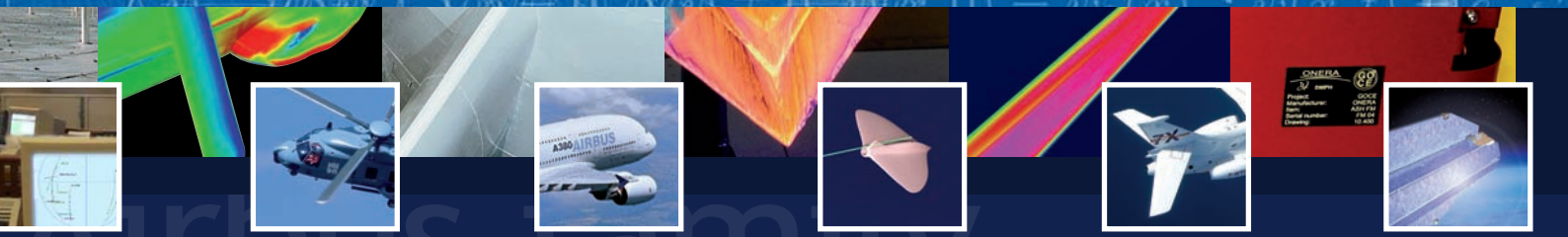


Return on innovation

Airbus family
Helicopters
Falcon 7X
Fermat software
Graves radar
ASMP missiles
UCAVs
Space accelerometer
Huygens
JEATS

