Activity Report 2007

EUROCONTROL Experimental Centre

EUROCONTROL

Content

Introduction

Jan van DOORN

In 2007, globalization continued to drive powerful economic, political and technological change, with escalating demand for natural resources, energy, communications, and global transport. The rise of the economies of India and China provided some insight into the demand that Southern Asia will place on the global ATM system in the near future. Even in the face of a heightened security risk, environmental concerns, congestion, and dramatic increases in the price of kerosene, total air traffic for passenger and freight increased steadily. Globalization presents formidable challenges for the sustainable future of aviation. The year witnessed growing public awareness of the environmental impact of aviation, the effects of emissions in the atmosphere, and the wider debate on global climate.

The above scenario has profound implications for air transport, and emphasizes the critical need for a revised European ATM system in a way that is safe, efficient, environmentally rational, and compatible with developments worldwide.

EUROCONTROL has been at the forefront of this change, especially in close alignment with the Single European Sky ATM Research (SESAR) Programme, the flagship vehicle for change in European ATM. Within the EUROCONTROL Experimental Centre (EEC), research, development and systems engineering is advancing to meet the challenges of a vast and complex European ATM.

The Experimental Centre operated within a 2007 budget of €61.73M of which €3.9M came from other EUROCONTROL resources and €1.98M from European Commission projects. From this budget the largest operational expenditures were SESAR operational concept validation and Research Infrastructure, which together accounted for about 50% of all expenditure.

The role of the EEC is both increasing and changing. This Activity Report for 2007 provides an overview of the Centre's contribution to European ATM research.

The EEC in the community of the Single European Sky initiative

The European flagship initiative for ATM, the Single European Sky (SES) will introduce a simplified and more coherent structure of control and regulation as well as new technologies for safer, more efficient and more capable traffic management. The Single European Sky concerns the way in which European nations work together in this international activity. This big programme of change must be designed and negotiated over a number of years. A cornerstone of the Single European Sky initiative is defining airspace independently from national boundaries in Functional Airspace Blocks (FABs). Although the concept is easy to grasp, there was no clear method for determining how this should be worked out or take account of the different assets of the national providers. There is also a major programme to deploy new technologies for the new European system of ATM. The provision of these technical means is the role of SESAR, a jointly funded R&D programme of the European Commission, EUROCONTROL, and the air transport industry. The SESAR Joint Undertaking will manage the €2B work programme.

SESAR is an ambitious programme: it will design, develop and implement a coherent, integrated, pan-European system of air traffic control. SESAR is the technological arm of the SES initiative that will deliver major improvements in the capacity and quality of ATM and bridge the gap between the potential capacity of today's systems and the forecast demands of ever higher traffic. The targets set for the Single European Sky are: increasing capacity threefold, a tenfold increase in safety, a reduction of at least 10% in the environmental impact per flight, with a halving of ATM costs to users.

These goals conceal the complexity and challenge that will be involved in their delivery. The role of the SESAR work programme is to establish the single roadmap for all R&D agencies across ATM in Europe, including the EEC.

The Centre welcomes SESAR for the clarity and direction that it offers. In providing a single programme that the whole aviation community can understand and use, SESAR will generate confidence in planning research and development work in the EEC and elsewhere. The EEC's work programme will become fully aligned with the aviation industry's first effective, governing and comprehensive ATM change programme.

In 2007, the process of alignment commenced that will establish the EEC within the SES community and the SESAR project. Externally, the Centre exists within a community of contributors, each having particular roles within ATM. Much of the work of the Centre is consequently collaborative, whether as a project leader or as a member of a group working on a particular programme. The EEC therefore does not exercise nor claim any monopoly of technical authority across the span of ATM. In particular cases the Centre has a unique skill, authority or role but this emerges from its expertise rather than from any internal requirement. The EEC is, however, singular in its contribution and reputation – its impartiality, independence of thought and pan-European view - which are widely admired and diligently upheld by the Centre and its staff. Preparing for the evolving role within SESAR and the Agency, the EEC is determined to maintain the values that have served the Agency and the ATM community over the years.

Internally, the principal activity and achievement of the Centre in 2007 has been preparing for SESAR. In many ways, the Centre's future role will be subject to the realignment of understanding, thinking and action that SESAR implies.

The pulse of the Experimental Centre in 2007 responded to these challenges to build on the networks of ATM collaborators formed over many years; and to review and align the internal workings of the EEC to adapt to the needs of SESAR.

The following sections of this Activity Report illustrate our internal realignment, partnership activites, and research projects in 2007.

