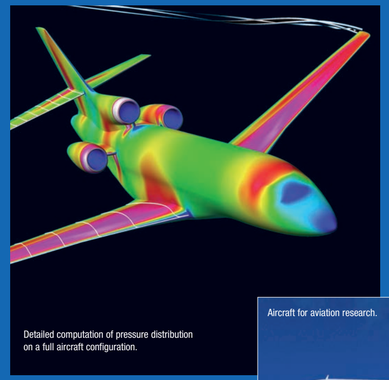
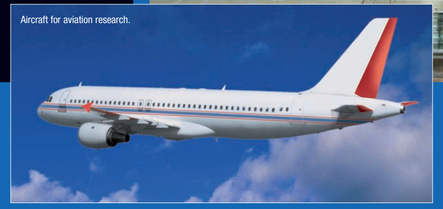


Detailed computation of pressure distribution on a full aircraft configuration.

Model ready for aeroacoustic investigation in a large wind tunnel.



Aircraft for aviation research.

TYPOLOGY OF EUROPEAN AERONAUTICAL FACILITIES

Strategic facilities
individually correspond to investments higher than €100m and have an operating budget as high as €10m/year. They are open to any customer and address the industrial market on a commercial basis as well as national and EU programmes. Such facilities are competing in a worldwide market. Europe boasts no more than 10 complementary strategic facilities in that category for civil aeronautics.

Key facilities
individually correspond to investments higher than €10m. They are also subjected to tariffs based on full operating costs recovery (excluding capital investments and depreciation) and are used by other players than the operator on the basis of their own funding. Facilities with an obviously unique character are also included in this category. There are about 100 such key facilities spread all over Europe.

Common facilities
refer to a large number of other medium or small size capabilities covering a wide range of applications in various disciplines. Such facilities are considered as basic tools whose associated costs are in general borne by operators/owners.

ACARE

BY ADDRESSING BOTH BASIC AND APPLIED RESEARCH, BY COVERING A WIDE RANGE OF SCIENTIFIC DISCIPLINES AND ASSOCIATED EXPERTISE, THE EXISTING COMPLEX NETWORK OF AERONAUTICAL RESEARCH INFRASTRUCTURES IS A KEY ENABLER FOR THE DEVELOPMENT OF EUROPE.
SUCH A NETWORK, AT THE HEAD OF WHICH STAND THE SMALL GROUP OF STRATEGIC FACILITIES, REPRESENTS A TREMENDOUS ASSET AND THE NEEDS OF THAT PARTICULAR COMMUNITY, WILL HAVE TO BE CONSIDERED WITH GREAT ATTENTION AT REGIONAL, NATIONAL AND EUROPEAN LEVELS IN THE FUTURE.

EREA

This brochure is published by the Association of European Research Establishments in Aeronautics (EREA - http://www.erea.org) under the auspices of ACARE (http://www.acare4europe.org) and within the framework of the activity of a specific working group led by ONERA.

Illustrations were provided by:
CIRA, DLR, FOI, INTA, NLR, ONERA, VZLU
And by: DNW, ETW

Some other useful links:
ATA: www.ata.aero EWA: www.eu-ewa.aero
AT-One: www.AT-One.aero

EREA

European aeronautical research infrastructures

ACARE

Advisory Council for Aeronautics Research in Europe

Within the ACARE, it is acknowledged that a set of world-class and efficient research capabilities is a strategic factor which enables the prosperous development of Aeronautics in Europe.

It is a fact that fundamental and applied research in various scientific disciplines (Fluid mechanics, Materials, Structures, Systems, etc.) as well as the development of sub-components and components (engines, etc.) and of aeronautical end products (fixed-wing aircraft, rotorcraft, etc.) have always been associated with extensive design, computation, testing, optimisation and validation activities.

This complicated process calls for the systematic use of various research facilities, for example aerodynamic wind-tunnels, combustion and structural test beds, material elaboration apparatus, clusters of small computers or, on the contrary, high power super-computers, air traffic management and air traffic control simulators, flight simulators and research aircraft.