ONERA

THE FRENCH AEROSPACE LAB

ONERA

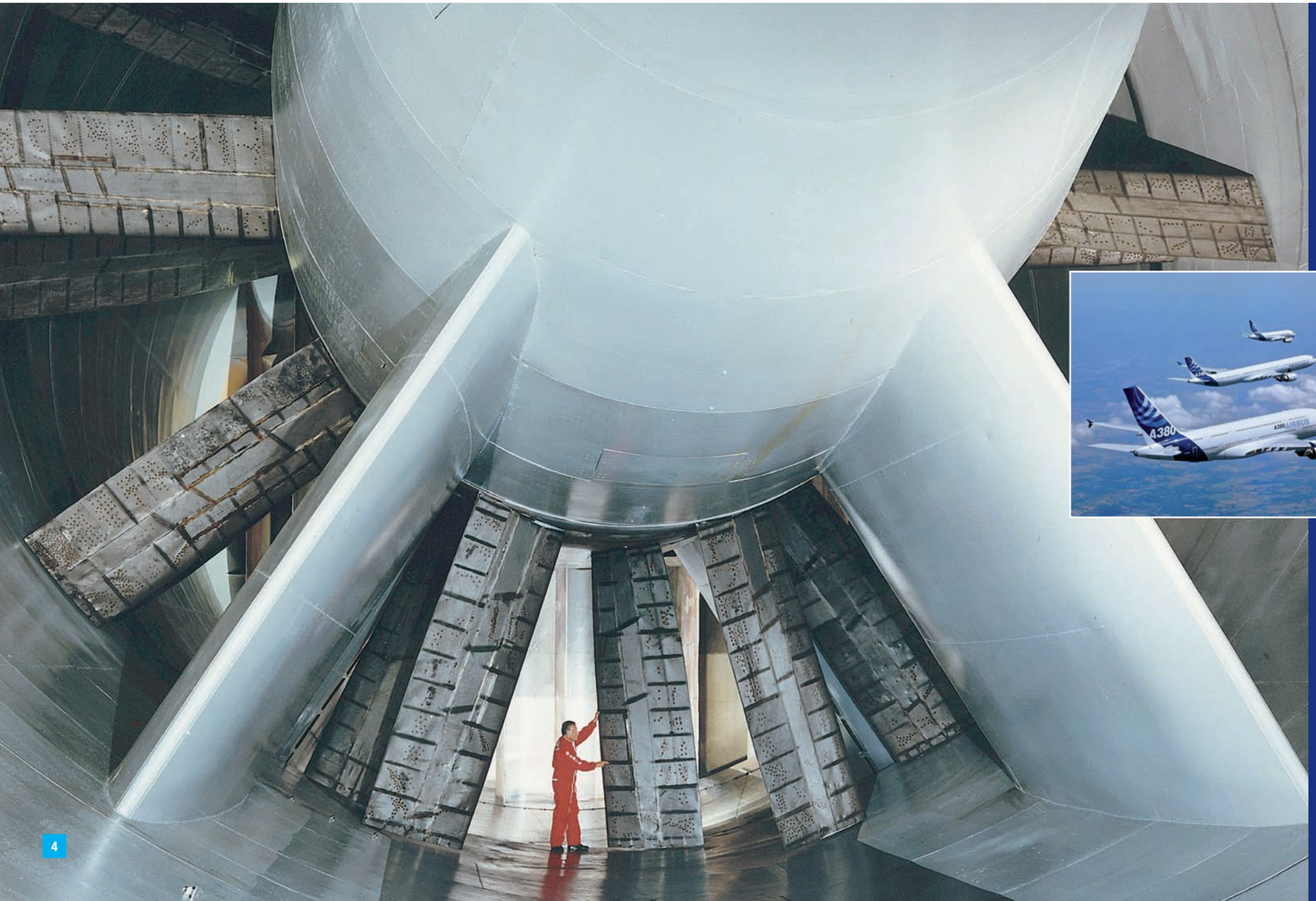
THE FRENCH AEROSPACE LAB

Onera is the leading French aerospace research organization, accounting for one-fourth of all application-oriented research for French industry.
A public establishment with 2,000 employees, Onera is the gateway between science and industry. Onera conducts and directs research initiatives keyed to industry requirements. It is a true multidisciplinary organization, with expertise spanning energetics, aerodynamics, materials and structures, flow physics, electromagnetism, optics, atmospheric and space environment physics, information processing, complex systems, long-term design and systems integration.

return on innovation

Return on innovation expresses Onera's basic mission and pledge: to convert research and solutions into successful applications for the companies and organizations that have placed their trust in us. Research at Onera, whether short, medium or long-term, always targets applications.
It results in innovative solutions transferred to industry and addressing the challenges facing Society. At Onera we anticipate future needs and develop our knowledge base to address these needs.
By investing in research today, we are ensuring a return on innovation tomorrow.

Denis Maugars
Chairman and CEO, Onera



Airbus family

Innovation springs from a wind tunnel

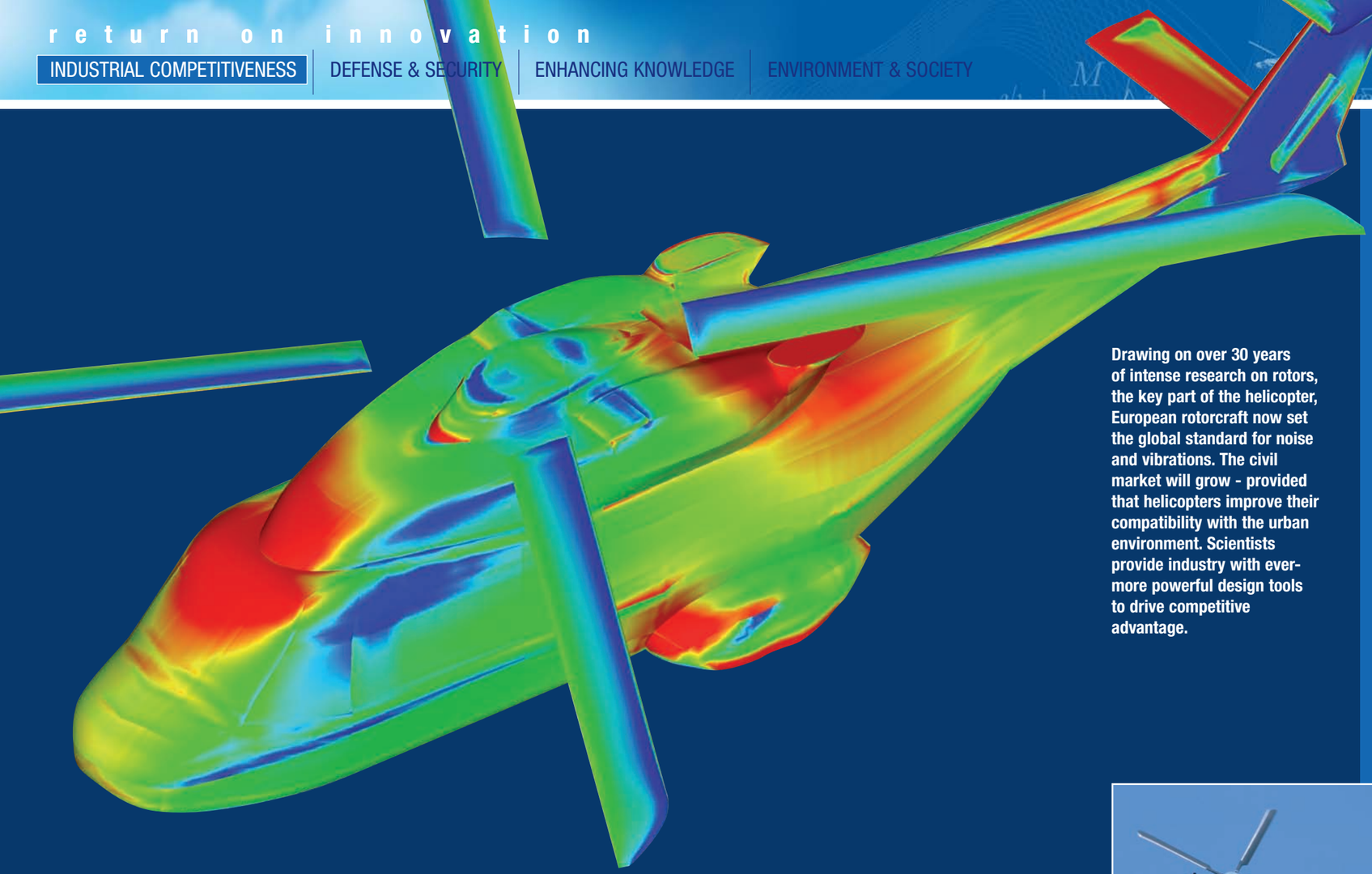
Onera deploys a fleet of world-class wind tunnels, which play a pivotal role in nurturing innovation in the aerospace industry. Aircraft and engine manufacturers, as well as researchers, can draw on our proven expertise to develop products with a competitive edge. We also continuously improve our wind-tunnel facilities and techniques to deliver top-flight experimental solutions.

