EREA NEWSLETTER
Association of European Research Establishments in Aeronautics
December 2008

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■ News from the Members

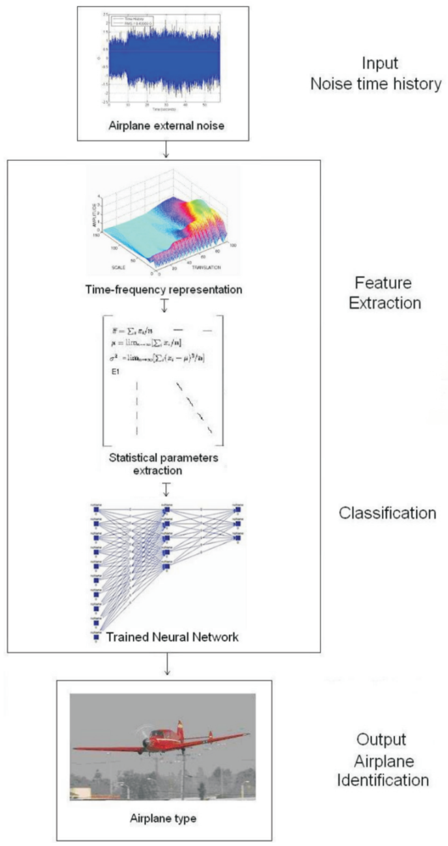
The "Monster" project: fighting against noise pollution

Aircraft identified through their acoustic signature

Noise pollution due to aircraft take-off and landing operations is perceived by the community who populates the vicinity of each airport, as the greatest impact on their life health.
This problem receives large attention, both by governing bodies that adopt more and more stringent measures to contain the noise impact, and by researchers and engineers, who are busy trying to find new solutions and technologies aimed at the containment of the noise emission.
All these efforts aimed to reduce the noise impact level in the surrounding of an airport can be meaningless, in case a single aircraft uses maneuver producing excessive noise, at low altitude immediately after take off or in the final approach path.
The development of an innovative, low cost system for the aircraft acoustic signature identification able to detect the excessive noise produced in a maneuver, could contribute towards the protection of the population from the harmful effects of air traffic both identifying the best maneuver to adopt for a low noise path, and working as a sort of "speed camera" to prove and eventually "punish" the "noisy" behavior.
The Monster (Monitoring of Noise at European Airports) project, selected and funded by the European Commission, was aimed to the development of such a system and after just three years of work a great deal has been done; coordinated by "Air Support", an Italian company located in Naples.
The project has involved various SMEs from Italy, Spain and Bulgaria, while CIRA and two others research institutes also participated.
The system developed, based on neural networks and on the statistical elaboration of signals, can now identify simply through noise emission. the aircraft, the maneuver performed, and the route taken. More than 200 take-off and landing operations were recorded and elaborated by researchers from CIRA's Vibrations and Acoustics Laboratory, at Capodichino Airport in Naples, with regard to five different aircraft: Airbus A320, Boeing B737, Mc Donnel Douglas MD80, Fokker F100, and Aerospatiale Alenia ATR72.
At the end of the project, a prototype was set up, consisting of four noise monitoring stations, located inside Capodichino Airport, and a Control station located at CIRA that receive and elaborate all the data collected.

The satisfactory results of the experimental tests (the margin of error resulted well within 5%) promise a great future to Monster-like systems which concept seems suitable for other purposes as well, such as for the surveillance of isolated and/or dangerous areas, for the continuous inspection of "no-fly zone", ensuring the respect of international agreements, and others.

Some interesting and promising applications outside aeronautic were also envisaged, such as the rapid detection of fires.



Flow-chart for the acoustic signature identification process.

