

# **TAKE OFF**

## **Preliminary Results from the Aeronautics Research and Technology Programme**





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# Foreword

## Federal Ministry of Transport, Innovation and Technology

As a result of increasing global integration and societal mobility, the international aeronautics industry is experiencing dynamic growth. Air traffic is expected to double in Europe by 2020.

During this period of growth, the Austrian aeronautics industry has seen its revenues increase over the last two decades from 30 million euros to more than 620 million euros. Alongside the great aeronautics nations of Europe like France, Germany, Great Britain, Italy, Spain, the Netherlands and Sweden, Austria's aeronautics supply industry has had success in specialised niche areas. The aeronautics technologies developed in these segments have already been supplied to markets all over the world, with an export ratio of nearly 100%.

Despite continuing growth, this internationally oriented industry is also undergoing a period of consolidation, which brings difficult times for suppliers. The major aircraft manufacturers are reducing the number of their suppliers, supplier relationships are generally set up by the supplier themselves only after the risk-intensive process of developing their own technology, and the export trade holds additional risks. Among such intense competition, the Austrian aeronautics industry has prioritised expansion of new niche areas along with inclusion of new companies into this growth market, in addition to stabilising existing supplier relationships.

The Federal Ministry for Transport, Innovation and Technology supports this dynamic process with the specifically tailored national Aeronautics Research and Technology Programme TAKE OFF. This brochure provides a survey of its preliminary projects results and measures accomplished.

A stylized, handwritten signature in black ink that reads "Christa Kranzl".

**Christa Kranzl**  
**State Secretary, Federal Ministry of Transport,  
Innovation and Technology**

# Foreword

## Advisory Council for Aeronautics Research in Europe

ACARE has become an European symbol of common goals and cooperation in the aeronautics industry. The air transportation system remains one of the most prominent R&D segments in Europe, and will continue to play an important role in the 7th Framework Programme of the European Union. In this regard, the second Strategic Research Agenda (SRA 2) offers a preview of the technological demands on air traffic in the coming 13 years and provides a comprehensive and coherent picture of the technology requirement as well as clear indications of those technologies which must be the object of future research programmes.

By building on these appendages, a diverse range of challenges can be met: namely, those posed by a rapidly expanding aeronautics market, shorter product life-cycles, higher public awareness of environmental and energy issues, a more pronounced service-provider orientation, intensified competitive pressure and a concentration of national core competencies. Austrian aeronautics industry and research institutes, supported by the aeronautics programme TAKE OFF, will make a substantial contribution to the technological implementation of this Strategic Research Agenda and a continued deepening of research cooperation in Europe.



A handwritten signature in black ink, reading "J. Szodrach".

**Prof. Dr. Joachim Szodrach**  
**Co-Chairman of the Advisory Council for Aeronautics Research in Europe**  
**(ACARE – European Technology Platform for Aeronautics)**

# The Austrian Aeronautics Industry Success Story

Though the number of aeronautics suppliers in Austria is small, the Austrian aeronautics industry boasted an export ratio of nearly 100% and sales of approximately 620 million euros in 2006. With substantial capacity for innovation and a fast growth dynamic, the industry represents a vital factor in the national economy which also enjoys a positive relationship with the European aeronautics segment. As suppliers, Austrian firms are taking part in the most renowned European and American projects of the future. For example, about 2% of the parts for the Airbus A380 wide-body aircraft are being manufactured in Austria. South American, American and Asian markets are also being supplied to an increasing extent.

## Outstanding Achievements from Austria

As a leading manufacturer in the aeronautics supplier industry, Fischer Advanced Composite Components (FACC) produces for example flap track fairings, winglets, access doors, ground spoilers and empennage panelling. FACC also supplied the first engine components and spoilers for the Boeing 787 Dreamliner and performed design and production work for the entire interior decoration of the regional aircraft ARJ21 in China.

In the general aviation sector, Austria has reason to be proud of a firm like Diamond Aircraft Industries, which manufactures piston engine aircraft and recently entered the business jet market

with its D-Jet. Besides its factory headquarters in Wiener Neustadt, Diamond Aircraft Industries has set up additional locations in the USA and China. A joint venture in China was established under the name Shandong Bin Ao Aircraft Industries Co. Ltd. to produce the single-motor DA40 by European and Chinese certification standards in a joint project.

Schiebel, another Austrian star company, entered the UAV (unmanned aerial vehicle) market and now sells its CAMCOPTER S-100 worldwide. The vehicle is used in border security.

Frequentis, a global provider of communication and information systems, offers solutions in the area of air traffic management through voice communication systems, air traffic management networks, tower and airport tools, touch entry devices and voice/data recording. With these offerings, Frequentis has become the market leader in the area of voice communication in air traffic control.

TTTech, the market leader in time-controlled technologies and leading provider of event-controlled (CAN) and time-controlled (time-triggered protocol, TTP) communication systems, is one of the most successful Austrian start-up small and medium-sized firms in the aeronautics market segment. Its customers include Airbus, EADS, Boeing and Honeywell.







Austria has some 180 companies and research institutes in all, which operate in the aeronautics segment through the following fields of technology:

- Composite technologies for structures and engines
- Structural health monitoring
- Metallic materials and processes for engines, structures and interiors
- Contributions to improved and new engine concepts (combustion chamber)
- Integrated modular avionics and hardware
- Air traffic management – ATM
- Simulator technology
- Image recognition for security and meteorological objectives
- Environmental aspects – external and in the cabin

Over the last few years, a number of prominent strides have been made:

- In 1999, the Austrian Aeronautics Industries Group (AAIG) was founded. It represents the common interests of the 36 members (currently) of the Austrian aeronautics supplier industry at national and international level. The AAIG is also a member of the AeroSpace and Defence Industries Association of Europe (ASD).
- In 2000, an aeronautics research competency network (Austrian Aeronautics Research Network – AAR) was created. Eight relevant industry partners and three university partners joined together in this technology cluster dedicated to engineering, lightweight materials and composites. Within AAR, new materials are developed and new mathematical and experimental methods for describing and/or measuring and evaluating damages to materials under aviation operating conditions are formulated. Forecasting the lifespan of components will be made easier with new methods for online monitoring (structural health monitoring).
- Since the founding of the European technology platform ACARE in 2001, Austria - represented by the BMVIT - has taken an active role in this organisation.

As a member state of the European Union, Austria was able to integrate successfully into the international environment. However, this success has also led to a growing bottleneck.

The most important steps toward resolving the problem include financing for those R&D projects necessary for growth, employee qualifications, and the most rapid certification of companies according to the guidelines of American and European certification authorities.

# The Austrian Aeronautics Programme

## TAKE OFF

The concept behind TAKE OFF as a research promotion programme aims at increasing the competency of Austrian companies in key fields of technology, strengthening human capital and improving market entry opportunities for new technologies and products. As a result of high competency in research, technology and cooperation, along with networks and acquisition of know-how in the industrial and university sectors, the competitiveness of the Austrian aeronautics supplier industry will be further improved.

TAKE OFF aims both, to support Austrian researchers and companies in expanding their strategic European and international partnerships, as well as to support local firms in developing new markets. Over the long-term, this ought to increase sales in the Austrian aeronautics sector and strengthen high-tech production in Austria, which will in turn generate secure and highly skilled jobs. The programme was started in 2002.



### Implementation of TAKE OFF goals through five programme lines

Measures that are part of TAKE OFF have been broadly conceived and are covered by the following programme lines:

The **Special Research Programme in Aeronautics** programme line is orientated around fields of technology that are of particular strategic importance, in which potential is seen for Austrian R&D players in the international environment, based on existing competencies. Till now, the focus has been on materials, components and systems for aviation propulsion systems, structures and interiors, information and communication technology-based solutions for aviation, as well as system and process innovations in the areas of general aviation, maintenance, repair & overhaul and test facilities and ground supply equipment.

The **Qualification Measures** programme line aims at upgrading the qualification of employees, the development of computer-based training tools and supporting a lecture series at universities and technical colleges.

In the **Certification Offensive** programme line, the framework conditions for rapid certification have been created according to the guidelines of the European Aviation Safety Agency – EASA – in accordance with POA (production organisation approvals) and DOA (design organisation approvals). The industrial norm EN 9100 will take a prominent place as a future focus.

In the **Long-Term Financing Models for Risk-Sharing and Technology Validation Projects** programme line, consultations on guarantees for loans and development projects are given.

The purpose of the **International Participation** programme line is to support the formation of strategically important technological cooperation with partners abroad.



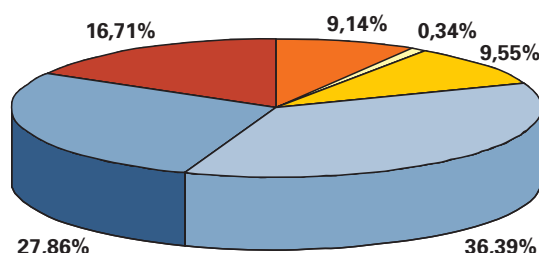
The programme is completed by accompanying measures and an agency function which is meant to support international networks as well as to provide information, give advice and do public relations work. As envisaged for all thematic technology programmes of the Federal Ministry of Transport, Innovation and Technology, a diverse range of consulting services for potential applicants as well as project recipients will be offered through comprehensive project management. TAKE OFF is managed on behalf of the Federal Ministry for Transport, Innovation and Technology (BMVIT) by the Austrian Research Promotion Agency (FFG), which also ensures the interface to space research through its Aeronautic and Space Agency.

### Summary of previous programme activities

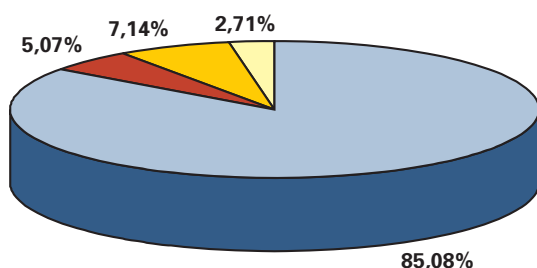
To date, 39 projects with an R&D volume of about € 20 million have been supported or commissioned through TAKE OFF. In supporting R&D projects, the focus of funding was on the

special research programme line. Within Austria, the distribution of funding up to now has clearly reflected the regional bases of the Austrian aeronautics industry and research institutes.