Challenge: From the original Airbus A300 to the new A380 and the upcoming A350, each model in the Airbus family incorporates the state-of-the-art innovations needed to meet the daunting challenges of air transport, from traffic growth to environmental requirements.

Onera advantages: Onera's large wind tunnels at Modane and Fauga-Mauzac have always played a vital role in Airbus development programs. For instance, advanced engine testing allowed Airbus to optimize nacelle-wing interactions, while our development of pressure-sensitive paints reduced costs and lead times. Onera's innovative “sting” mounting system for wind-tunnel tests has been copied worldwide. Our balances have also earned global recognition, along with our instrumentation and the production of one-off models for advanced testing.

Return on innovation: Pushing back the boundaries of knowledge, we validate calculations and predictions. We continue to improve testing facilities and techniques for more precise characterization of physical phenomena, generating more information - faster and more accurately - and shortening the development cycle for new aircraft. Our seasoned teams of experimentalists make a direct contribution to enhanced industry competitiveness.

Tomorrow: Computer-aided wind tunnels, combining the power of numerical and experimental simulation.



Drawing on over 30 years of intense research on rotors, the key part of the helicopter, European rotorcraft now set the global standard for noise and vibrations. The civil market will grow - provided that helicopters improve their compatibility with the urban environment. Scientists provide industry with ever-more powerful design tools to drive competitive advantage.