Materials and Structures Research Center

For the Warsaw Institute of Aviation last year was a period of constant development and technological improvement, especially in materials' research domain. Materials and Structures Research Center (MSRC), unit of the Institute, which specializes in material, structural and non destructive tests and analysis, implemented the highest technology in fatigue research Strain Controlled Low Cycle Fatigue (SCLCF) testing. This technique is one of the most advanced in research performed for the commission of aircraft engines producers. As an outcome Institute of Aviation became a significant provider of that sort of services and joined the up-to-date laboratories' group which carries out tests of high-strength metals alloys in extremely high temperatures. Such technological implementation required the highest qualifications from laboratory personnel which were approved with certification of American aircraft engines producers such as: Pratt & Whitney and General Electric.

The same year MSRC was audited by specialists of Materials Testing from MTU Aero Engines, a leading producer of aircraft engines and driving sub-assembly for civil aviation and armament industry. This audit demonstrated MSRC's conformance with the applicable specification requirements for materials testing in accordance with applicable standards for Strain Controlled Low Cycle Fatigue (SCLCF), Load Controlled Low Cycle Fatigue Testing (LCLCF) and Creep Testing. As a result of audit MSRC was granted the certificate concerning above mentioned material testing techniques valid until 2011. Following this audit MSRC management visited MTU material testing laboratories in Munich and collected valuable knowledge on modern testing techniques.

MSRC's successful operating activities in the near future will eventually lead to the further development and uprising of new research units such as Metallographic & Fractographic Laboratory and Dynamic Testing Laboratory. Their objective is to create an innovative center for technical-scientific base support and to initiate wide cooperation for improvement of technologies in aircraft and aerospace industry between science and enterprise representatives. MSRC also announce participation in European research projects within Seventh Research Framework Programme.

■ EREA News

EREA at ILA 2008

EREA participated in the ILA 2008 air show with its own stand. During 4 days lectures were given at the stand on a variety of topics showing the capabilities and high level of excellence of the aeronautical European research establishments. Specific topics of interest were the environmental challenges for aviation to achieve the ACARE goals but also the longer term objectives beyond 2020. Other topics covered were amongst others dealing with UAV research and Future personal air transport system.

Technical presentation at ILA 2008

New EREA Member

Finland is now represented in EREA through the new associate member VTT (The Technical research Centre of Finland) in Helsinki. Contact persons for EREA in VTT are Executive Vice President Jouko Suokas and Customer Manager Aslak Siljander.

■ European Charter

EREA members adhered to the European Researcher Charter

On September 29, 2008, as many as 12 major aeronautical research organisations in Europe signed up a letter addressed to the Science & Research Commissioner Janez Potočnik, materializing their common decision to adhere to the principles of the European Charter for Researchers and on a Code of Conduct for the Recruitement of Researchers. The letter was handed over to the Commissioner who attended the signature ceremony. The presidents or general directors of the 12 members and associate members of the European Research Establishment in Aeronautics (EREA) association came together to express their willingness to adhere to the Charter. Denis Maugars, ONERA President & CEO, and Fred Abbink, General Director of NLR, respectively Chairman and vice-Chairman of EREA, were the final signatories of the adhesion letter. The Charter and Code initiative is a cornerstone "of the overall process to improve career development and the mobility of European researchers" and is fully in line with "the spirit of the European partnership for Researchers between the Commission and the Member States, which is at the heart of the European Research Area" said Janez POTOČNIK who welcomed the signature of this instrument by Denis Maugars and Fred Abbink. The initiative comes after EREA contributed to the debate on the new perspectives for the European Research Area and expressed its support to the charter. The signature of this adhesion letter is a recognition that, indeed, researchers are the most valuable assets of the EREA member organisations and therefore attractive careers and job conditions have to be offered to them. The Charter represents a common basis upon which these conditions can be built, at European scale, and therefore it should contribute to fostering mobility within and between the aeronautical research organisations members of EREA. The signature of this adhesion letter reflects also EREA intention to place itself as a prominent contributor to furthering ERA construction.

Commissioner Potočnik flanked by present and past EREA charimen, Denis Maugars and Fred Abbink.

The signature event took place in Rhode Saint Genèse near Brussels, at the premises of the Von Karman Institute VKI, one of the most recent associate members of EREA. VKI was named after the famous Hungarian/American engineer and physicist Theodore von Karman.