Partnerships

A co-operative approach to the development of ATM in Europe is an absolute necessity imposed by the wide range and diversity of its actors and their business objectives - a fact long since recognised by EUROCONTROL. Consequently, most of the projects with which the Centre is concerned involve collaboration with a diversity of partners: ANSPs, Airports, Airlines, Industry, Academia and Regulators across Europe, and in some cases worldwide. The EEC has represented the Agency in developing partnerships in ATM R&D for over 10 years, and now has connections with more than 180 different agencies, firms and suppliers. These networks will need to be adapted to the demands of SESAR.

Objectivity is a vital characteristic of the Centre's reputation for technical excellence and knowledge. The EEC is concerned only with the end result and with attracting, using and bringing to completion the best technology for the work in hand. The Centre has been able to contribute this impartial view of life very constructively over the years; it has not mattered much whether the outcome has been the EEC leading a team or simple membership. Partners have valued the Centre's approach, which continues to serve the interests of ATM.

SESAR Project Definition

A first class example of the way the Centre can contribute to an important collaborative activity lies in the SESAR Project Definition Phase. The SESAR project needed to gain acceptance from a large number of separate firms, agencies and other organisations. This acceptance depended upon bringing the diversity of technical agreement, understanding and enthusiasm for individual elements of SESAR to a common point. The EEC was able to make an important contribution to this process during 2007 by working with the community, building industrial networks and providing specialist support. The Centre is not in the business of imposing solutions from above. Rather, our approach is to engage in active dialogue with individual organisations to design effective solutions. Where the Centre possessed appropriate technical knowledge and could assist, we offered to do so by providing additional analysis, models, or architectures that delivered impartial, expert material to inform and assist the partners. In the technical area, the Centre was often able to take a leadership role when there was an apparent hurdle emerging in the acceptance process. These actions collectively contributed to a successful outcome: the acceptance of the SESAR deliverables by the whole ATM community.

Episode 3

Alongside the work in SESAR, the Episode 3 (EP3) partnership kicked off. EP3 is a project of the European Commission's (EC) Sixth Framework Programme (FP6). The Experimental Centre leads and takes part in EP3 by facilitating and coordinating as well as participating in a number of the work packages. EP3 collects 24 partner stakeholders from across the European ATM spectrum. The establishment of effective working relationships with clear goals was a major success for the partnership in an intensely political transition period towards the SESAR Development Phase.

ATM Seminar

The 7th US-Europe ATM Seminar was held in Barcelona and organised by the Experimental Centre in cooperation with the FAA. The ATM Seminar is recognised as an important forum in the ATM research area. The ATM Seminar was again able to improve its quality content in 2007: from 146 full papers submitted, 66 were selected and presented to an invited audience limited to 220 leading experts in the ATM field, including delegates from the USA, Russia, Japan, Australia and Brazil. Apart from some topics of continuing relevance the seminar focused particularly on providing more active support to ACARE, SESAR and NextGen (the future US air transport management system). There were new topics for this direction, including, for example, 4-D Trajectory Management and Separation, and Enhanced Surveillance and Navigation. This seminar is a major facility for the EEC to orchestrate exchanges and compare new ideas with a group of acknowledged experts across the ATM community.

Stimulating Innovation

Innovation is the foundation on which Europe's industries will remain competitive in the global market. The ATM industry at large recognises the need to stimulate creativity and innovation to develop scientific knowledge and extend the SESAR vision.

The EEC provides an increasing stimulus to innovative ATM research with special focus on the academic community. The Centre has a number of instruments which are applied to ensure the development of scientific and technical excellence. The EEC is committed to the promotion of ATM research as a serious and attractive topic for study, which in turn will draw young scientists into a challenging career.

The annual Innovative Research Workshop is a "must attend" event for the innovative ATM research community. The workshop provides a forum where innovative ideas and concepts in the field of ATM are presented, compared, and critically assessed by a group of experts. This 6th INO Workshop was organised as an associated event of the 7th ATM Seminar with participation from 23 countries including Australia, Japan, China and Russia.

Other facets of the EEC stimuli are the innovative projects financed through the CARE-INO instrument. A significant contribution in 2007 resulted from one such project which investigated the possibility of sensing pollution emitted by individual aircraft. A useful (albeit negative result) was achieved by demonstrating that the current generation of sensors lacks the necessary discrimination to accomplish this task.

Airborne Separation Assistance

Airborne Separation Assistance Systems (ASAS) are essential elements of the paradigm shift called for in SESAR. Our ASAS team at the Experimental Centre is recognised worldwide as a driving force in the development of these applications. The present focus of activity comes under the heading ASAS-Thematic Network II. In addition, many organisations, companies and agencies, amounting to over 100 further partners in collaboration, also contribute to the network effort.