**Regional Distribution of Funding**



**Distribution of Funding by Programme Line**



### Measures during the 2004-2007 Certification Offensive

- A total of 13 trainings were completed, with about 290 representatives from 52 firms participating.
- In one coaching session for 16 firms, certification was prepared as companies with production organisation approval (POA) or design organisation approval (DOA) or as training sites.
- Up to now, eight certification processes have been completed.
- By the end of 2007, the trainings are to be completed and all 16 certifications obtained.

# Future Focus of the Programme

With the formulation of an Austrian FTI aeronautics strategy under general direction of the BMVIT, future measures in TAKE OFF will also be re-aligned with international developments. In doing so, these measures will be orientated towards new developments arising from the Strategic Research Agenda formulated by the technology platform ACARE, the reorientation of the 7<sup>th</sup> EU Framework Programme in the area of aeronautics including the planned "Clean Sky" Joint Technology Initiative, and the establishment of GALILEO and SESAR as large-scale European technological projects.

## Emphasis on Key Priorities

The future orientation of TAKE OFF will be focussed on the following priorities:

- Tendering of joint projects with a focus on industrial research
- Continuation and expansion of technological cooperation with international aeronautics corporations
- Articulation of a new certification offensive on the topic of EN9100 and re-alignment of the Qualification Measures programme line
- Fostering of cooperation within ERA-NET AirTN
- Coordination of TAKE OFF activities with the 7<sup>th</sup> EU Research Framework Programme
- Concluding the "Airborne" certification offensive as well as accompanying programme measures such as exchange of experiences among project recipients, dissemination of research results, or continuation of international networking



*"The Austrian Aeronautics Industries Group joined ASD (formerly AECMA) in 1999. We are happy to see this relatively new member proliferating and particularly acknowledge the contribution of comparably smaller high-tech companies in the European supply chain."*

**Charles Edelstenne, President of ASD**



# European Activities

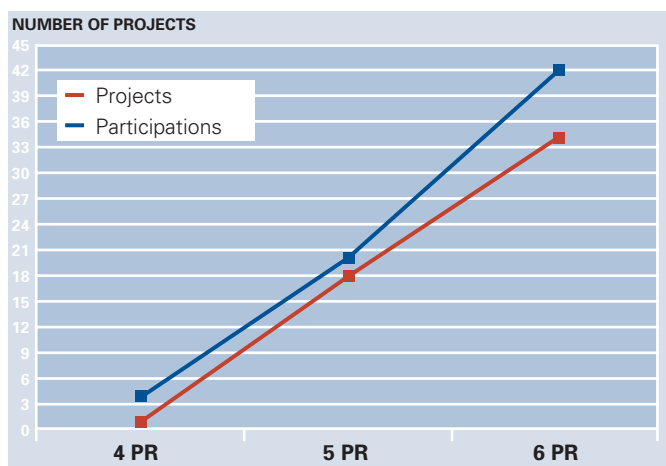
## ACARE – Advisory Council for Aeronautics Research in Europe

The BMVIT represents Austria within the European technology platform ACARE, the Advisory Council for Aeronautics Research in Europe, which brings together representatives of all key stakeholders in the aeronautics industry. The goal of ACARE is the implementation of the jointly-formulated European Strategic Research Agenda (SRA) by the year 2020.

## Fast-growing participation in the EU Research Framework Programme

The importance of public support for the R&D activities of the European aeronautics industry is clearly reflected in the growing endowment of the research budget in the area of aeronautics over the 4<sup>th</sup>, 5<sup>th</sup>, 6<sup>th</sup> and the beginning of the 7<sup>th</sup> EU Research Framework Programme (4<sup>th</sup> RP: € 260 million; 5<sup>th</sup> RP: € 700 million; 6<sup>th</sup> RP: € 840 million; 7<sup>th</sup> RP: € 300 million). Starting from a low level of participation in the 4<sup>th</sup> Framework Programme with only one Austrian company, Austria has since been able to increase its rate of return on investment to 1.11 %.

Austrian Participations in Aviation within the EU Frame Programs



## AirTN for exchange of experiences among national funding programmes

As part of strengthening the European Research Area under the 6th Research Framework Programme, "ERA NETS" were established to ensure cooperation and coordination among national funding programmes. With Austria's participation in the AirTN ERA NET, the interface between Austria's TAKE OFF programme and other European research programmes in aeronautics has been assured.

More flexible forms of cooperation between European member states are to be enabled and promoted through joint calls with individual partners from the other 26 ERA NET members. In AirTN, work package 3 (data gathering from aeronautics programmes of EU member states) is headed by BMVIT and operationally maintained by FFG.

## Environmentally-friendly wide-body aircraft through Clean Sky JTI

The "Clean Sky" Joint Technology Initiative is likely to be started under the 7th EU Research Framework Programme with a planned research funding volume of € 1.6 billion. The initiative, which has been started as a bottom-up research project by eight large European aircraft manufacturers under the leadership of ACARE, focusses at the radical reduction of the environmental impact of air transport. Thus, its goals are to reduce fuel consumption, develop low-noise aircraft and design the aircraft life-cycle to be more economical and ecologically balanced.

Thanks to their competitive position in the market, Austrian companies will contribute their expertise to the "Clean Sky" initiative as a cooperative partner. The research competencies they will share lie in the areas of composites, aluminium alloys, environmentally-friendly surface and production technologies, as well as electronics and power generation.

### **SESAR, a Europe-wide air traffic control and management system**

The Single European Sky initiative is meant to bring together the individual regional or national air traffic control agencies of Europe into a unified system in order to manage the future volume of air traffic in Europe. Together with a consortium, Eurocontrol (the European air traffic control agency) is creating a master plan for air traffic management as part of the SESAR project, which is to be implemented by 2020 with a financing amount of approximately € 1.8 billion, through a series of measures such as the development of high-performance data and voice telecommunication systems, mature automated systems for optimised landings and the active integration of satellite navigation in all phases of flight.

Austro Control (the Austrian air traffic control agency) is already a consortium member of the Air Navigation Service Providers Group and is cooperating on work packages such as the evaluation of ATM systems, the creation of an ATM master plan for consolidation and the identification of technical requirements for long-term implementation of ATM systems.

### **EREA – Association of European Research Establishments in Aeronautics**

EREA acts as a contact for its members vis-à-vis the European Commission and vis-à-vis representatives of industry interests, identifies future areas of research in the aeronautics sector and coordinates project submissions sent in response to announcements by the EU Research Framework Programme.

To ensure Austria's connection to European aeronautics research centres, ARC (Austrian Research Centers Ltd.) has been supported as part of TAKE OFF since 2003 and has been an associate member of EREA (Association of European Research Establishments in Aeronautics) since 2006.

### **Aeronautics Days 2006 in Vienna**

Thanks to the success of Austria's international network, in 2006 the European Commission held the Aeronautics Days 2006 in Vienna together with BMVIT, developing the event in association with the FFG as well as the DGLR (German Aerospace Society). From 19th - 21st June 2006, more than 860 international participants from government, industry and research came to the city to gain an overview of the scientific and technical achievements in aeronautics from the European Research Framework Programme, as well as to learn about current research findings presented by other member states.

The conference served as a discussion forum for government, industry and research on the outlook for strategic development in an expanded EU and was particularly focussed on the 7<sup>th</sup> EU Research Framework Programme. As a result of this conference, Austria was able to position itself as a small member country with a technology-intensive enterprise structure within the field of aeronautics.







## **INTCOS**

Integration of performance-optimised, structural components for systems

## **AEROPAR**

Development of aerodynamically sensitive large components made of composite material

## **INTERIOR-COMPONENTS**

Development of interior components for passenger aircraft

## **State of the Art SHM**

Technological and market potential for future SHM systems

## **REDUX**

Achievement of a continuous process chain for the efficient production of textile preforms



# Focus on Composites

Because of their excellent weight-specific rigidity and strength, as well as their integral production possibilities, composites are being used increasingly in aircraft construction. The Airbus A340 already owes 17% of its structure and components to composites. The figure is about 25% for the A380 and Boeing hopes to achieve a share of 50% for its "Dreamliner" 787 model.

Composites represent the largest share of sales for the Austrian aeronautics industry, at 30.6%.

As a first tier supplier & risk-sharing partner, FACC supplies interior components, panelling for the fuselage, wing and empennage as well as parts for the engine and the engine nacelle. HTP develops plastic parts and assemblies for the interiors of passenger aircraft. The Technical University of Vienna, FACC and PCCL have made innovative contributions to research.

Composites are also becoming increasingly attractive to the automobile industry. The challenge presented by these modern materials lies in combining "old" textile techniques such as sewing, weaving or knitting with new developments such as resin injection techniques or microwave hardening. Accordingly, Fischer, Westcam and Austrian Research Centers Ltd. are working with the Technical University of Vienna, Linz University and other international partners to develop a technique for automatic production of stitched textile preforms which are to be subsequently impregnated through the resin transfer molding (RTM) process.



*"Boeing appreciates the technological input of Austrian companies into the global aerospace market, which is demonstrated through the participation of our Austrian suppliers on the 787 Dreamliner and Next-Generation 737 programmes. Our Next-Generation 737 airline customers are benefiting from greater operational and fuel efficiencies as a result of installing blended winglets on their airplanes. These winglets, manufactured by one of our Austrian suppliers, demonstrate Austria's competence in aerospace."*

**Steven Schaffer, Vice President, Boeing Global Partners**

## Integration of Performance-Optimised, Structural Components for Systems

Weight reduction is a key technology driver for new aircraft development. The primary reason for this is that modern aircraft must operate ever more efficiently in order to ensure the competitiveness of airlines. Increasing the share of composite materials used in aircraft structures by substituting these for metallic components is one way of reducing weight; integrating component parts into complete structural systems is another.

In this project, various aircraft assemblies were analysed in terms of their use in the maximal integral method of construction which was also the most cost-effective. Because the selected components represented the entire spectrum of the firm's component portfolio, the required advances in technology could be evaluated for all relevant components (proof of fulfilling specified requirements).