■ News from the Members

Windmills on the roof: NLR assists in development

This summer saw the first 'Own Urban Windmill' installed on the roof of a company in Arnhem. These small windmills are intended for private homes and companies, allowing them to ultimately generate a large share of their own energy. The National Aerospace Laboratory (NLR) developed the design for the windmill's enclosed cap.

The DonQI Urban Windmill - a product of the company DonQI Quandary Innovations – is a small wind turbine with a high yield. The windmill is specifically designed for use in urban areas. DonQI Quandary Innovations asked the NLR to help develop the 'Venturi', which is the horizontal tube that equalizes and thus accelerates the airflow. Despite its small dimensions, the Venturi aims to generate higher yields for the windmill. The target is 1400 kWh per year, based on an average speed of 4.5 meters per second. This would account for nearly half the electricity consumption of an average household.

In addition to accelerating the air flow, the turbine casing also dampens the noise generated by the rotors. The NLR calculations took into account the turbine casing's aerodynamic properties. NLR offered guidelines for creating the best looking design for the turbine casing. These guidelines were used in the windmill's design by DonQI Quandary Innovations who also patented the wind turbines.

For more information about the DonQI Urban Windmill: www.donqi.nl.

Fuel cell systems for applications in aeronautics, DLR and Airbus Germany get awarded for their common developments

At the 8th international fuel cell forum „f-cell“ in Stuttgart 29 September 2008 DLR and Airbus Germany together got the f-cell award silver. Subject of the award were the research activities of the DLR institute of technical thermodynamics on fuel cell systems for application in aeronautics that were performed together with Airbus Germany.

Fuel Cell Demonstrator - A320 ATRA

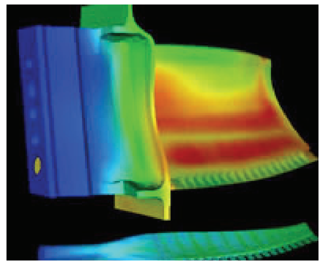
Since more than 5 years the DLR Institute of technical thermodynamics and Airbus Germany GmbH investigate in a strategic partnership the possible applications of fuel cell systems in aviation. The primary objective of the research is to replace the Auxilliary Power Unit (APU) at the rear of the aircraft by a fuel cell system. The APU is a gas turbine which is providing electric energy in order to run the aircraft systems on the ground without having to use the main engines. According to a study of the Zürich airport the APUs are responsible for about 20% of the NOx emissions at the airport.

Yet the on Board electrical power energy supply and the replacement of the APU alone do not justify the relatively big development effort for fuel cell systems. “The specificity of the concept of fuel cells in civil aviation is the so called multifunctional approach”, says Prof. Dr. Andreas Friedrich, director of the electrochemical energy department at the DLR institute of technical thermodynamics. “This means that we take advantage of the fact that the performance spectrum is not limited to the electrical energy supply”. In aeronautics several products of a fuel cell can be used, namely water and the oxygen poor exhaust air. The fuel cell can produce per kilowatt performance 0,5 liters of water per hour. That means that in the course of a long haul transatlantic flight 500 to 3000 liters of water can be produced and used depending on the aircraft type. By this you can drastically reduce the amount of carried along water and reduce also the size of the water tank.

Innovative is also the usage of the exhaust air, which is very poor in oxygen when leaving the fuel cell. Tests of some systems have shown that the exhaust air of the fuel cell system contains only 8 % of oxygen. These small oxygen shares have the effect to be fire and explosion resisting within the Kerosine tank. By this the new standards of the European and American civil aviation authorities concerning fire resisting systems can be met.

“Two in one” calculations

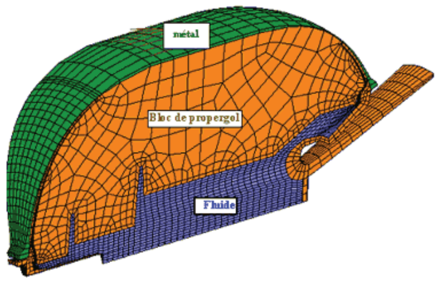
The air deforms the structure of an aircraft, while the aircraft’s vibrations modify the air flow. To take all of these phenomena into consideration, ONERA is developing models coupling fluid mechanics and solid mechanics.