Helicopters

The next 100 years of innovation

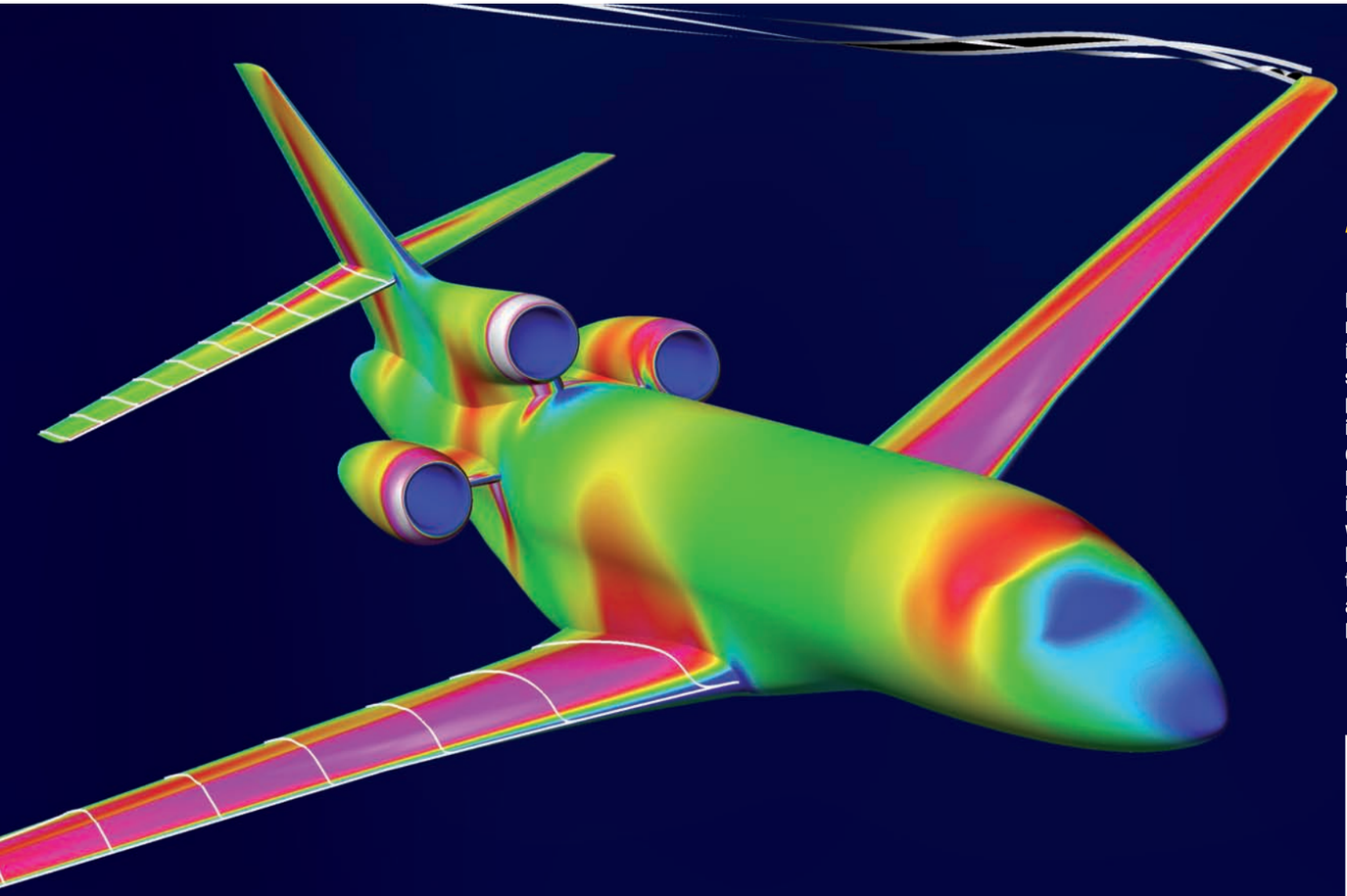
Challenge: Long considered noisy, the helicopter is becoming quieter. Its turbine engines are more efficient, and it offers higher performance and greater comfort. But more research is needed to drive these ongoing improvements.

Onera advantages: Complementary numerical simulation and experimentation to define blade tips and airfoils, and create new shapes. Onera continues to enrich its aerodynamic computation codes validated bu experimental date bases. Extensive wind-tunnel tests, on the Erato research rotor for instance, have demonstrated considerable noise reduction potential.

- Onera developed the aeroacoustic computation code used by Eurocopter to predict and reduce noise; it helps defining flight procedures for urban environments.
- Onera has an unmatched grasp of Eurocopter's requirements because our laboratories study all key aspects fo helicopter. Furthermore, we can call on the vast potential of our joint French-German research program to tackle each new project with a overall perspective and multidisciplinary skills.

Return on innovation: Back in the 1970s Onera designed the blade airfoils for the Ecureuil helicopter. Today, most of Eurocopter's civil and military machines use airfoils and blade tips designed by Onera.

Tomorrow: The next breakthrough will undoubtedly be rotors with active-control blades, now being studied by joint French-German teams and ready to move from concept to test. Scientific research is also shaping tomorrow's tiltrotors and unmanned aerial vehicles (UAV).