In one example, a larger share of composites to replace metal parts was tested for a spoiler bracket and other wing components. The object of this exercise was not just to evaluate the use of new materials systems and an associated increase in performance, but also to analyse a possible increase of the value chain for this first tier supplier. Another component group under consideration is engine components, where significant potential for the use of new materials and production technologies is.

In future, engine parts must be designed to reduce noise in order to meet the requirements of environmental authorities. Accordingly, they were tested for improved acoustic properties and increased levels of integration.



The project resulted in key findings for the use of new materials, new production technologies and new design approaches not only with respect to technology, but above all, to cost-effectiveness. Principles were also articulated for deciding on the future technological orientation of the company.



### Infobox

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## Development of Aerodynamical Sensitive Large Parts made of Composite Material



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#### **Partner:**

LKR, Ranshofen

The development of the newest generation of wide-body aircraft poses enormous challenges for optimising the structure of aerodynamical sensitive components. Thanks to modern engines and aerodynamic improvements, wide-body aircraft of the newest generation are to become far quieter than the previous largest long-haul aircraft, the Boeing 747-400. That is why component parts must become lighter and more compact, in order to reduce the aircraft's weight, air drag and noise levels.

The objective of several design studies was the structural optimisation of flap track fairings for use in wide-body aircraft. Together with Airbus, new design criteria were formulated to compensate for the missing empirical values of these new component dimensions as well as to estimate the expected load levels. To do this, existing data was taken from earlier component development projects such as the A340-500/600 programme, and scale models were created and applied to analyse the enormous effects of increased size.

The goals in developing the structural design of components were the optimal selection of materials and their application in

order to fulfill static as well as dynamic requirements. In doing so, particular emphasis was put on the development of different sealing concepts and on achieving optimal surface properties through a deliberate selection of coatings. The component size also demanded the creation and evaluation of new reinforcement concepts, which resulted in a number of concrete solution approaches.

These design studies were also aided by building component prototypes which allowed simulation results to be verified with test components. The final test results were compared with initial test flight data from the Airbus A380. This allowed valuable findings to be gleaned for further improvements to this component series, which will go into subsequent product developments.



## Development of Interior Components for Passenger Aircraft

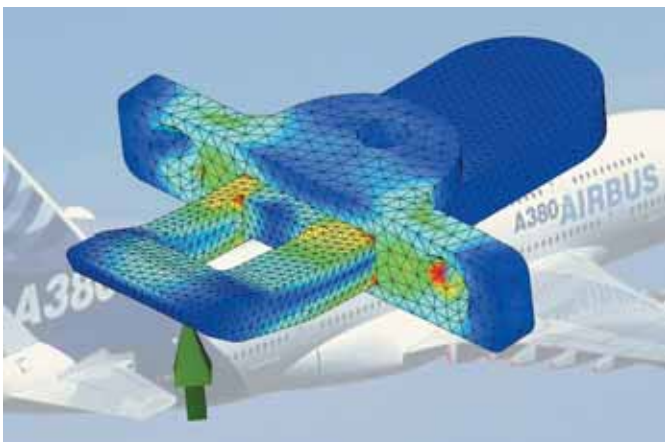
At the beginning of the new millennium, the international aeronautics industry's current projects are presenting new challenges to suppliers. In projects such as the development of the Airbus A380, it were not just traditional requirements which had to be fulfilled, such as the least possible weight. Suppliers were also asked to set new standards with regard to interior design, functionality and haptics.

The objective of the current project was to develop components for the cabin interior of passenger aircraft. In doing so, the primary emphasis lay on the use of high-performance materials in order to achieve the best possible combination of design, functionality and advantageous component weight. One way of doing this was by looking into the degree to which state-of-the-art technologies from the automobile industry, such as backmolding of décor films or gas assistant molding, could be transferred to the

more demanding requirements of aeronautics, particularly with regard to component weight and fire safety regulations.

Entire research and development packages were processed in a highly systematic project environment, accompanied by the creation of master documentation orientated specifically toward the development of cabin components, and which is to be applied in subsequent projects.

Afterwards, the results of the project were able to be successfully used in serial applications. To take two examples: a gas assistant molding process was used for the first time in producing components for the latch assembly of the A380 and the cabin window assembly of the Airbus A380, which is currently the largest component assembly of its type worldwide in the realm of passenger air travel.



### Infobox

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Advanced Polymer Engineering

Fleischmann Technical Information Service

Wladar Technical Office

Centre for Electron Microscopy

Polymer Competence Center Leoben



# STA-SHM: Structural Health Monitoring

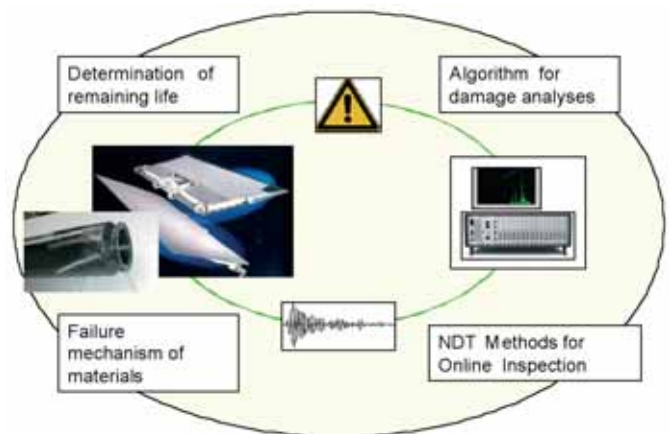
## State of the Art – Technological and Market Potential for Future SHM Systems

To reduce the weight of aircraft, the concept of “damage tolerant design” has been used for many years in the aeronautics industry. This concept is based on the idea of allowing a certain degree of damage or defect to structural components before they have to be repaired or replaced. To guarantee the structural integrity of structural components, non-destructive tests are continually required, leading to more down time for the aircraft.

If a non-destructive monitoring system could be installed and operated online, a sharp reduction in maintenance times could be expected along with a decrease in the associated maintenance costs, besides a further reduction in weight (since the components could be made thinner with a reduced requirement for safety reserves).

The goal of this study is a worldwide screening of the development level of various SHM technologies, with a particular emphasis on sensory technologies and the evaluation algorithms used to quantify the degree of damage of structural components used in aviation. In addition, the requirements which end users make on SHM systems will be included – which in themselves provide the foundation for developing these systems – as will the market opportunities for an Austrian consortium of suppliers.

The results of this study will go into the project entitled “Structural Health Monitoring: Development and Verification of a Structural Monitoring System Implemented in a Real Demonstrator Component”, which is intended to help develop a SHM technology demonstrator using a selected structural component, with in-flight tests to follow. The success of the project will be gauged by the significantly greater technological maturity of the SHM system.



### Infobox

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#### **Partners:**

EADS – CRC  
EADS – M  
Airbus Germany





## Achievement of a Continuous Process Chain for the Efficient Production of Textile Preforms

As weight reduction is one of the most important goals in numerous areas of technology, carbon fibre composite parts are being used in ever-greater numbers. This requires new technologies in carbon fibre-reinforced plastic (CFK) production.

Carbon fibre reinforced plastic components could be used even more extensively if high manufacturing costs due to manual production steps (cutting the individual layers and laminating in layers also) were rationalised. One particularly promising approach to solving this problem consists in the use of innovative textile techniques for the automated production of textile preforms which are then impregnated in a further job step through a resin injection procedure (such as RTM) or extrusion pressing.

Sewing has emerged as a particularly attractive possibility. It allows conventional textile structures to be reinforced three-dimensionally or to various "base textiles" to be tied to complex components. The keys to this are one-sided sewing heads with blind stitch and tufting.

In this project, the software tools required for the production of three-dimensional textile surfaces (CATIA basis V5, DELMIA,

KUKA SIM) as well as a pilot plant with the appropriate sensor technology are both being developed and tested using demonstration components (wing carrier, structural components) from various industry segments (aviation and automotive). By the time the project finishes, a continuous process chain is to be achieved, from the CAD drawing to fully automated production, as well as integrated quality assurance and documentation, a reduction of scrap and lower throughput times, and a reduced time to market. The complexity of this R&D project is reflected in the large number of partners involved, covering the entire process chain all the way to the end customer.

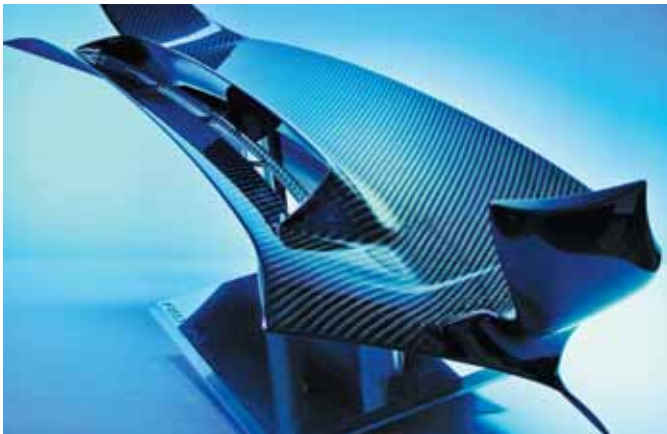
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KUKA InnoTec Germany  
Robot – Technology Germany  
Saertex Wagner Germany  
Vienna Technical University, Austria  
University of Linz, Austria  
University of Stuttgart, Germany  
Westcam Projectmanagement, Austria*









## **INTERMET**

Intermetallic materials and structures for a revolutionary increase in performance for future engines

## **ENVIRONMET**

Revolutionary materials and components for the environmental friendly engines of the future

## **TIMI**

Modelling of microstructural and microstructure-dependent mechanical properties of  $\beta$ -titanium alloys

## **TIZ**

Economical titanium machining

## **InnMAG**

Magnesium Process Chain Innviertel Region

# Focus on Metallic Materials and Metal Processing

In 2005, the entire Austrian metal industry had a production value of 50 billion. With a share of 42% of Austrian manufacturing, it is by far the largest industry segment. The largest division within the metal industry, at a production value of € 14 billion, is mechanical engineering, followed by motor vehicles and vehicle parts at € 13.5 billion, and metal manufacturing and processing at € 11.5 billion.

According to statistics from the Austrian Aeronautics Industries Group, 25.4% of the aeronautics industry's sales is earned in this market segment.