Temperature calculation of a turbine blade where the wall and a cooling channel are taken into account, with coupling of “fluid” and “solid” software (Cedre and Abaqus resp.).

In numerical simulations of aircraft, fluid mechanics specialists model the motion of air around the wings or in the engines, and structural mechanics researchers analyze the behaviour of the mechanical parts. But the air and the aircraft’s structure are not unrelated: they interact with one another. The air flow deforms the wings, causing vibrations, which in turn modify the fluid flow. The complexity of these phenomena must be taken into consideration in “multi-phy” simulations.

“Unfortunately, there is no universal calculation software”, regrets François-Xavier Roux, researcher at the ONERA “Modeling and Information Processing” Department (DTIM). “The fluid and mechanical structure calculations are already complex, and the same language isn’t used in these fields, nor the same meshing (dividing space into small volumes, or elements) and it would thus be very complicated to create a new calculation code integrating both branches of physics”. It is simpler to link existing software programs. “We do not know how to calculate both aspects at the same time”, the researcher points out. “That is why we carry out successive calculations with multiple round trips between the two calculation programs, introducing structure calculation information into fluid calculation and vice versa”. These software programs operate simultaneously on a network of computers, and thus it is necessary to fine tune the data exchange between the machines.



Fluid /solid meshing of the geometry of a simplified thruster. The front is on the left and the gas ejection nozzle is on the right. The fluid /structure coupling allows access to the thruster distortion, including that of the metallic envelope, as the pressure rises.

Jean-Didier Garaud, PhD from the Solid Mechanics and Damage Mechanisms Department (DMSE) is interested, for example, in flow issues in the cooling circuit of the Vulcain2 engine of the Ariane launcher

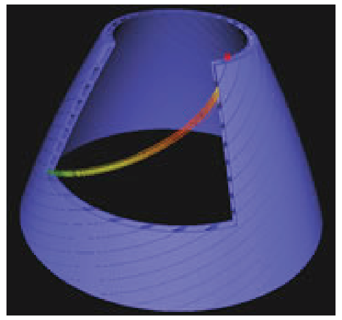
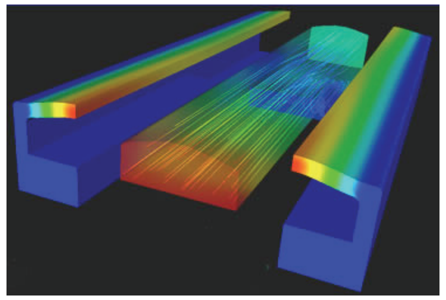