Falcon 7X

An innovative wing for higher performance

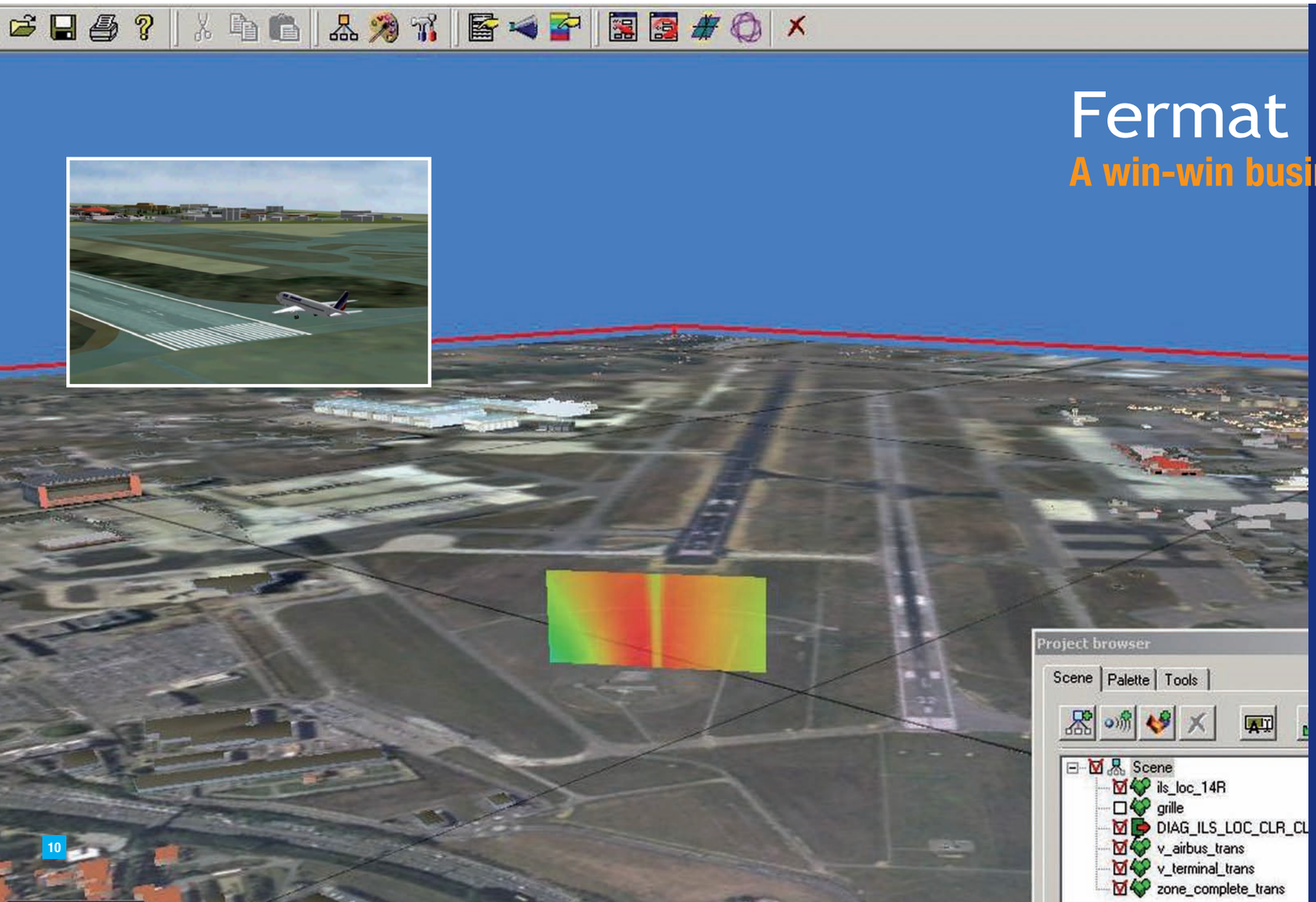
Dassault Aviation's new Falcon 7X business jet is already a major market success. During the design phase, Onera helped enhance its aerodynamics and reduce drag, to lower fuel consumption. More than 2,500 hours of testing in the high- and low-speed wind tunnels at Modane and Fauga-Mauzac helped validate the digital predictions, as well as the basic technical choices, like the use of winglets.

Challenge: Evaluate all possibilities for lower fuel consumption. The ability to accurately predict drag is a key to a successful aircraft, since it cuts fuel consumption, increases range and lowers operating costs.