The principal objective of ASAS-TN II is network communication to accelerate the implementation of ASAS applications in Europe. Five workshops have been held to

date - with two in 2007. The fourth workshop addressed "ASAS – A Reality Check" and the fifth, held in Toulouse in September 2007, focused on "Equipping for ASAS". The workshops were well attended by more than 100 delegates from around Europe with some visitors (including the FAA) from other parts of the world.

World-wide Co-operation

The Single European Sky cannot exist in isolation: it must interface with the global transport system, with common challenges being faced across the world. This interface allows for the possibility of using the best ideas and, by avoiding duplicate development programmes, contributing to faster, cheaper solutions. Close working contact needs to be sustained with Australia, China, Russia, India and others to ensure that each is aware of the potential synergies that might arise from co-operation between SESAR, NextGen, and CARATS. In 2007, this effort continued with visits to the Asia-Pacific region, which provided the opportunity to discuss potential collaborative relationships. Important steps were also made toward a Memorandum of Understanding with the Russian Service Provider FANA and the large TsAGI Aeronautical Institute.

Taking Research into Reality

Denmark & Sweden System Modernisation

One of the successes of the EEC during 2007 illustrates the long lead times between research activity and the deployment of improved services. The Denmark-Sweden Interface (DSI) Project of the mid-1990s was performed at the EEC in partnership with the Danish and Swedish civil aviation authorities to develop their future ATC systems. Interestingly, this activity carried the positive results from the ODID era through further simulation prototyping and detailed engineering specifications into the development of modern ATC systems. These are now operational in both Denmark and Sweden, featuring human-machine interfaces and controller support tools.

The DSI Project came about as a consequence of the two countries having separately examined their needs for more integrated and capable systems to replace those existing in 1990. Both countries arrived at the view that their new systems would need to incorporate a number of the same advances. For example, both wanted to replace the paper strip aide-mémoire used by controllers with a combined electronic data input and message system. This would enable a controller to highlight or pass the now electronic 'strip' to another controller, saving effort and increasing efficiency. The Operational Display and Input Device (ODID) had already demonstrated that such a concept was feasible. In 1996, the EEC was asked to support this activity. The Experimental Centre provided a real-time simulation platform, SweDen96, evolved from the work already done on the ODID-4 platform. This portrayed a section of the Swedish-Danish airspace and a number of new features of interest to the two countries. The simulation was a success and the two nations decided to adopt the concept for their new systems. Since it was clear that further work would be needed on the Human Machine Interface (HMI) the DSI Project was launched. In the course of this work, the tower HMI was embraced for the first time, with the creation of a complete suite of HMIs, including the interface with small airports and the military. The DSI was simulated successively in 2001 with a large-scale simulation that concentrated on co-operation between sectors and area control centres (ACCs), controller working and system learning time.

As with all new technology, DSI met with scepticism in the beginning. Not all the supply industry or air traffic controllers initially supported this development. However, a quick look at the HMI being proposed lately at various ATM exhibitions demonstrates that the principles developed by this project have in the event been widely accepted. Most of the major system providers are proposing DSI-like human-machine interfaces for their new systems, not only in Europe but also in the Middle East and Asia.

Wake Vortex Sensing

The Centre is involved with setting safe separations for high-traffic airports especially where closely spaced parallel runways are in use. The main concern here is the extent to which vortices formed on one runway can migrate to endanger aircraft landing or taking off from another runway. Safety dictates that adequate allowances must be made for this vortex migration, but efficiency considerations urge that these should be as low as possible in conditions that are often changing rapidly. Empiric separations have been used for many years but the subject has lacked data on the vortices actually formed at airports or how these change with time. This has been made easier since the invention of laser sensing of vortex parameters. In 2007, the Centre established a real-time wake vortex sensing unit using a EUROCONTROL LIDAR Wind Tracer at Charles de Gaulle Airport (CDG). The unit assesses arriving traffic and makes continuous records of the scale and position of the wake vortices being formed, which allows for a dynamic reaction to the influence of traffic and weather conditions for safe separation. The deployment of the unit has also proved to be very useful in researching the causes of pilot experiences on landing. The current plan is that the Wind Tracer installation now at CDG should move to Heathrow in spring 2008 to assist in gathering data in support of validating the time-based separation concept there (see below).

The CDG data-gathering exercise will also provide valuable information for the execution of a European project: Crosswind-reduced Departure Concept of Operations (CREDOS).

An EC FP6 project, CREDOS started in June 2006 and will last for 42 months. The work is being performed by eleven European organisations in close collaboration with the FAA. The main project objectives are to:

- demonstrate the feasibility of a concept of operations that allows reduced separations for single runway departures under crosswind conditions
- provide, through extensive validation, all stakeholders with the required information to facilitate appropriate implementation of this concept in the near-term (pre-2012)
- increase the body of knowledge concerning wake vortex behaviour during the initial climb phase of flight.