Major firms in Austria include Böhler Forging, AMAG Rolling, Pankl Racing Systems, MCE Group, Wild Austria, Plansee, Magna Steyr and the research institute ARC Light Metal Competence Center. Böhler Forging, for example, supplies titanium-steel alloys for landing gears and wings. Wild Austria secured a contract to supply mechanical precision parts for the flap tracks of the Airbus A380.

The following projects provide a glimpse into the R&D activities of the companies and R&D institutes just mentioned.



*"Substantial investment in aeronautical R&D activities is an indispensable element to reach the Vision 2020 goals. Austria's contribution to the Airbus A380 and the ACARE Strategic Research Agenda is very well recognized and the Aerodays 2006 in Vienna proved to be another successful platform in this direction."*

**Alain Garcia, Executive Vice President Engineering, Airbus**

## Intermetallic Materials and Structures for a Revolutionary Increase in Performance for Future Engines

Nickel-based super alloys are used in gas turbines at temperatures approaching their melting point, making it difficult to further optimise either the gas combustion temperature or the turbine efficiency. Refractory metal silicide alloys are supposed to replace nickel-based super alloys. Because of their outstanding mechanical properties at temperatures above 1000°C, refractory metal alloys (RM) represent a revolutionary alternative. However, the use of refractory metals in gas turbines is limited by their tendency to oxidise under high air temperatures. Over the last ten years, composites based on refractory metals with silicide phases have been developed in order to combine strength and oxidation resistant properties into a balanced mix.

The addition of silicon and boron to molybdenum and niobium results in the formation of 20 to 60% brittle intermetallic silicide phases (crystal mixture with metallic bond), which makes these alloys very difficult to process in conventional plants used to produce refractory metals.

The aim of the Internet project was set up a powder-metallurgical (PM) process route which would define standards for the manufacture of silicide materials. The approach of modelling and defining an industrial process route from data obtained from fundamental laboratory investigations proved to be successful. In addition, by applying a special PM manufacturing process, properties such as the ductile-to-brittle transition temperature (DBTT) and strength were significantly improved. A precise analysis of metallic and intermetallic alloy components improved the understanding of this class of materials and enabled a targeted design of alloys in order to better meet the requirements of end users.



### Infobox

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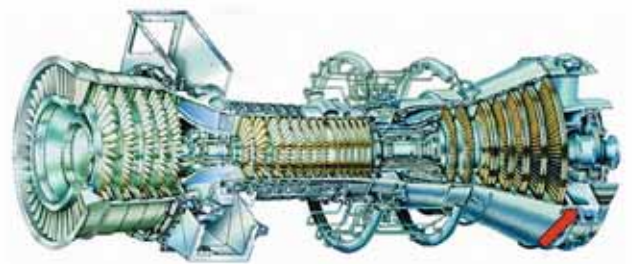


## Revolutionary Materials and Components for the Environmental Friendly Engines of the Future

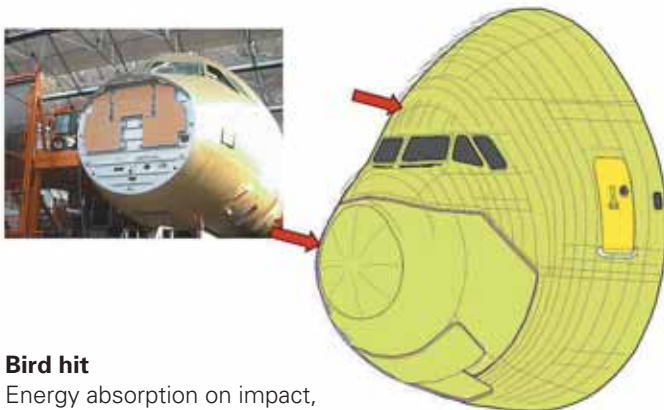
Interest in cellular materials has grown considerably in recent years. By creating metallic cellular structures, low densities can be achieved that are not possible with alloys. The specific properties such as energy absorption or isolative capacity, make this group of materials attractive for numerous applications and even promises to be a technology which could revolutionise various sub-systems in aircraft. One such possibility is the creation of innovative structures which could be applied as thermal and vibration control, or in light-weight construction and noise absorption.

The aim of the ENVIRONMET project is to raise the development level of hollow-sphere structures in the aeronautics industry to technology readiness level (TRL) 4 (components meet the specified requirements by laboratory standards). Some of the components which would benefit from this development come from areas such as sound absorbers for turbines, impact protection in aircraft construction and high temperature gas path seals for turbines. Within five years, the technology is meant to be sufficiently mature and tested to include hollow-sphere structures in the development of new aircraft and engines as one of the new, revolutionary technologies.

Under the auspices of the TAKE OFF programme, Plansee was able to join the French national research programme MAPO, which is aimed at the strategic development of these types of materials systems. EADS, ONERA and INPG are the leading firms and research institutes heading the development of these new material concepts for aerospace. Through the strategic partnership with these firms, a group has been created with which this material class can be established for application in aerospace.



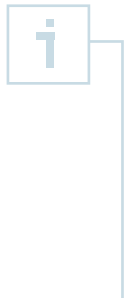
**Acoustic panels for hot end gas turbine nozzles**  
Temperature and pressure resistance, acoustics



**Bird hit**  
Energy absorption on impact,  
structural load

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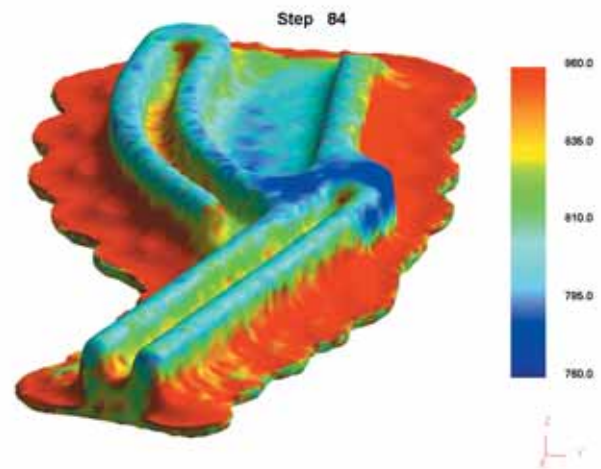


## Modelling of Microstructure and Microstructural Mechanical Properties of Near $\beta$ -Titanium Alloys

Forged parts made of high-strength titanium alloys are used for engines and structural parts. For the latter,  $\beta$ -titanium alloys are being increasingly favoured. They are the most versatile group of titanium alloys.

In addition to the usual  $\beta$ -titanium alloys, Ti-5-5-5-3 is employed by most aircraft manufacturers because of its excellent combinations of strength/toughness and hardenability. In order to get customer approval to supply forged parts made from new materials, the mechanical properties of multiple trial parts must be well above the specified values. It is also vital to demonstrate an accumulation of know-how regarding thermo-mechanical treatment, micro- and macro-structures, as well as achievable mechanical properties. The primary goal of the project is therefore to characterise the metallurgical changes during thermo-mechanical processing of  $\beta$ -titanium alloys to the extent that the final microstructure in forgings can be predicted with a greater degree of certainty.

To numerically simulate the development of microstructure, a set of specific data must be obtained with respect to thermo-mechanical treatment and the resulting changes in structure. These data are determined in extensive experiments at the university level and through experiments with trial forgings. In addition to the thermo-mechanical and physical data obtained, the



micro-structural development of titanium-based materials during the thermo-physical process is characterised through light- and electron microscope methods.

Thanks to the experiments carried out in this project, so much know-how was accumulated that the certification for using the new material Ti-5-5-5-3 was given by major aircraft manufacturers by 2006. Now this material is to be used for components in the undercarriage area in particular.



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## High Economical Titanium Machining

The growing requirement for light-weight construction in aircraft engineering has led to the use of carbon-fibre reinforced plastics (CFK) and titanium alloys in greater proportion, in addition to other modern materials. The goal of this project is to achieve a quantum leap in the economics of titanium machining.

To meet the high standards of the project, a multi-disciplinary approach with complementary additions was chosen. Accordingly, the industrial and research firms in the consortium represent a broad range of expertise, to be able to cover areas of research as for example standards and new destructive and non-destructive test methods, finite element methods (numeric procedure for the approximate solution of partial differential equations with boundary values) rapid production of prototypes, milling in a laboratory or industrial environment, new milling concepts or advanced milling cutter equipment.

A wide variety of substrate materials, coatings and micro-geometries for the cutting tools were evaluated by wear, friction and milling tests, allowing for a number of continuous improvements to be derived. Precise evaluations of the forged parts also showed the effect of the tool's condition on tool life.

The use of infrared measurements during the milling process allowed the finite element calculations to be calibrated, and the deviation between the laboratory standard results and those from the simulation was shown to be minimal. Virtual milling proved to be a valuable complement to the hardware test. After just over a year, the goals formulated for the project have been achieved. In further iterative loops (step-by-step improvement), the efficiency of the machining process is to be significantly increased.



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## Magnesium Process Chain Innviertel Region

Light-weight design plays an important role in the aircraft industry. In addition to the growing share of production taken by materials such as carbon fibre reinforced plastic (CFK), GLARE (glass fibre reinforced aluminium), titanium alloys or aluminium-lithium alloys, the metallic structural material with the lowest specific weight, magnesium, shows considerable potential for reducing the weight of a range of aircraft components.

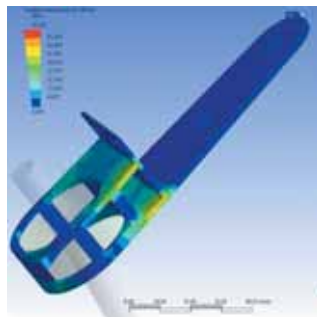
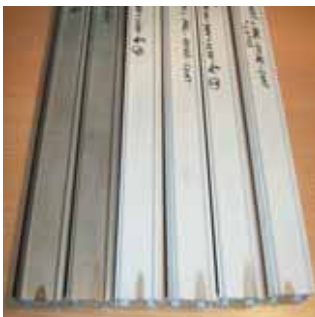
The aim of this project is the production of specific metallic parts made of magnesium alloys for civilian aircraft cabins. The strategy chosen for the project was to develop both an innovative alloy as well as conventional alloys, in order to guarantee a response to short-term market demand as well as the potential for long-term improvements. Three key areas of concern had to be addressed: manufacturing components out of magnesium alloys with a high reproducibility in geometry; ensuring a durable corrosion coating; and proof of the suitability of the magnesium alloys as an interior material in the standard fire test.