These facilities, which address different disciplines and specialities, may differ greatly in size and range of application and are often linked to one another through a complex immaterial network which in the end transforms basic scientific knowledge into competitive products, while integrating environmental, safety and security concerns. As such, they actually represent an essential asset for Europe even if the vast majority of them were originally developed to meet national objectives.

A380 model in a large transonic wind tunnel for accurate lift & drag measurements. In such tests the aerodynamic drag is measured with an accuracy better that 10^{-4}.

CAPABILITIES FOR EXPERIMENTAL AND NUMERICAL SIMULATIONS ARE KEY ENABLERS FOR THE DEVELOPMENT OF AERONAUTICS

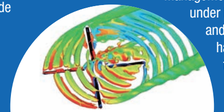
The importance of research infrastructures for the aviation industry and the scientific community involved in aeronautics is a well known fact.
All past and present aeronautical components or products have been tested in aerodynamic wind tunnels. It is likely that the same will be true for future products. This observation is not in contradiction with the trend towards increasing dependency on numerical simulation. Indeed, the fast, detailed and accurate design procedures necessary to meet increasing constraints (in particular those related to environmental and safety issues) call for increasingly powerful testing and evaluation capabilities involving multi-disciplinary and multi-physics features. In short, both experimental and numerical simulations will still be complementary. Consequently, in parallel with the effort regarding testing capabilities, effective and affordable access to top level European High Performance computing resources should be made available to the aeronautics research community.

AERONAUTICS INFRASTRUCTURES ADDRESS BOTH SCIENTIFIC AND INDUSTRIAL RESEARCH IN A COMPLEMENTARY WAY

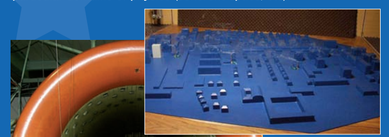
Industrial customers (aircraft manufacturers) use facilities - on a commercial basis - during limited test periods for developing and improving their products. This contributes towards making these facilities available for scientific research to alternate users who also need them for limited periods of time.

This situation benefits the numerous research projects conducted within the framework of various national or EU programmes on both fixed and rotary wing aircraft and also serves the need to improve basic knowledge (e.g. flow stability, transition, wakes, vortices, combustion process...) through tests directly funded by Research Establishments with the underlying objective of increasing fuel efficiency and reducing noise. Conversely, the industrial community benefits from the results of fundamental research which provides improved technologies in several areas.

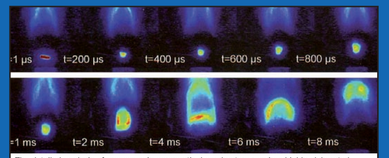
The need for increasingly accurate experimental databases also calls for the development of highly sophisticated non-intrusive measuring instruments, which stimulates fundamental research in particular domains of physics (coherent optics, etc).



The numerical simulation of complex multi-physic time-dependent phenomena requires extensive computer resources. The aeronautics community needs access to the world's top 10 supercomputers.



The automotive, rail, civil engineering and wind power industries can also benefit from publicly maintained infrastructures and associated know-how.



The detailed analysis of processes in aeronautical combustors requires highly elaborated measurement techniques like the Coherent Anti-Raman Stokes (CARS) Scattering.

Aeronautics research facilities also contribute to European integration through the exchanges associated with various industrial customers (mostly trans-national companies) or researchers of different nationalities involved in operating them. Additionally, formal pan-European networks have also been established in order to improve overall efficiency, by exchanges of best practices and progressive specialization in areas of application. Examples are AT-One in the field of Air Traffic Management, DNW, ATA or EWA (Network of Excellence created under EU/FP-6) in the field of aerodynamic wind tunnels and measurement techniques. Very encouraging results have been obtained so far and this approach will have to be developed in other domains (flying test beds, airport research, etc.) in the future.