The research is addressing the severity of a wake vortex encounter by identifying those characteristics of the vortex that present particular threats to the safety of the aircraft and how these are increased in low crosswind conditions. CREDOS is also concerned with ways in which safe separation can be maintained at increased airport throughput. Validation activities are meanwhile identifying the operational benefits which may be expected from a real-world application of crosswind-reduced departure separations. The airports involved in data collection at Frankfurt and St Louis made good progress during the year supporting CREDOS and enabled a first draft of the Crosswind-reduced Departure Concept of Operations to be issued in 2007.

Exploring Time-Based Separation

As part of the SESAR intention to examine all means of increasing the capacity of the airspace, and necessarily with the focus on dense traffic regions, the Centre has been exploring aids to maximise arrival traffic. Strong headwind conditions have caused loss of capacity as the ground speed is reduced without any means to use the closer separation that would otherwise be safely possible. The Centre has been looking at replacing distance-based separation criteria with time-based separation (TBS) as a means to recover this lost capacity. The TBS system includes a graphical tool to help controllers optimise spacing on final approach. The concept was subject to a real-time simulation at the EEC in December 2007. EUROCONTROL has worked collaboratively with NATS on the potential use of this system at Heathrow, and controllers from the DFS have also assessed the

concept during the simulation exercise. A consortium led by M3 Systems also carried out a modelling study of the impact of wind velocity on the use of Time-Based Spacing. The report was published early in 2008. Making maximum use of separation minima has clear safety implications and this is being addressed as a high priority. This work has significant promise for increasing capacity and the intention is now to bring all relevant TBS work together more effectively in a structured and coherent way.

Safety Culture

Understanding, measuring and enhancing safety culture has been a major effort at the EEC in recent years, working with nine separate ANSPs to develop tools and ways forward in this sometimes difficult but important area. A safety culture measurement approach has now been applied within four ANSPs, leading to a clearer understanding of where ANSPs are excelling, and where improvements can be achieved. This work is central to assuring that there is organisational commitment to safety at all levels in the ANSPs. The EEC has also used a tailored version of the tool to determine how to improve its own safety culture. None of these efforts would have been possible or effective without co-ordination and collaboration both within the Agency and outside with ANSPs and research organisations.

Point-Merge System

Stemming from some of the work within ASAS, the Centre has developed a new approach procedure that sustains runway capacity and improves environmental impact, predictability, and controller workload in practical systems. An agreement has been reached whereby Point-Merge will be rolled out, initially in Oslo and Dublin, and probably with Rome and others to follow. The procedure uses Precision Area Navigation (P-RNAV) technology. The existing system employs a set of heading and speed instructions to adjust the routing of the approach with the effect of expediting or delaying its progress. This is an accurate method for maintaining separation and runway throughput but also has some limitations. The Point-Merge system is based on a specific route structure which consists of a geometrical point (the merge point) with pre-defined legs equidistant from this point that are used for path shortening or stretching. As aircraft are flying along a leg, and depending on the preceding traffic in the sequence, the controller passes an instruction to turn towards the merge point. Speed adjustments can also be given to the aircraft. Controllers can use the Point-Merge system without any other system aids beyond, of course, the facility to use P-RNAV.

Several trials were used to crystallise the concept, refine the details of the overall geometry, and assess the performance under different wind conditions. Controllers reported a reduction in workload compared with today's methods without message saturation, since instructions in the Point-Merge system consist only of speed and level during final approach. Frequency occupation was correspondingly reduced. Controllers also noted a better distribution of tasks. The overall accuracy of final spacing under the new system was similar to that obtained with the baseline system. Although the actual trajectories were quite different, the distance flown under the two systems was very similar. The dispersion of trajectories is also more structured, and this should contribute further to safety by reducing the potential conflict situations and improving controller situational awareness. The Point-Merge project illustrates the engagement of the EEC, within a partnership to take research towards implementation. The concept may also provide an excellent building block for incorporation into SESAR Trajectory-based operations.

Improving Controller Communications with Link 2000+

Link 2000+ provides a first set of en-route Controller/Pilot Data Link Communications (CPDLC). Up to 50% of a controller's time spent on repetitive frequency changes or flight level instructions of a routine nature will transfer to data link services. The system also generates improvements in the interaction between pilots and controllers by providing a second communication data-link. Link 2000+ is at pre-implementation safety case stage and is due to be implemented by 2009. The EEC provided support to a number of airlines for customer acceptance and certification of the system.

In 2007, the first Boeing 737 was certified for CPDLC over the data link services. Dedicated training sessions were provided to Malev pilots at EEC, allowing them to exercise CPDLC on the Brétigny avionics test-bed to prepare for the certification test of their first equipped aircraft. The Link 2000+ compliant ground automated CPDLC end-to-end test capability has been a clear success in support of airlines. More than ten of the Link 2000+ pioneer airlines were regularly connected from equipped aircraft for an independent installation check as well as for aircrew CPDLC familiarisation.