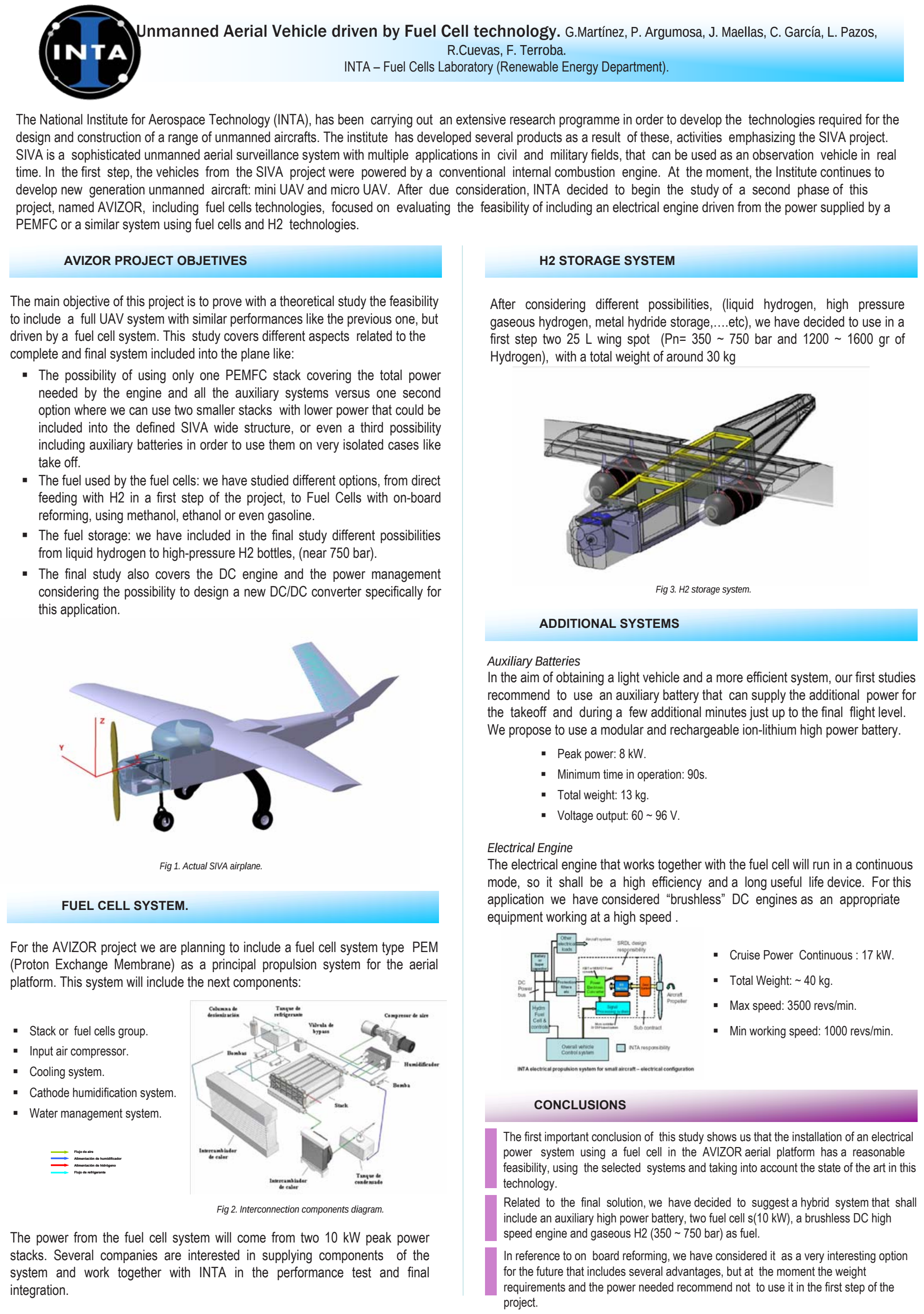
Diagram of the upper part of the Vulcain nozzle, comprised of 288 tubes made of Inconel 600, in which hydrogen cools the wall.

This circuit is made up of hollow tubes with a rectangular cross section, coiled in a spiral around the nozzle wall and through which hydrogen circulates to cool the walls. Besides the motion of air and mechanical parts, it is necessary to take into consideration the heat exchanges, which also deform structures. If the deformation is too strong, the nozzle may break, or prevent the passage of fluids. “We have carried out calculations taking into consideration the thermal aspects”, says the researcher. “The result is satisfactory: we correctly reproduce the thermal exchanges, both in the steady and unsteady states (integrating the changes in time)”.

These calculations were carried out in this case by coupling fluid mechanics software developed by ONERA [Cedre], with a mechanics software [ZebuLoN] designed by ONERA in collaboration with Ecole des Mines in Paris. They were the subject of a thesis. A second thesis is underway dealing with the behaviour of the nozzle in the case of large deformations. “This is the type of service that industrialists expect of ONERA”, says François-Xavier Roux. “It is not just a case of being a specialist in a field, but also to give a global answer to a question. This is why it is of interest to be multidisciplinary”.