Even if it is true that 'traditional' ground based facilities (like aerodynamic wind tunnels, propulsion test beds, etc.) are the most emblematic and well known examples of aeronautics research infrastructures, the sector also needs and exploits a large variety of other capabilities. Examples are Vibration and Fatigue test beds, Crash facilities, Electromagnetic compatibility facilities, Control Tower simulators and, of course, Flying Test Beds.

Similarly, at system level, an all new operational concept of Air Traffic Management will have to be validated using a sophisticated infrastructure covering, amongst other things, automatic / Fast-Time simulation Tools, Human-in-the-loop simulation Platforms and Field experiment Platforms.

Aeronautical R&T calls for a large variety of capabilities ranging from Control Tower simulator…

… to Crash test beds.

AERONAUTICS FACILITIES REPRESENT AN ASSET THAT HAS TO BE PRESERVED

Most of the major aeronautics facilities were funded by national governments in the '50s and '60s to fulfil national needs and it is striking when you realize that a product like the A380, which is likely to be in service for the next 40 years, was extensively tested in 50-year old aerodynamic wind tunnels.

Most large and medium size facilities are run on an operating costs recovery basis by national aeronautics research establishments and are open to any customer.

ETW, the European Transonic Wind Tunnel is the largest aeronautics facility built at the European scale (FR, GE, UK and NL). It represents an asset worth more than €500m and is a unique facility.

University aeronautics departments also operate laboratory facilities more suited to conducting basic research whilst industrial companies own some limited research equipment for their exclusive use.

Aeronautics facilities are essential for improving basic knowledge and for supporting the competitiveness of the European industry. They represent a tremendous asset that is estimated to be worth more than €4b. Maintaining, renewing / upgrading or replacing these facilities represents an enormous challenge and a financial burden that operators using national funding schemes are increasingly less bale to support alone. The result is that less than 1% of the total asset is re-invested each year. Such a situation is unsustainable in the long term.

Europe (through the Union and through intergovernmental tools) will have to be increasingly involved in the process of (re)investments while facility operators will have to make further progress in the rationalization process undertaken several years ago and which already produced tangible results. In this field, as in others, Europe should be in a position to compete on an equal footing with the US where large aeronautics facilities are considered to be national assets and supported as such at federal level.

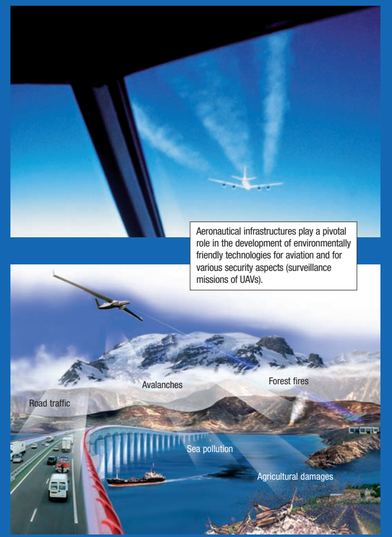
Operators, in particular of medium-size (key) capabilities, will also have to examine, in relation with national and European public authorities, fair ways and procedures for fostering the optimal use of existing facilities, reducing existing unnecessary duplications and preventing any risk of new duplication involving public funds.

AERONAUTICS FACILITIES BENEFIT OTHER SECTORS

"Low-speed" as well as "high speed" aeronautics research infrastructures (in particular wind tunnels) have been serving the objectives of several sectors other than aeronautics. Surface transport (road and rail) and the civil engineering sectors have already been mentioned. Similarly in the space sector, launch and re-entry configurations have been extensively modelled and tested using tools developed for the aeronautics sector.

Flow visualization on an Ariane 5 model.

The Environment and Aviation Safety also benefit from aeronautics infrastructures. This is, for example, achieved through regular improvements at component level (e.g. combustor performances) or through the direct study of specific phenomena (e.g. wake vortices and icing). Security is also likely to profit more from the investments made so far by the aeronautics community (e.g. UAVs).



Aeronautical infrastructures play a pivotal role in the development of environmentally friendly technologies for aviation and for various security aspects (surveillance missions of UAVs).