Support to ANSPs also started in 2007. Tests were conducted to validate interoperability between the French Link 2000+ compliant ground implementation and the Rockwell Collins and Honeywell avionics at EEC. This allowed the CPDLC operational trials at Reims en-route control centre to start in January 2008. The Datalink Test Facility was also the major actor in interoperability tests to meet the target of full bi-directional interconnection. Since becoming operational in December 2007, this allows any ATC centre to perform CPDLC exchanges with any equipped aircraft regardless of their choice of service provider.

Amsterdam, the Ruhr and Frankfurt Airspace

One of the direct assistance projects undertaken by the EEC during 2007 was AMRUFRA (Amsterdam, Ruhr, Frankfurt), a real-time simulation being used to validate new airspace organisation across these three control zones. Langen ACC has a problem both now and more acutely in the future when the new runway at Frankfurt further increases traffic in the region. This centre interfaces with the control of the Amsterdam control zone managed by LVNL. Under the current route structure, the use of a single outbound route is causing congestion and this is expected to worsen. Departures from Düsseldorf also complicate the scenario and the whole needs to be considered as a single problem area. The issue is a very good example of the pressure under which airspace is in Europe. A few rather narrow problems very quickly involves a large set of stakeholders, all with a legitimate and necessary need to be involved in the solution. These include: Langen (DFS) and Amsterdam (LVNL), naturally; Frankfurt, Düsseldorf, the MILATCC (Netherlands Military), Lippe Radar (German military), and MUAC in the immediate vicinity and, indirectly, the adjacent control zones. The EEC has set up a real-time simulation of this problem area to examine the issues; it will assess safety and capacity but also investigate efficiencies and usability aspects as well. Controllers from the regions concerned will assist in playing the simulation and testing out the alternative management strategies. The simulation will operate at a large scale having 25 controllers and 20 pilots working for three weeks in the early part of 2008 to validate the proposed solutions. The agreed solutions are due to be implemented in the regions concerned in late 2008 with Frankfurt's new runway coming on stream in about 2011.

Preparation for the Challenges of the Single European Sky

SESAR

The Single European Sky ATM Research (SESAR) programme is, of course, the principal driver of change at the EEC. Although SESAR is not yet in its full research and development stage, the Centre's workload is increasingly oriented towards its achievement. This process of re-alignment is running in parallel with project work to modify or examine a number of potentially useful processes against the SESAR concept.

In 2007, the Experimental Centre spent some 1600 man-days on SESAR. The work included a number of contributions to the process of providing the SESAR deliverables together with the project stakeholders. These contributions principally involved the development of components and support to the SESAR Concept of Operations, the definition of the related Operational Improvements, the Future Network architecture, and performance assessment. At the end of the year, significant EEC expertise contributed to the SESAR Master Plan and the SESAR Work Programme (2008-2012), the R&D and Safety Management plans, the definition of the Mid- and Long-term work programmes, and the Validation Infrastructure for the SESAR JU. Of great importance for the EEC is our contribution to the SESAR Definition Phase: this is of technical and strategic concern as SESAR will colour the whole future use and operation of the Centre.

Adapting Episode 3

A considerable volume of work was devoted to an update and adaptation of Episode 3 (EP3) for possible use as a contribution to the SESAR validation activities. Episode 3 is a major programme of work that the European Commission initiated through its Sixth Framework Research Programme. EP3 is a €35M, three-year project, launched in 2006 to undertake an initial assessment of SESAR (building on the SESAR Definition Phase conclusions). EP3's scientific and technical objectives were directed toward building assurance that the SESAR concept satisfies the required levels of performance of the future European ATM system. The goal was to provide evidence, for:

- the safety of the SESAR target concept
- the performance of the SESAR target concept
- the operational viability of the SESAR target concept
- the technical viability of the SESAR target concept.

Work on the performance framework started during the second half of 2007 with Cycle-1 of the assessment process, together with the 26 stakeholders who form the core partnership group. In September 2007, more than 20 of these partners gathered in Southampton. The meeting investigated the ways in which EP3 could contribute to the emerging validation needs of SESAR and examined how EP3's original generic outlook might be realigned to a more SESAR-oriented application.

The Southampton workshop also increased understanding of SESAR significantly and allowed the partnership an opportunity to focus on the contributions that EP3 might provide to SESAR. The wider understanding of SESAR by a much larger number of people within the ATM community was reflected in the Centre where the number of people having familiarity with SESAR increased tenfold.