The two branches of physics – here, the flow of a fluid and the structure deformations, are separately solved by two different specialized software programs, using the coupling method called “partition”.



Unmanned Aerial Vehicle driven by Fuel Cell technology. G.Martínez, P. Argumosa, J. Maellas, C. García, L. Pazos, R.Cuevas, F. Terroba.
INTA – Fuel Cells Laboratory (Renewable Energy Department).

The National Institute for Aerospace Technology (INTA), has been carrying out an extensive research programme in order to develop the technologies required for the design and construction of a range of unmanned aircrafts. The institute has developed several products as a result of these, activities emphasizing the SIVA project. SIVA is a sophisticated unmanned aerial surveillance system with multiple applications in civil and military fields, that can be used as an observation vehicle in real time. In the first step, the vehicles from the SIVA project were powered by a conventional internal combustion engine. At the moment, the Institute continues to develop new generation unmanned aircraft: mini UAV and micro UAV. After due consideration, INTA decided to begin the study of a second phase of this project, named AVIZOR, including fuel cells technologies, focused on evaluating the feasibility of including an electrical engine driven from the power supplied by a PEMFC or a similar system using fuel cells and H2 technologies.

AVIZOR PROJECT OBJETIVES

The main objective of this project is to prove with a theoretical study the feasibility to include a full UAV system with similar performances like the previous one, but driven by a fuel cell system. This study covers different aspects related to the complete and final system included into the plane like:

- The possibility of using only one PEMFC stack covering the total power needed by the engine and all the auxiliary systems versus one second option where we can use two smaller stacks with lower power that could be included into the defined SIVA wide structure, or even a third possibility including auxiliary batteries in order to use them on very isolated cases like take off.
- The fuel used by the fuel cells: we have studied different options, from direct feeding with H2 in a first step of the project, to Fuel Cells with on-board reforming, using methanol, ethanol or even gasoline.
- The fuel storage: we have included in the final study different possibilities from liquid hydrogen to high-pressure H2 bottles, (near 750 bar).
- The final study also covers the DC engine and the power management considering the possibility to design a new DC/DC converter specifically for this application.

Fig 1. Actual SIVA airplane.

FUEL CELL SYSTEM.

For the AVIZOR project we are planning to include a fuel cell system type PEM (Proton Exchange Membrane) as a principal propulsion system for the aerial platform. This system will include the next components:

- Stack or fuel cells group.
- Input air compressor.
- Cooling system.
- Cathode humidification system.
- Water management system.

Fig 2. Interconnection components diagram.

The power from the fuel cell system will come from two 10 kW peak power stacks. Several companies are interested in supplying components of the system and work together with INTA in the performance test and final integration.

H2 STORAGE SYSTEM

After considering different possibilities, (liquid hydrogen, high pressure gaseous hydrogen, metal hydride storage,….etc), we have decided to use in a first step two 25 L wing spot (Pn= 350 ~ 750 bar and 1200 ~ 1600 gr of Hydrogen), with a total weight of around 30 kg

Fig 3. H2 storage system.

ADDITIONAL SYSTEMS

Auxiliary Batteries
In the aim of obtaining a light vehicle and a more efficient system, our first studies recommend to use an auxiliary battery that can supply the additional power for the takeoff and during a few additional minutes just up to the final flight level. We propose to use a modular and rechargeable ion-lithium high power battery.

- Peak power: 8 kW.
- Minimum time in operation: 90s.
- Total weight: 13 kg.
- Voltage output: 60 ~ 96 V.

Electrical Engine
The electrical engine that works together with the fuel cell will run in a continuous mode, so it shall be a high efficiency and a long useful life device. For this application we have considered “brushless” DC engines as an appropriate equipment working at a high speed .

INTA electrical propulsion system for small aircraft – electrical configuration

- Cruise Power Continuous : 17 kW.
- Total Weight: ~ 40 kg.
- Max speed: 3500 revs/min.
- Min working speed: 1000 revs/min.