Onera advantages: Onera is a visionary in this field, anticipating the demand for accurate drag predictions. After ten years of intensive work, our scientists have become leaders in this key discipline. To design its new Falcon 7X bizjet, Dassault Aviation used an innovative drag “extraction” method developed by Onera. It uses CFD (computational fluid dynamics) to provide a precise forecast of drag, including details on its different components. This impressive achievement also reflects Onera's unmatched ability to combine numerical modeling and experimentation, including wake vortex detection and measurement in our wind tunnels.

Return on innovation: Using CFM to analyze the aerodynamic field around the plane, plus measurements of a test model in the wind tunnel, have enhanced the Falcon 7X's aerodynamic performance while also reducing design time.

Tomorrow: Onera's scientists are now concentrating on extending these methods, already perfectly suited to the cruise phase, to other flight phases (at low speed for instance), and adapting them to all types of computation meshes.



Fermat software

A win-win business/research partnership

Working with the company Oktal-SE and Paul Sabatier University of Toulouse, Onera developed an application called Fermat to model electromagnetic waves and predict their interaction with the environment. Marketed by Oktal-SE for both civil and military applications, Fermat is a success in international markets.

Challenge: Predict the radar cross-section to characterize an object's signature according to the observation angle, for new detection, recognition and identification applications; simulate the environment at sites like airports, where the many different equipment items can cause interference. Today, these indispensable calculations can be handled by Fermat software.

Onera advantages: Combine electromagnetism and ray tracing to integrate wave propagation and the wave's diverse interactions with objects in the scene (reflections, diffusion, diffraction). Only Fermat offers this capability.

Return on innovation: With both civil and military use of the radio spectrum exploding (mobile phones, DTTV, GNSS, etc.), Fermat meets a crucial need for tools capable of predicting the operation and interaction of these systems with the environment. Fermat is also a culmination of impressive scientific work at the crossroads of information systems and electromagnetism, plus synergies between Onera and university design teams and the company Oktal-SE, which produces, publishes and markets the software. The upshot is fast-growing export sales plus major clients worldwide.

Graves radar

Europe's first space surveillance system

Onera was fully responsible for the design and construction of the Graves space surveillance radar, from initial feasibility studies, to the overall architecture and performance assessment using a demonstrator. It gave the French air force a fully operational space surveillance system, capable of tracking satellites in low orbit.

Challenge: Space capabilities underpin national independence and sovereignty, in both civil and military terms. Europe, like other major powers, wants to know about everything that overflies its territory. A vital first step was to give the French air force an operational space surveillance system.

Onera advantages: The Graves system designed and built by Onera under contract to French defense procurement agency DGA is truly innovative: it is a total solution combining a bi-static radar with orbital data processing, using sophisticated digital techniques. A fully automated system, it creates and updates a database containing satellite orbital parameters. Based on innovative, yet proven technologies, sourced from dynamic small businesses, Graves is a reliable, robust and low-cost system

Return on innovation: The French air force's aerial operations and air defense command center has operated Graves since the end of 2005, identifying a total of 2,000 objects flying over France, including about 20 that weren't listed in the American catalog. Its original design makes it fully autonomous, with performance exceeding initial expectations and dispatch reliability among the best of any air force system.

Tomorrow. Graves is the first building block in a surveillance system that will add imaging and fine analysis capabilities. Onera has the full range of competencies needed to meet these new challenges, including radar and optical imaging technologies. Graves paves the way for the development of advanced space debris detection and tracking systems.

ASMP missiles

Ramjet and ducted rocket development

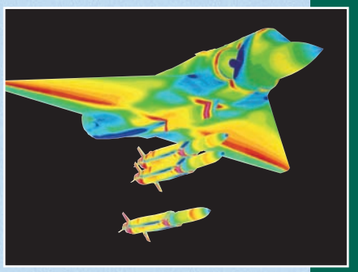
The ASMP missile, developed through an exemplary partnership between DGA, Onera and Aerospatiale, entered service in 1986. The new-generation ASMP/A will take over in 2008. After 30 years of close-knit teamwork between scientific and industrial teams, Onera and MBDA are already working on the next generation of this key component in France's national deterrent force.

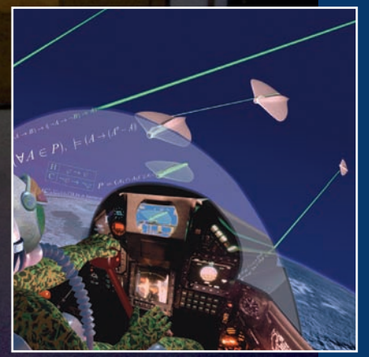
Challenge: In 1978, the French government launched the development of the ASMP medium-range air-to-surface missile for its nuclear deterrent force, offering standoff range and Mach 2+ speed to penetrate enemy defenses. But a missile powered by a solid rocket motor would weigh over 4.5 tons, making it inappropriate for this mission.