A re-design appropriate to the material was undertaken on the basis of an extrusion from standard aluminium alloys.

The most significant results of the project are the reduction of minimum wall thickness to 1.00 mm; the components passing fire and corrosion tests; the new alloy's improved properties of



strength and elongation to fracture as well as the definition of form and specifications of interior components from a major aircraft manufacturer with a view to evaluating the short-term use of a magnesium wing section.



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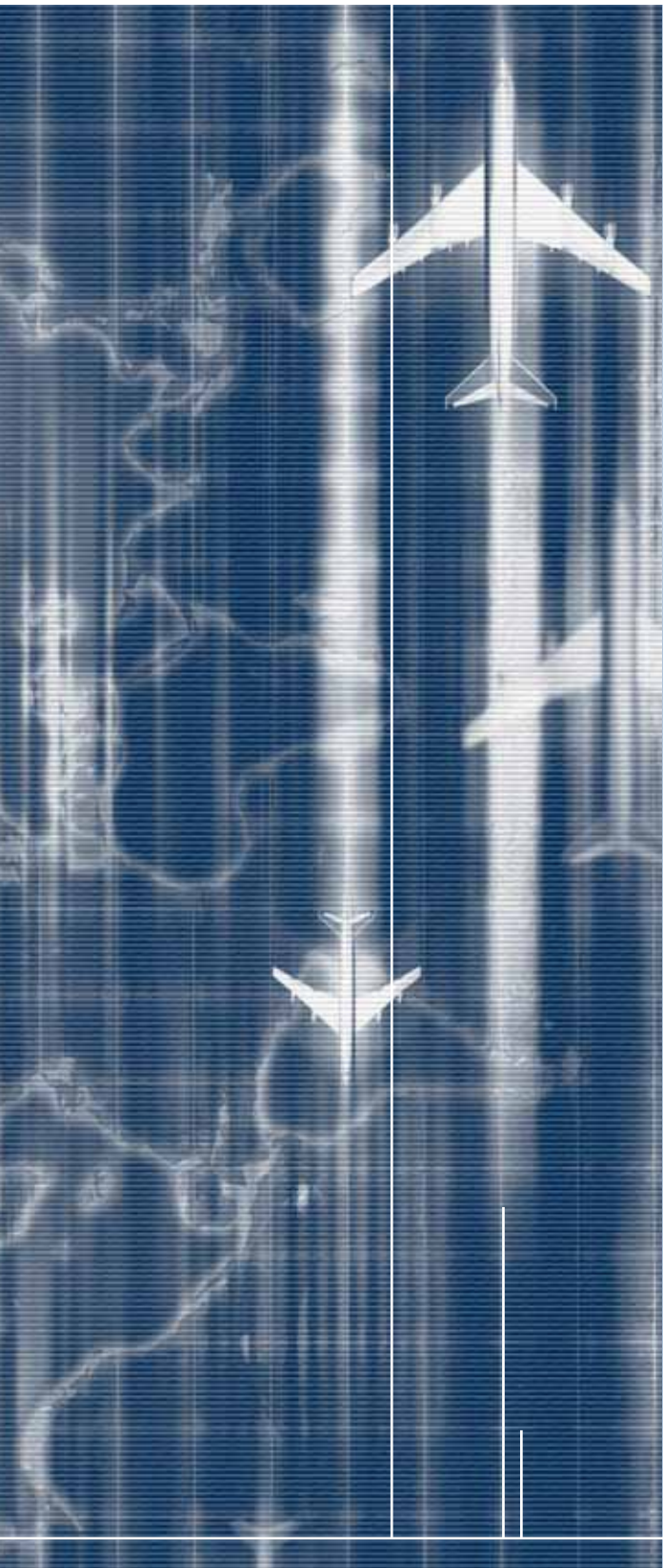
Fischer Advanced Composite Components Ltd.







# Project Results from **TAKE OFF**



## **FISN**

Flight Information Sharing Network

## **CDM**

Collaborative Decision Making

## **ATM**

Security Improvement for Air Traffic Management

## Focus on Air Traffic Management / Electronics

The economic cost of delays in European airspace caused by lack of transnational coordination is estimated at € 10 billion annually. In the light of limited performance capability of the European air traffic system, political agreements (implementation of the Single European Sky EU guideline, for example) must be supplemented by innovative technical solutions.

To overcome the communications bottleneck which is hindering long-term growth, European and Austrian firms are researching solutions in the realm of ATM which would improve the performance capability of existing firms. Frequentis, for example, is undertaking research with other stakeholders such as the University of Salzburg as part of the 6<sup>th</sup> EU Framework Programme in the "B-VHF" project on ATM solutions which would increase the number of frequency channels through overlaps. The Austrian air traffic control agency Austro Control is working with Frequentis on a project called "Flight Information Sharing Network". This project is intended to drive software development for air traffic control.

As a provider of highly automated, modern and cost-saving flight planning systems, Flugwerkzeuge aviation software Ltd. (f:wz) was able to acquire five new customers in one year, including airlines like United, Malaysian, Sky Service and Gulf Air. Its partnership with Lockheed Martin was also expanded.

TTTech Computer Technology Inc. is the leading provider of technology, and hardware and software products in time-controlled systems and TTP® (time-triggered protocol). Products from TTTech allow its customers from the areas of automotive manufacturing, aeronautics (Airbus, EADS, Honeywell, Messier-Bugatti, Nord-Micro and Ultra Electronics) and general industrial control to develop fast and efficient time-controlled computer systems for their industrial solutions.



*"The increasing participation of Austrian companies and research institutes in the European Framework Programmes is simply remarkable. In parallel, the establishment of the national TAKE OFF programme and Austria's participation in the ERA-NET AirTN is the culmination of a continuous development during the last decades."*

**Dietrich Knörzer, Senior Expert, Principal Scientific Officer  
Aeronautics, DG Research, European Commission**

## Flight Information Sharing Network

Inconsistencies and mis-matched flight data, along with the fact that it is currently impossible to access important information belonging to individual stakeholders in air traffic control are all factors which not only generate significant costs, but also safety risks. Both risks and costs could be reduced by technical innovations as well as organisational measures.

At the moment different types of information are produced and saved by stakeholders on different platforms. The information which exists may be redundant, contradictory or sometimes incomplete at different times and in different places.

The Flight Information Sharing Network under development in this project is intended to provide users of information services with transparent and straightforward access to a homogeneous information service repository defined in terms of its service quality. The network will also improve the quality of that information, besides ensuring its availability.

The goal of this project is to define a new Flight Information Sharing Network (FISN) and to test it with a prototype. Based on a model for flight data, procedures are being developed which

will allow individual stakeholders to gain a consistent view of scattered data as well as a mean of actively influencing the data content of these objects. Using the prototype specified by Austro Control, the dimension of using and integrating legacy systems will be a particular focus.

This makes FISN one of the first concrete research projects to be undertaken as part of the wider-ranging concept of SWIM (system-wide information management). In its Vision 2010 goals, this firm has set itself the objective of being number 1 in control centre solutions.

Networked control centre solutions typically have a distributed character. Access to these distributed resources from any location provides users an information pool that never before existed. System-Wide Information Management, as it is currently being conceptualised in the EU research project on aviation, will become an important decision-making and process control tool.



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## Collaborative Decision Making

Collaborative decision making (CDM) stands for processes, models and methods that allow multiple, heterogeneous actors to work together in order to find shared decisions that are best for a system.

The current project was aimed at investigating the possibility of establishing a new IT platform to serve the shared decision-making process of different participants at the airport (airline, air traffic control, airports/ground handling, catering, refuelling, etc).

In creating a system prototype, new methods and IT tools were used. Having the know-how associated with these tools and methods could give the company a considerable advantage over its competition in the marketplace. In addition to the study on technical feasibility, the organisational conditions required for a collaborative decision-making system were also investigated.

Apart from the experience gained by the firm in the aviation sector, particularly with regard to air traffic control (in air traffic control centres and towers), this research allowed it to begin building up cross-segment know-how for the airport system, which would in turn make air traffic control technologies usable for safety-critical systems in other market segments. The first project results are now emerging which show the benefits of building up know-how through the CDM@airports project. They are also illustrating the ways that the CDM solution can be made accessible to other market segments. Some initial successes have already been achieved by the firm's Public Transport division.



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## Security Improvement for Air Traffic Management (ATM)

Until now, air traffic control relied mostly on local, siloed solutions which were connected through private IT networks. However, the trend today is toward using shared backbones (a backbone is a connective core area of a telecommunications network with very high bandwidth) which allow a whole range of different areas and applications to be connected and networked. This generates new and increased requirements on air traffic control networks.

One particular requirement in this regard is the expansion of a "safe" communication system to a "secure & safe" communication system, especially given that systems are being networked through various backbones not under the control of air traffic management itself.

The core aspects of the Security Improvement for ATM projects therefore involve safety & security and user-friendliness of speech and data communication between air traffic controllers and pilots, as well as between towers and air traffic control centres. Security aspects, such as increasing the security of radio traffic between pilots and the tower, occupy the foreground of these concerns. However, ergonomic user interfaces for air traffic controllers also help to increase security by avoiding operating errors.

In the course of this project, technological innovations in the area of interception and fail-safety as well as electronic "flight



strips" and support systems for air traffic managers and air traffic controllers were developed and evaluated, in conjunction with an associated integrated recording system.

The electronic flight strips developed under the auspices of the TAKE OFF programme have since been introduced successfully to the market as "smart strips" and are being used both at the Hamburg airport as well as more exotic destinations such as the Fiji Islands. The electronic flight strips can replace earlier flight strips made of paper, thereby fulfilling the need to provide better and faster information within air traffic management.