As a result of the achievements of the Southampton workshop, the Description of Work (DoW) for EP3 was re-written fully focused on SESAR. The partnership for EP3 continues to execute the FP6 objectives of initial validation of SESAR over the medium term, and within the Centre a number of individual tasks for SESAR development and validation have been completed.

At the Experimental Centre, the Mid-Term Validation (MTV) Programme met a series of objectives connected with support for EP3 alignment. An important goal was the delivery of a set of initial Detailed Operational Descriptions (DODs) into the project by the cross Research Area team which refined the SESAR concept and added non-contentious detail in support of the EP3 exercises. More difficult areas in the concept are currently being detailed in partnership with stakeholders. The structure used for the DODs will facilitate their adaptation to the industry standard format of the Operational Services and Environmental Description (OSED) as a step towards implementation.

Airspace Management

While SESAR traces out strong lines for the future of European ATM, other facets of the Single European Sky provide additional challenges for the EEC. For instance, the integrated management of airspace through the Functional Airspace Blocks (FABs) is another cornerstone whereby the Centre's impartiality and capabilities may be considered as a valuable asset for successful implementation.

Although not directly related to the FABs initiative, preparation for the AMRUFRA simulation has shown the EEC's capability in assembling complex technical facilities and expertise to support the resolution of airspace organisational issues similar to those that may be encountered through the development of the FABs.

In this area, our capabilities and expertise were also deployed following a request from the parties involved in the BLUE MED initiative. The EEC provided support in a number of specific areas, which included the high-level business case study and the definition of performance indicators and targets.

Support to Regulation

A new activity in the EEC's portfolio is support to regulation. We noted an increased awareness and acceptance in 2007 that EEC validation capabilities can and should contibute to support regulation, standardisation and certification and began to develop this strategic role. The initial task was to make an assessment of how this support would demand new or improved methods or facilities in use at the Centre. Test methods and facilities are not only used for design-focused technical work but can also be employed to characterise, test and help certify the results of European R&D as these go into operation. Certification support therefore carries a burden of responsibility to ensure that the tools used in the certification process are accurate, stable and managed by a controlled process that justifies confidence in the results delivered. Closely related to this work is the extension of the E-OCVM validation methodology. The results obtained from R&D programmes can then be planned and structured in a way that most effectively allows them to be used by regulatory and standardisation bodies. R&D validation can provide early and validated inputs to regulation and standardisation, supported by evidence, thus forming an integral part of the regulatory life cycle.

Focusing Research, Refining the SESAR Concepts

The Centre continued to provide support for the design of the future SESAR development while pursuing research and validation activities in a number of areas, the results of which contribute to the body of knowledge required to refine the future concepts.

Trajectory Control by Speed Adjustment - ERASMUS

A key principle of the SESAR ATM target concept is that the ATM service should respond to the requirements of airspace users – down to the level of individual flights. This principle has led to the development of the concepts of "business trajectory" and partnership between airspace stakeholders. Business trajectories will be expressed 4-dimensionally (position and time) and flown with far greater precision than is currently the case. This will reduce uncertainty and pave the way for the increased use of both airborne and ground-based automation, with the possibility of using innovative ways of ensuring safe separation between aircraft; and, in particular, ways of maintaining separation nearer to minimum distances to maximise the capacity of the airspace. SESAR has already identified new separation modes. One is Trajectory Control by Speed Adjustment (TC-SA). TC-SA will have the ability to minimise potential conflicts through applying trajectory control and airborne separation systems to ease the workload of controllers by reducing the number of occasions on which they need to intervene. This is being explored in ERASMUS – a project under the EC's Sixth Framework Programme, which is being performed in partnership with European ATM organisations. The ERASMUS Strategic De-Conflicting function is aimed specifically at optimising separation management with the provision of a conflict-free trajectory over short (15 minute) flight segments. This has the capacity to greatly alleviate controller workload by reducing the need for routine monitoring, conflict detection, and the associated ATC interventions to change flight profiles. One approach to achieving this is by a trajectory modification through minor speed adjustments under TC-SA that are so slight as to be undetectable by controllers (hence their "subliminal" description) but which are sufficient to maintain a conflict-free trajectory without controller intervention. This approach could remove up to 80% of the potential conflicts that would otherwise need to be resolved by controller action.

Ground Based Augmentation

In 2007, a trial of an A320 outside Toulouse using the Ground Based Augmentation System (GBAS) was successfully completed. Planning used data from the Malaga GBAS for analysis at the EEC with PEGASUS tools. The Spanish controllers assisting with the simulation provided good feedback on the possibility of introducing such approaches at Malaga. During the simulation, all the

safety issues identified by the EEC were reproduced and possible mitigation methods are to be proposed. The concept of GBAS is to devise improved IFR approach procedures that will increase airport capacity, maintain or improve safety, and decrease environmental impact from noise by aircraft and rotorcraft. The work uses available improvements in navigation and location accuracy through the use of the Global Navigation Satellite System (GNSS) to produce greater accuracy and reliability of data that will allow separation minima to be safely reduced. Together with the introduction of continuous descent and 4-D trajectory profiles (an important element of SESAR), this will provide enhanced traffic flows on approach to busy airports. The project is moving towards its planned conclusion in 2008.