Onera advantages: Ramjets, which Onera has developed and tested since its creation, offered a breakthrough propulsion technology for supersonic missiles. Based on thes new concepts developed by Onera, tested and then transferred to the manufacturer Aerospatiale, France was able to launch the ASMP program. It was deployed starting in 1986, right on schedule!

Return on innovation: In addition to its innovative propulsion system, our scientists also designed the internal and external aerodynamics, low-stealth and control laws, plus performance enhancements. With the geopolitical environment rapidly changing, as early as 1984 Onera and industry were already planning for a follow-on version: the upgraded ASMP/A. France's aerospace lab worked on all critical aspects of this missile, which made its first test launch in 2005. In addition to strategic missiles, ramjets or ducted rocket are also used for tactical missiles such as future generation long-range air-to-air missiles.

Tomorrow: Onera is already working on future versions, including a mid-life upgrade of the ASMP/A, or a hypersonic long-range air-to-surface missile, combining very high speed and long range.





UCAVs

Innovative technologies for the future

Along with surveillance drones, unmanned combat air vehicles (UCAVs) will be the next step in an integrated defense system. Onera, a prime source of innovative solutions for aerospace and defense in France, is already fully committed to the UAV "system of systems" concept, driving basic research to develop enabling technologies.

Challenge: Tomorrow's armed forces will deploy increasing numbers of pilotless aircraft. But first we have to demonstrate their ability to carry out surveillance missions, as well as deliver precision weapons at a distance. Meeting these objectives depends on high reliability, system integration and low-observability.

Onera advantages: Radar and infrared stealth, non-conventional airframe shapes, fluid control surfaces, embedded powerplants, bay-carried stores and new control laws - just some of the topics now under study at Onera, in conjunction with industry. This type of research demands sophisticated modeling, coupled with wind-tunnel tests. Onera's extensive digital and experimental systems really come into their own in this field.

Return on innovation: Research into UAVs has helped develop new vehicle architectures. It also paves the way for applications that will call on their unrivaled ability to penetrate enemy defenses, as well as very long endurance.

Tomorrow: Eventually, surveillance drones, UCAVs, manned combat aircraft and missiles will all be part of an integrated defense network. Tomorrow's armed forces will have to count on unmanned aerial vehicles.

Space accelerometers

Global leadership

Onera is a key partner to the space agencies NASA, ESA and CNES, supplying ultrasensitive accelerometers for missions spanning oceanography, geodesy, geophysics, climatology and fundamental physics.

Challenge: Measure extremely weak forces and control infinitesimal movements, determine the Earth's gravity field and its monthly fluctuations, verify Einstein's equivalency principle to the 15th decimal point, measure ice melting in the Antarctic… just some of the challenges facing scientists today. Since they can't be met on Earth, we conduct space missions.

Onera advantages: Starting in the 1960s, Onera's researchers conceived contactless suspension devices (based on electrostatic forces) with accelerometer proof masses to design ultrasensitive detectors. The first one, dubbed Cactus, was qualified in orbit from 1975 to 1979. Onera then called on all its expertise to develop a device used to characterize microgravity on the Columbia Space Shuttle in 1996-97. These instruments lived up to their promise. Since then, our scientists have continued to push back the frontiers of high-resolution capacitative metrology, high-precision mechanics and finely controlled electrostatic design to develop ultrasensitive spaceborne accelerometers. For example, we provided the Star accelerometer on the Champ satellite, and the Super-Star accelerometers for the two Grace satellites - all three still operational, with the first in orbit for seven years already.

Return on innovation: The first of ESA's four Earth Explorer missions, Goce, to be launched around 2008, will map the Earth's gravity field with unprecedented accuracy. The CNES/ESA mission MicroScope will test the equivalency principle. Onera provided the accelerometers for the gradiometer on Goce, and is prime contractor for MicroScope's scientific payload.

Tomorrow: A post-Grace/Goce mission has already been proposed, using similar technologies. The Girafe matter wave gravimeter, marking an ambitious new objective in precision, is now being defined. Based on the cold atom interferometry principle, it is designed for absolute gravity measurements for new spaceborne applications.