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## **The D-JET Concept**

A new category of aircraft

## **Rotax 936: 4-Stroke Piston Aircraft Engine**

Development of a low-noise piston engine for general aviation

## **Aircraft SOFC**

Fuel cell system for aircraft applications

## **HGPU**

Ground supply for aircraft hydraulics systems

# Focus on General Aviation, Propulsion, Test and Production Facilities

Worldwide there are more than 312,000 general aviation aircraft (including helicopters, single-engine piston aircraft, aircraft with propeller turbines and intercontinental business jets), which represents a very attractive and growing market. Eurocontrol anticipates air traffic growth of more than 30% by 2010.

Diamond Aircraft was quick to act on this growth trend. Diamond Aircraft developed the first diesel motor-driven aircraft which could cross the Atlantic without a stopover. Then, with its D-Jet project, Diamond Aircraft made another successful entry into the very light jet segment.

Another segment which looks especially promising for the future is the unmanned aerial vehicle (UAV) market. Operating in this area already, Schiebel Electronic Equipment developed the CAMCOPTER® S-100, which can be used for such tasks as aerial mapping and routine surveillance of communication lines. KTS has specialised in wiring UAVs and is also doing more research in this area.

Meanwhile, BRP Rotax researched and developed a piston engine for two- to eight-seater aircraft. More than 350 types of motors have been developed in the past 50 years. But at the moment, only six different aircraft engines (two- and four-stroke technology) are on offer in the marketplace. The size of the global MRO (maintenance, repair and overhaul) market is estimated at US\$100 billion annually. In this segment, Europe has a share of 25% of the overall market.

Austrian companies are enjoying increasing success in this market segment. Test-Fuchs, for example, offers MRO products for the Airbus A380, Eurofighter, Airbus A-400M, Tiger helicopter and the NH90, and has also developed a new monitoring and regeneration system for aircraft hydraulics oils. Meanwhile, the Austrian firms WFL Millturn Technologies Ltd. and GFM each provide solutions for technical requirements involving turning, milling and drilling materials.



*"It was a pleasure to give advice to the Austrian TAKE OFF programme, which in turn was an excellent opportunity to learn from. Austria's industry and R&D institutions have a lot to offer and the establishment of an aeronautics agency at the FFG adds substantial value to the Austrian aeronautics sector."*

**Henk Van Leeuwen, Head of Aeronautics, NIVR – Netherlands Agency for Aerospace Programmes**



# The D-JET Concept

## A New Category of Aircraft



The current D-Jet project is focussed on the new category of five-seater aircraft made of composite materials in the price category of 1 million.

The project goal was to construct a small jet for an emerging market segment which had a significantly more favourable price-performance ratio than earlier business jets, better performance capability with regard to cruising and climbing speed and minimal requirements for take-off and landing, as well as a total registered weight under 2,000 kilos. Another goal was to reduce training requirements for pilots, especially in comparison to business jets and multi-engine piston aircraft, as this has a significant effect on insurance costs in the USA in particular.

These goals could be reached thanks to the development of smaller jet engines, which have lower fuel consumption rates because of their high bypass ratio. Using an engine like this is of prime importance for the company with respect to its price competitiveness. On the operational level, this leads to significantly lower fuel consumption as well as lower maintenance costs. With many years of experience in the area of composite materials, Diamond Aircraft has also developed a preliminary concept with which a consistent use of carbon fibre reinforced plastics can exploit the full range of aerodynamic capabilities and weight advantages as compared to the most efficient metal air-



craft (piston and jet). Using state of the art avionics systems for greatest use completes the concept. In the course of this project, a proof of concept aircraft was developed and built. Its maiden flight took place on 18 April 2006. The firm's expectations regarding performance, usability and market acceptance were greatly exceeded. Deliveries will begin in 2008, and there are already more than 250 pre-orders.

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# 4-Stroke Piston Aircraft Engine Rotax 936

## Development of a Low-Noise Piston Engine for General Aviation

The propulsion units used in general aviation today are large-volume, six-cylinder engines with a performance up to 320 hp. The basic design of these engines is about 50 years old. One disadvantage of these engines is that the cylinders and cylinder heads are air-cooled, which leads to high noise levels from the cooling fins. The noise problem is further compounded by the fact that the crankshaft powers the propeller directly, causing high propeller tip speeds which in turn make the aircraft louder.

For this reason, a new V6 aircraft engine was designed, built and tested in this project. The engine is liquid-cooled, thereby avoiding noise radiation from the cooling fins. The propeller is driven by a reduction gear box. This allows propeller rotation speed to be reduced independently of engine performance.

Both these measures allow the engine to be driven at 6,000 rpm, which allows for a smaller and lighter basic design at the

same power level. The propeller is designed to turn just 2,000 rpm at maximum speed.

In order to make full use of the new engine design, the engine is directed by an engine control unit, thereby avoiding the possibility of pilot error. The new design stands out by virtue of its extremely quiet engine operation. In a typical installation, the outside noise of the aircraft will be reduced by about 10 dB(A), but the noise in the cockpit is also much more tolerable, thereby reducing strain on pilots.

The engine was flown in various aircraft installations and was tested for thousands of hours. Each of its components, such as the wiring harness, the engine control unit (ECU), sensors and connectors underwent rigorous testing according to FAR33 rules which govern engine standards for the American market.



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## A Fuel Cell System for Aircraft Applications

Today gas turbines are being used in aircraft as auxiliary power units (APUs). These are relatively small, self-contained generators used to start engines (using air pressure) and to provide electricity, hydraulic pressure and climate control on the ground as well as to generate electrical energy in flight. Since these APUs generate noise and exhaust fumes, the search is on for alternatives – such as fuel cell systems.

As part of the TAKE OFF project, a fuel cell is being investigated, built and tested as a functional model for future systems which will be superior to current energy generators on board aircraft in terms of its environmental friendliness, low weight and minimal maintenance and production costs.

Aircraft SOFC is a joint research project by ALPPS with Airbus and EADS. For this project, the firm used its own, in-house developed microtubular solid oxide fuel cell (SOFC) technology, as well as its know-how in system integration. EADS and Airbus provided their specific know-how of energy supply, fuel cell technology and infrastructural specifications in aircraft construction, along with their test facilities. To date, general requirements for an energy system suitable to aircraft have been formulated and the first individual cells produced and tested. The



next step will be the evaluation of a standalone fuel cell with hydrogen, as well as one that is part of a kerosene-powered system at an Airbus/EADS test facility. Once these specific goals have been reached, a ground demonstrator is to be built in a later phase which will have the key characteristics of a flight-adapted system. Finally, actual product development is planned for use in future civilian aircraft.



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## Ground Supply for Aircraft Hydraulics Systems

Ground supply and aircraft represent one inseparable unit. For each new aircraft, weight reduction is a central concern for designers. And like all other systems and components, the hydraulics system must also fulfil the most rigorous conditions with regard to its mass. A hydraulics system with pressure of 5,000 psi instead of the previous norm of 3,000 psi has already made its appearance in civilian aviation. This high pressure allows for smaller conduits and components, which in turn serves the first principle of weight reduction – about one ton less in the end result.

But weight reduction is not the only goal: the lowest possible running costs are also required, particularly in maintenance. An appropriate ground supply system would not only fulfil general requirements such as supplying two independent circuits of the aircraft hydraulics system with controlled flow and pressure; filling, draining and flushing the hydraulics system and testing its leakage; but the system would also check the quality of the hydraulic medium for pollutants in the air or water, and reduce these to their required threshold values.

This ground supply system ought also to communicate with the flight control system (FCS) of the aircraft and trigger the hydraulic components for testing. Lifecycle costs ought to be reduced by

automatic calibration of the ground supply system. An additional aim was greater ease of use through implementation of user-friendly, error-reducing software.

As part of the TAKE OFF programme, the firm developed a new and innovative ground supply system for the maintenance of hydraulics systems for civilian as well as military aircraft. To collect and reduce pollutants in the hydraulic medium, a procedure and special sensory system were successfully developed. Communication with the FCS was achieved through the electronic control & monitoring unit of the aircraft. The lifecycle costs for ground supply were reduced by 85%. Neither highly qualified staff nor intensive training sessions are now required for the operation and use of ground supply systems.

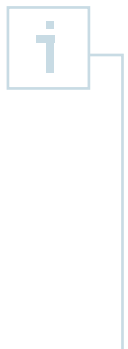
With its special features, the ground supply system developed for aircraft hydraulics systems fulfils current as well as future requirements of civilian and military aircraft operators. These testing devices can be used universally, for aircraft such as the Airbus A380 or the Eurofighter Typhoon.



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## **BRP-Rotax Aircraft Know-How**

ROTAX Aircraft Engines Quality & Know-How Programme

## **AUTO**

Training on automatic generation of preforms for the design process of forged parts in aviation

## **Traning Offensive – Aviation**

Qualification steps and transfer of know-how at Test-Fuchs

## **Employee training for EASA Part 21 G**

Company certification with system integration and educational training

## **Software: JAR (Part) 66**

Development of web-enabled training software for the training syllabus of JAR (part) 66

## **EASA Aviation Legislation**

Development of web-enabled training software on the subject of EASA aviation legislation

## **E-Learning Study Room@FREQUENTIS**

## **ISAP**

International Summer School on Aviation Psychology

## **Lecture series: “Focus on Aviation”**



## Focus on Qualifications and Transfer of Know-How

The goal of this programme line was to expand the pool of highly qualified specialised staff, technicians, engineers and young as well as experienced academic researchers in the Austrian aeronautics sector. Among the participating firms, Böhler Forging, BRP Rotax, TESTFUCHS, flugwerkzeuge aviation software Ltd., infoWERK multimedia, Frequentis and KTS Sporrer were able to benefit from the range of measures designed to promote higher qualification under TAKE OFF. By achieving a higher qualification, BRP Rotax was able to obtain POA (production organisation approval) and DOA (design organisational approval) status, through which more than 100 employees in the operation received further training. KTS Sporrer successfully completed the project with one EASA PART 21G certification as well as one EN9100.

In addition, employees of Böhler Forging received training in the USA on 2D and 3D software packages. Test-Fuchs was able to gain higher qualifications for its employees through engine training courses (Rolls-Royce), trainings on JAR 145, soft and hard soldering, trainings on non-destructive materials testing, and Human Factors Awareness Training. "flugwerkzeuge aviation software" was able to obtain higher qualifications at Danube University Krems.