Prediction in Congested Airspace

In the area of network technologies, work was started on a quality of prediction network with a scoping study that will characterise the planning layers necessary for managing a congested airport or sector. An early step will be to analyse the traffic status at a particular congested airport/sector at different times. Also in this area of work there was progress on the management of traffic through Logical Functional ATFCM Areas (LFAA). The potential for using pattern recognition techniques to refine the LFAA methodology was evaluated in the European SW and NE traffic axis in close collaboration with CFMU flow managers.

One of the fundamentals for developing traffic management tools for use in a variably loaded airspace is the ability to insert accurately characterised traffic forecasts into the scenario being used. The characterisation is complex. Real traffic patterns embrace a range of situations that are managed by controllers. These patterns include, for example, the way traffic behaves as the volume of traffic exceeds nominal airport capacity – a frequent challenge during busy times. A traffic-forecasting tool has been developed within the Centre that generates a realistic traffic pattern, including handling situations where the traffic growth extends beyond forecast airport capacity. The significance of the work is part of the more general aim of SESAR to explore new approaches to safely increasing traffic density around the major hubs within the system. The forecasting work being done by the Centre, in this and in other ways, will be of great relevance and assistance in the SESAR gaming exercises concerned with traffic growth responses.

Surface Movements

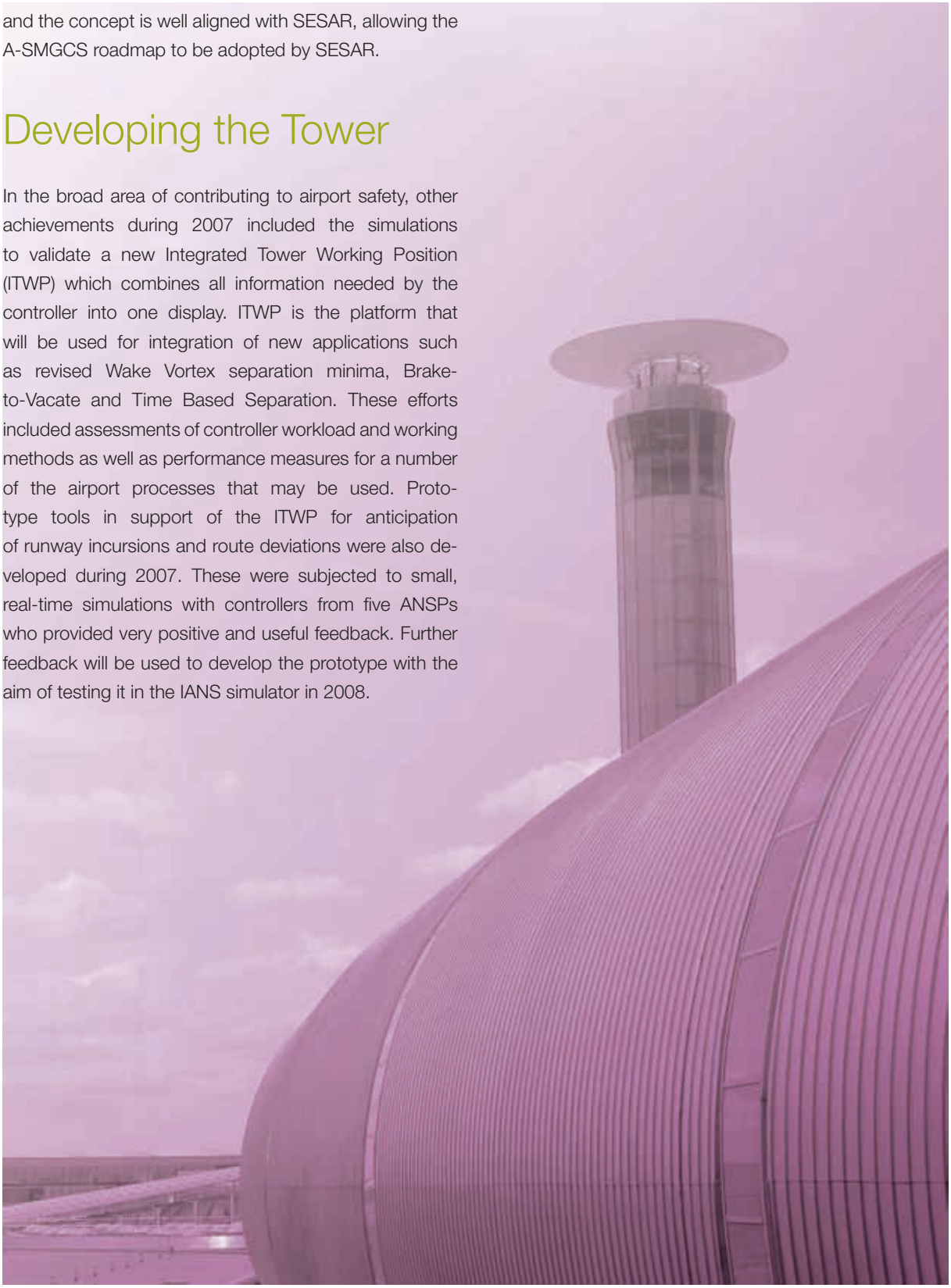
EMMA 2 is a current example of partnership at work; in this case, 24 partners from 9 countries, together with 6 other contributors representing 7 sectors of the ATM community. EMMA 2 is the most recent a series of projects dealing generically with the control of surface movements at airports: A-SMGCS. Collectively, these projects have addressed the impending bottleneck of airport surface movement. The intention is to provide a safe, integrated air-ground system for surface movement guidance and control that is seamlessly embedded within the overall ATM system.