Huygens

History of an interplanetary success

On January 14, 2005, the European spacecraft Huygens made a soft landing on Titan, one of Saturn's moons. The data generated during this mission has provided a rich harvest of discoveries. Following are some of the highlights in an international interplanetary mission that called on Onera's vertical wind tunnel in Lille and the Toulouse research center.

Challenge: Understanding atmospheric reentry is a key to the success of both planetary exploration missions and the development of tomorrow's reusable launch vehicles.

Onera advantages: It all started back in 1985, when ESA commissioned a study of a probe's entry into the atmosphere of Titan, in particular a truncated heat shield. Scientists had to determine the heat flux and choose the best material. In 1991, they studied the two reentry phases: a ballistic phase involving strong thermodynamic heating and high speeds (could the parachute be released under these conditions?), and a free-fall probe stabilization phase. Experiments were needed to simulate the dynamic system, comprising the heat shield, probe and parachute. Onera's vertical wind tunnel in Lille, one of only three in the world, along with facilities in the U.S. and Russia, was just what the doctor ordered! Engineers designed tests in compliance with the three similitudes (geometrical, aerodynamic, Froude similitude), accounting for different layers of the atmosphere. In Toulouse, Onera's researchers focused on the atmospheric particles recovered during the descent to Titan at a temperature of 70 K, and successfully integrated the ACP (Aerosol Collector and Pyrolyzer) experiment in a chamber that duplicated the space environment.

Return on innovation: After a trip lasting seven years and covering some 3.5 billion kilometers, the Huygens probe made a perfect descent through Titan's atmosphere.

Tomorrow: Onera is now analyzing aerothermal phenomena (through numerical simulation and wind-tunnel tests) and developing innovative onboard measurements techniques to provide its invaluable reentry expertise on the Pre-X experimental vehicle, whose first flight in the Earth's atmosphere is slated for 2010.

IFATS

The shape of air transport in 2040-2050

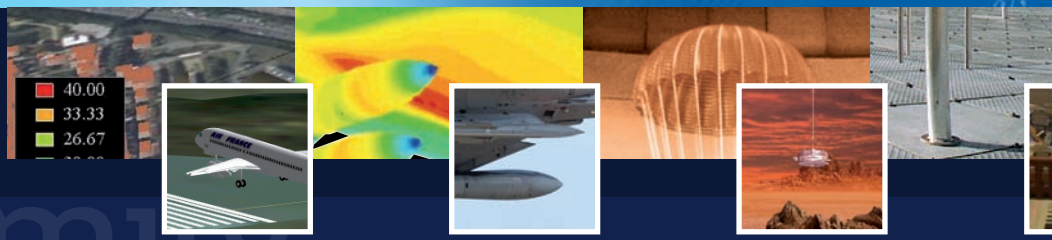
Facing air traffic bottlenecks and growing environmental pressures, the automation of our air transport system could provide solutions. European researchers, universities and industry are teaming up to imagine an air transport system that requires neither pilots nor controllers. Onera came up with this automated system concept, and is coordinating partners through the IFATS (Innovative Future Air Transport System) initiative.

Challenge: A plane without a pilot, a control tower without the controller… Is this a planner's dream, or a passenger's nightmare? Neither, but rather the long-term work of an Onera-led industry/academia/research consortium, which is trying to determine to what degree the air transport system can be automated.

Onera advantages: The European project IFATS (Innovative Future Air Transport System), running from 2003 to 2007 and coordinated by Onera, conceived, modeled and evaluated an automated air transport system concept.

Return on innovation: Airlines would be able to submit their flights to this centralized system, which will calculate the optimum flightpath for each aircraft. They will then depart according to the assigned flight plan, following the system's recommendations. Of course, this automated system will be able to integrate failures and other problems that would inevitably arise sooner or later. The result would be enhanced safety and lower fuel consumption.

Tomorrow: New technologies, innovative air traffic management procedures, advanced technologies for “greener” aircraft…. It's up to us to model the audacious solutions proposed by researchers and industry. Onera has launched a new program called IESTA, providing a shared Europe-wide platform that would be able to evaluate all concepts designed for tomorrow's air transport system.



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Published by Onera - Communications Department - May 2007 • Printed by K design impression
Photos: Airbus, Onera, Yannick Chosse, CNES, ESA, Dassault Aviation, DLR, Eurocopter, CD Art, MBDA, Oktal-SE, Stephane Muratet, Rémi Poinot, X.