CONCLUSIONS

The first important conclusion of this study shows us that the installation of an electrical power system using a fuel cell in the AVIZOR aerial platform has a reasonable feasibility, using the selected systems and taking into account the state of the art in this technology.

Related to the final solution, we have decided to suggest a hybrid system that shall include an auxiliary high power battery, two fuel cell s(10 kW), a brushless DC high speed engine and gaseous H2 (350 ~ 750 bar) as fuel.

In reference to on board reforming, we have considered it as a very interesting option for the future that includes several advantages, but at the moment the weight requirements and the power needed recommend not to use it in the first step of the project.

UHTC-based Hot Structures: another step towards Hypersonic Transportation System

On October 28th and 29th 2008 at CIRA premises in Capua, Italy, was held the 1st Workshop on Science and Technology of UHTC-based Hot Structures; the event, organized by CIRA and CSM (Centro Sviluppo Materiali: a research centre sited near Rome and focused on materials), was aimed to present to the scientific community and press the progresses achieved towards hypersonic transatmospheric airplanes and space vehicles development.

The Workshop, which was attended by the major experts in this branch on behalf of ESA, NASA and the Italian Space Agency (ASI), Universities and Industry, was an important opportunity to meet and take stock of the hypersonic transportation technologies status.

The innovative techniques and materials employed to produce some prototypes currently under testing in CIRA’s Plasma Wind Tunnel, like the sharp-configured nose and wing leading edge (notoriously, the most critical parts of an hypersonic vehicle for being subjected to very high heat fluxes and temperatures) merit the centre of the attention, demonstrating the result of the strong technological effort that is allowing Italy to become an important actor in the field of advanced thermo-structures needed in the development of new generation hypersonic aircraft and space vehicle.

FLYSAFE in thunderstorms

Last summer the National Aerospace Laboratory (NLR) has successfully completed 21 weather-related measurement flights for the European Union project FLYSAFE.

As part of the FLYSAFE project, NLR’s Metro II research aircraft regularly flew near thunderstorms over a period of two months, as the pilots searched for storm clouds. These flights marked the first time that real-time weather forecasts relayed from the ground - via a Satellite data link - have ever been combined with information derived from a weather radar system installed on board the Metro II, with the combined results then displayed on a test screen in the aircraft cabin.

Never before has weather information onboard an aircraft been obtained and processed in this way. By combining weather forecasts received from the ground with the data from the onboard weather radar system, thunderstorms can be located with high reliability. Moreover, it also becomes immediately apparent what lies behind the thundercloud: is another thundercloud approaching? And how fast is it developing? Current radar systems cannot determine this. This improved presentation of weather conditions ultimately aims to improve flight efficiency, flight capacity and flight safety during bad weather.

A new Rockwell Collins Multiscan radar was installed on board the Metro II for these test flights. Once airborne, ice and storm-related weather data was relayed to the aircraft from ground stations. DLR, UK Met Office, Meteo France and the University of Hanover provided the weather data. Spain’s GTD, Portugal’s Skysoft and France’s Rockwell Collins were responsible for the software that combined the ground and onboard weather data. The Metro II flew near storm clouds over the Netherlands, Germany, France and Spain.

The FLYSAFE project aims to improve the integration of information flows in the cockpit, thus allowing pilots to better anticipate potentially dangerous situations. The better a pilot understands his location, the location of other aircraft, and the weather patterns, the better the pilot is able to make the right decisions.

FLYSAFE therefore focuses on reducing accidents caused by collisions with other aircraft or ground objects (such as mountains), and accidents caused by bad weather. The test flights conducted by the NLR concerned only those aspects related to weather conditions.

FLYSAFE stands for Airborne Integrated Systems for Safety Improvement, Flight Hazard Protection and all Weather Operations. The project involves 36 partners from 14 countries and has a budget of 53 million euro. It is partially funded by the EU under the Sixth Framework Programme

The Metro II’s test flights yielded a great amount of data, which is now being analysed. The results of this analysis will be used for various other projects, including CleanSky, a major European Union joint technology initiative aimed at developing the greener aircraft of the future.

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