Frequentis and infoWERK multimedia used this programme line for learning and training tools. infoWerk created a multimedia-based training system for aviation legislation in order to illustrate graphically the principles of aviation legislation, such as the roles of the ICAO, the EASE and the EU member states. With its e-learning project "study room@frequentis", Frequentis pursued its objective of developing an online study room. This learning tool serves participants in "train the trainer" courses, while also supporting individual technical sales processes.

TAKE OFF supported the Joanneum University of Applied Sciences with 17 events where renowned Austrian and international lecturers from fields such as avionics, computational fluid dynamics (CFD) and finite element methods (FEM) spoke to students, employees and other members of the specialist audience in the lecture halls of the Joanneum. The Institute for Psychology at the University of Graz, with the support of TAKE OFF 2003 and 2005, presented once again its International Summer School on Aviation Psychology. ISAP has been recognised internationally.



*"We created the TAKE OFF programme specifically in response to the needs of the Austrian aeronautics industry. Accordingly, diverse elements such as research, training, certifications and risk guarantees ought to be implemented on similar lines. TAKE OFF is a milestone and must be continued with substantial volumes of funding."*

**Franz Hrachowitz,**  
**General Secretary of the Austrian Aeronautics Industries Group**

## ROTAX Aircraft Engines Quality & Know-How Programme

To ensure the long-term competitiveness of the firm vis-à-vis American aircraft engine manufacturers, obtaining specific qualifications for employees was of the utmost importance.

The training measures undertaken with the support of TAKE OFF encompassed both higher qualification for employees with regard to aircraft technology, engine technology, hardware and software know-how, accident investigation etc., as well as training and further education in aircraft engines through the required European standards according to JAR 21. BRP Rotax also became a recognised production operation (production organisation approval – POA) and recognised development operation (design organisation approval – DOA).

In 2005, this qualification process was successfully completed with the receipt of both certifications. This makes BRP Rotax

one of only three Austrian firms and 85 European firms which have gained the combined POA-DOA certification.

Another milestone resulting from this qualification process and support from TAKE OFF was the approval granted by the Upper Austrian Chamber of Commerce to offer “aircraft technician” as a skilled trade within the firm's own training programme.

In the short term, the completed qualification process and goals achieved led to a qualitative and quantitative enhancement of the firm's certification and quality team for aircraft. Over the long term, these achievements will influence and foster the international competitiveness of the company as a whole, particularly through creating the right conditions to manufacture a new piston aircraft engine.



### Infobox

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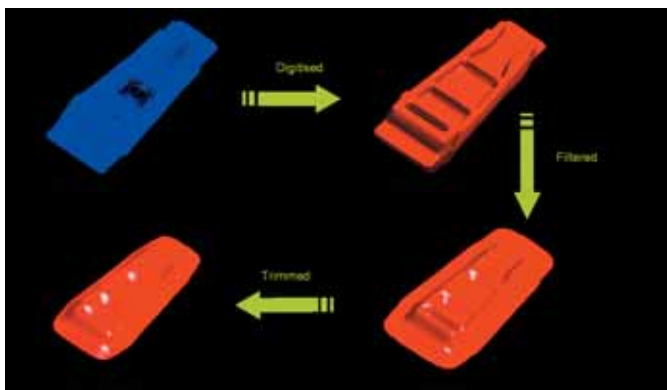
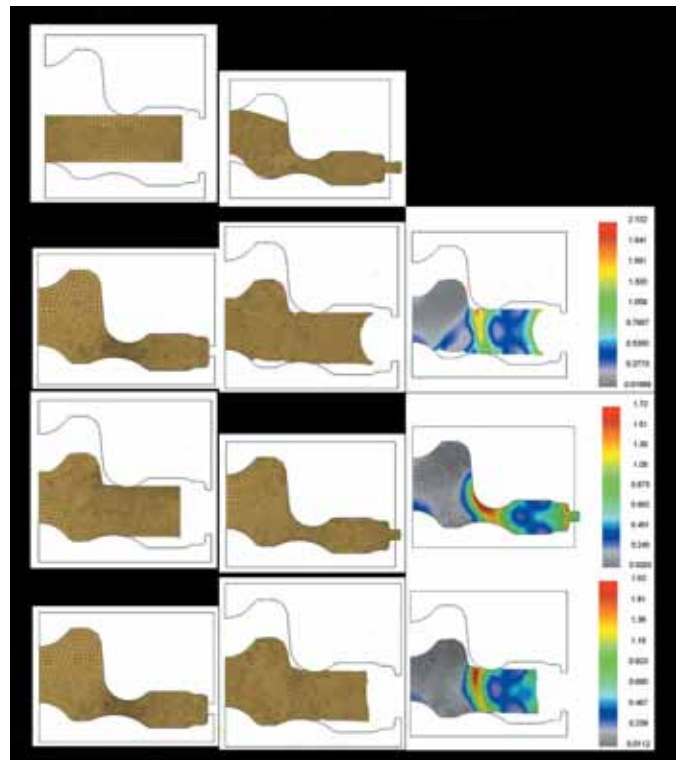
## Training on Automatic Generation of Preforms for the Design Process of Forged Parts in Aviation

The development of a complex multi-step forging process for aircraft parts made of nickel or from titanium alloys requires the use of specially designed finite element programmes. At the moment, the design of the die pieces and the forging steps is done manually, in several steps.

Modern CAD systems used for the design of the dies and forging pieces also serve as a means of gathering input data for FEM simulation. The process of analysing the simulation results and changing the CAD design accordingly goes on until a satisfactory result is achieved. This iterative process must be continued for each individual forging step until the entire thermo-mechanical process has been optimally designed. Recently two software packages for this "reverse-engineering" work became available which enable a significant degree of automatic process optimisation.

Accordingly, the goal of this project was to train all R&D employees of this firm which specialises in the manufacture of forged parts on the newly developed 2D and 3D software packages, and subsequently to verify the applicability of the software for prototype development. For that purpose two R&D employees were accordingly being trained at the software-manufacturer's site. In turn the skills learned thereby could be passed on to all R&D employees through internal trainings.

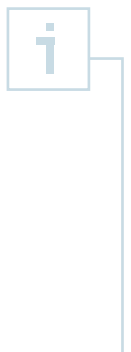
This qualification process helped to make this software deployable for hands-on prototype development in the firm, which in turn has led to greater efficiency in the design process.



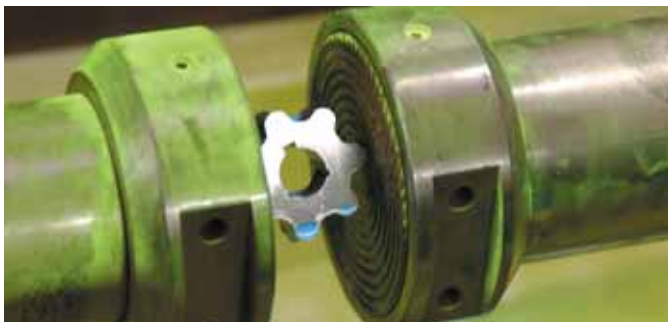
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## Qualification Process and Transfer of Know-How at Test-Fuchs



Due to the firm's very high degree of added value, comprehensive investments in employee competencies are an essential element of maintaining and increasing competitiveness in the marketplace, as well as developing new areas of business.

Accordingly, a comprehensive training and education offensive was begun under the auspices of TAKE OFF. The wide-ranging programme helped to maintain and improve the quality of products and services. Some of the training courses completed by employees included: Rolls Royce 250 engines, the JAR 145 approved maintenance organisation, the certified quality manager, the quality auditor, soft and hard soldering, non-destructive material testing according to DIN norm EN 4179, and human factor awareness training. Another result of these trainings was the additional knowledge transfer of external know-how to the company. By holding regular, highly specialised trainings it became possible to offer an additional range of services, such as non-destructive material testing according to the aviation DIN norm EN 4179. The continuing training course for the next level (PT2 and MT2) was completed in fall 2005.

Thanks to these completed training courses, a contract was signed with a leading manufacturer of fuel components for shaft output turbines. The completion of these courses also opened up further possibilities for the firm to increase its sales in the aviation field, as it is now one of only 15 officially authorised maintenance centres for the components of this manufacturer.

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# Employee Training for EASA Part 21 G

## Company Certification with System Integration and Educational Training

Due to growing international pressure to become an EN9100 certified firm, this company decided to go for international aviation certification according to EASA Part 21 G, as well to take further steps toward becoming an EN9100 certified company. This is especially important when considering its product portfolio, which includes the manufacture of cable assemblies for military and civilian use, serial cables for robot installations and machine tools and medical equipment, as well as wiring systems for helicopters and engines.

In pursuit of this goal, employee training courses were completed on subjects such as soldering, CAD, POA, issue of EASA FORM 1, human factor awareness training, quality management and ESA soldering. In the course of being issued EN9100 certification, which was characterised by several customers as the condition for a future business relationship, the company was also entered in the OASIS database as a globally certified aviation supplier.

As a result of this higher qualification, KTS received the contract for wiring an unmanned aerial vehicle in accordance with EASA Part 21G. The key criteria for this contract were weight reduction and the highest degree of security in the smallest area for the purposes of military use, with the option of later civilian use. The wiring of the unmanned aerial vehicle was undertaken using civilian specifications and is already being flown under military conditions. Ongoing improvements in terms of modifications are being worked out with the customer and implemented as per Part 21G.

The general agreement is in effect for the first series and is currently being expanded. By virtue of the close cooperation with Austro Control in trainings and definitions of the practical implementation of Part 21G, a place for UAVs in the future of civilian aviation has been secured as well.



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# JAR Software (Part) 66

## Development of Web-Enabled Training Software for the Training Syllabus of JAR (Part) 66

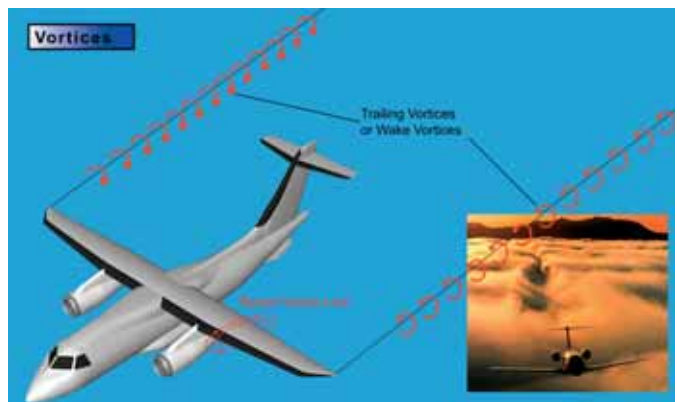


The introduction of the JAR 66 licensing regulations for aircraft technicians required the development of a new training system according to the guidelines provided. These requirements were adopted in 2004 by EASA (European Aviation Safety Agency) as Part 66 and have since become mandatory for all EU member states. To enable worldwide use, this training system for aircraft technicians had to be web-enabled, support multi-channel learning and provide automatic progress monitoring with a feedback system to tele-trainers.

During the project, “aircraft technician” was established as a new skilled trade, which required modification of the Part 66 training software for apprentice training. One important part of course development was the inclusion of pedagogical aspects into multi-channel learning, the use of appropriate presentation elements and interactive elements for learners. At the same time, the lessons had to be divided up into appropriately small modules, in order to meet the needs of pre-qualification and required depth of learning for different target groups according to Part 66.

To ensure the web-enabled nature of the courses even for slow connections, it was necessary to use animated vector graphics instead of videos or photos. The training system supports the “blended learning” approach and reduces the need for classroom attendance by more than 50% and thereby saving time and money.

This modern, flexible and innovative training system enables aircraft technicians and apprentices to take part in Part 66 train-



ings from any location. Course contents can be called up according to individual requirements at any time of day, thereby enabling “learning on demand” at the learner’s own pace, with the requisite on-line support. Customers from South Korea, India, Thailand, Australia, Russia, Ukraine, Scandinavia, Switzerland, France, Slovenia, Germany and of course Austria have demonstrated the interest and acceptance with which this concept has been greeted around the world.

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Austrian Airlines – Technical School

AERO Bildung – Aviation Training Center



## Development of Web-Enabled Training Software for EASA Aviation Legislation

Since aircraft technicians generally do not have a legal background, it cannot be assumed that aviation rules and regulations will be properly understood and applied without targeted, effective training on the subject. Otherwise, people may find themselves in a situation where decisions must be taken but where they themselves may not be able to assess the legal consequences. Complicating the matter is the fact that aircraft technicians are not only expected to master these laws in their own native language but in English as well.

The objective of this project was the development of an internet-enabled, multimedia-based aviation legislation training programme to instruct aircraft technicians on EASA Part 66 guidelines, which include all requirements of the European aeronautics industry. The use of electronic learning media allowed the share of traditional classroom training to be reduced to the minimum, making the entire training course much more flexible as a result.

In fact, flexibility has increased enormously for the firm as well as the students, thanks to this new teaching concept. This new

instructional offering combines individual computer-based learning with a summary and enhancement of the knowledge acquired in seminars. The advantages of this approach include: greater flexibility of training (individual study and time management, a varied course offering); a significantly shorter absence from the job than before (benefitting the employer); and lower course costs for both participants and companies. Aside from the economic aspects, the multimedia approach offers other benefits too. By using a multimedia approach to present legal structures and procedures, comprehension and retention of information in different formats is substantially improved, and students' own ability to learn through different media is enhanced for the purposes of acquiring skills and abilities needed for their regular jobs. The selected form of multimedia presentation was also successful in sensitising participants to the need for regulations, thus strengthening direct integration of regulations into the work process. Widerøe Airlines of Norway was the first customer for this instructional software.



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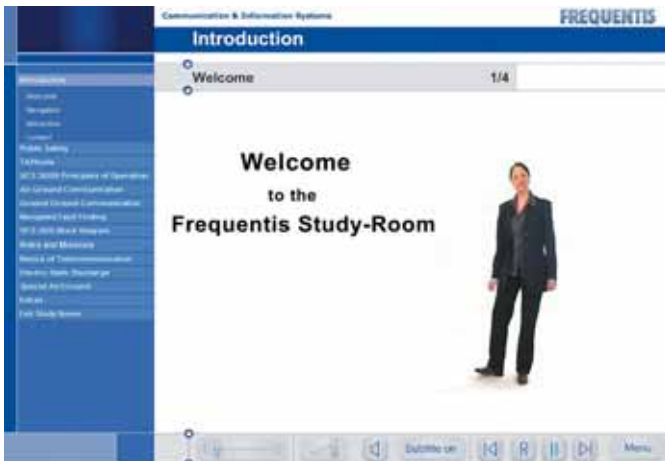
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#### Partner:

Lufthansa Technical Training



# E-Learning Study Room@FREQUENTIS



This company develops, produces and sells data transmission systems in the field of air traffic control, primary control units for public safety, railways and shipping, as well as TETRA technology. In the segment of air traffic management in particular, computer-based instruction (CBI) is experiencing increasing demand for training customer staff, particularly for end users such as air-traffic controllers.

The goal of this project was to set up a web-based training (WBT) study room with regulated access to certain technical course content on technology and solutions in the field of safety-critical applications. A study platform was also to be created which would provide potential business partners with access to the specialised know-how acquired by this firm. To meet this requirement, the "e-learning study room@Frequentis" project was begun.

As part of the project, an online Frequentis study room with 13 new e-learning modules was developed. After training eight employees to become "scriptwriters", they were able to shape technical information in an appropriate way for e-learning modules which would explain the firm's technologies and products in a comprehensive way. These modules have in turn been made accessible via the internet on a newly created e-learning platform. The "blended learning" concept of teaching was applied throughout. The CBI modules are designed to convey theoretical course contents in order to prepare employees enrolled in the course for their time in the classroom, which is when they get the necessary practice on the live system.



With this project supported by TAKE OFF, the company was able to include CBI solutions in its offerings. This helped it to win a very important tender, as technical support in the form of e-learning is being specified increasingly as a concrete requirement for international contracts. The acquired know-how of training users of air traffic control facilities through e-learning has since become an integral part of the resource competencies of customer training at Frequentis.

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## International Summer School on Aviation Psychology

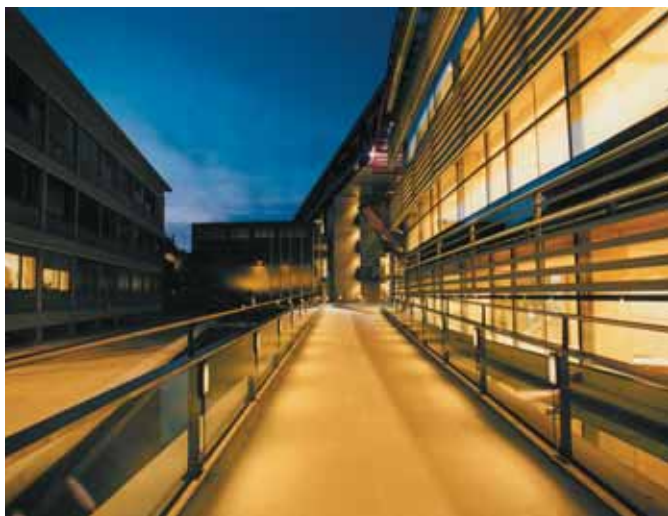
ISAP is an international summer academy embracing a wide array of subjects related to aviation psychology, from stress management in crisis situations to team resource management and personnel selection. The real significance of aviation psychology lies in the enhancement of security and safety as well as accident prevention.

One of the primary goals of ISAP is the continuing education of people working in aviation, such as pilots, cabin crew, air traffic controllers or psychologists, as well as the creation of a balanced course of training for students. The key requirement in this regard is the establishment of an internationally accepted standard for training and continuing education in this vital area.

An additional goal of ISAP is an active transfer of knowledge between aviation and related fields of research and application, such as traffic and transportation psychology. This would help create a network for aviation psychology in Europe, besides making a contribution to more safety and security. With its base in Graz, an internationally recognised centre for aviation psychology would be established and consolidated in the European region, particularly in the south-eastern zone.



The quality of the summer school is guaranteed by the roster of international, highly qualified speakers from renowned and important universities and aviation or air traffic control companies from around the world, a promise that is underlined by the international recognition and certification by well-known organisations such as the European Association of Aviation Psychology. Since 2003, ISAP has been held every two years, lasting for a week each time. From the start there has been enormous interest in this qualification; participation levels have always been full to capacity.



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# Focus on Aviation

## Lecture Series: “Focus on Aviation”



The lecture series entitled “Focus on Aviation” aims to identify, discuss and present current issues in the Austrian aviation industry through evening lectures and workshops. Students enrolled in an aviation-related course of study also have the chance to gain insights into different fields of work within aviation, as well as to identify topics for their own projects and dissertations.

In all these ways, the “Focus on Aviation” lecture series offer an independent platform for the exchange of knowledge. However, the workshops and lectures are not meant to replace a reg-

ular course of training. Instead, they are intended to supplement and expand existing knowledge, with the possibility of open knowledge transfer in both directions. This makes “Focus on Aviation” a valuable addition to the classic instructional offering.

As part of the evening lectures and workshops, Austrian and international experts are invited to present their field of work, methods and institutions. The lively discussions resulting from the detailed questions and responses given by the speakers – largely expressing their own point of view – are characteristic of this one-of-a-kind lecture series.

With a total of ten evening lectures and seven workshops during the funding period, the lecture series covered technical, economic, environmental, operational and legal subjects, thereby providing an outstanding overview of current issues in aviation. By virtue of its timely topics, expert speakers and subject matter depth, the lecture series has drawn renewed interest from the international aeronautics community to the Austrian aviation industry and its training programmes.



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# Links

## Internationale Links:

[www.aaig.at](http://www.aaig.at)  
[http://cordis.europa.eu/fp7/home\\_en.html](http://cordis.europa.eu/fp7/home_en.html)  
[www.acare4europe.org/](http://www.acare4europe.org/)  
[www.sesar-consortium.aero/](http://www.sesar-consortium.aero/)

[www.asd-europe.org/Content/Default.asp?PageID=32](http://www.asd-europe.org/Content/Default.asp?PageID=32)  
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[www.erea.org/](http://www.erea.org/)  
[www.aerodays2006.org](http://www.aerodays2006.org)

## Partners of the TAKE OFF Programme

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HTI High Tech Industries  
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