EMMA 2 is the fourth part in a series of projects launched in 1996. The work is being conducted under the EC's FP6 and is coordinated by DLR in Germany. EMMA 2 will contribute an incremental step through its definition of A-SMGCS higher services, such as CPDLC and Planning, validation through simulation and field trials, and in feedback to ICAO. The project began in 2006 and sets out 20 implementation steps covering 6 distinct areas of operations relevant to safe and efficient surface movement. The partnership complexities for the 30 partners and contributors are therefore considerable but are also representative of all new projects with the ambition to contribute significantly to the new ATM system. In 2007, results have been extremely promising and the project will continue into 2008. Six simulation platforms have been running in conjunction with the test aircraft, tower locations and data processing centre. Indications are that the performance for the system will meet requirements

and the concept is well aligned with SESAR, allowing the A-SMGCS roadmap to be adopted by SESAR.

Developing the Tower

In the broad area of contributing to airport safety, other achievements during 2007 included the simulations to validate a new Integrated Tower Working Position (ITWP) which combines all information needed by the controller into one display. ITWP is the platform that will be used for integration of new applications such as revised Wake Vortex separation minima, Brake-to-Vacate and Time Based Separation. These efforts included assessments of controller workload and working methods as well as performance measures for a number of the airport processes that may be used. Prototype tools in support of the ITWP for anticipation of runway incursions and route deviations were also developed during 2007. These were subjected to small, real-time simulations with controllers from five ANSPs who provided very positive and useful feedback. Further feedback will be used to develop the prototype with the aim of testing it in the IANS simulator in 2008.



Anticipating Research infrastructure needs

Providing the infrastructure of tools and platforms that enable the EEC's projects to move forward is a major responsibility (about 20%) in the Centre's budget. Each of the tools has to be developed, maintained, supported and evolved. Each must be able to support the absolute dependence placed upon it by users across the ATM community. New tools have to be developed cost-effectively by suppliers from the breadth of industry to ensure their readiness and applicability to SESAR. The deliverables are new tools and enhanced versions of existing ones that are reliable, stable and relevant to the validation, simulation and project work of the community. Although some of the development of these new tools is done at the EEC, much of the work is subcontracted to industry under the Centre's leadership.

Simulation

The Agency is a major user of the simulator platforms that the EEC supports with real-time simulators in operation at Maastricht, Luxembourg, IANS and CRDS Budapest. ANSPs also use the Centre's simulators; for example, at ENAV in Italy. In 2007, there were two new users: SICTA in Italy and AENA in Spain.

In 2007, work started to investigate the route towards a fully integrated, fast-time simulator platform that would simulate the domains of ATC, ATFCM, and Airport in a fully consistent manner. This anticipates SESAR's needs in its phased development under the Joint Undertaking.

The EEC Simulation Capability and Platform for Experimentation (ESCAPE) continued to evolve its simulation capabilities. ESCAPE allows simulation of ground ATM systems, aircraft and avionics systems, and communication systems - both voice and data. ESCAPE is used for real-time simulations to evaluate new concepts, technical enablers, airspace changes and procedures. These 'Air', 'Ground' and 'Communication' segments permit a high degree of adaptation to allow configuration for the particular scope and objectives of a simulation or trial. In 2007, the EEC delivered the next upgrade of the platform. Thanks to this development package ESCAPE is now ready to support 4-D applications such as computing 4-D trajectories.

2007 also saw the launch of a concept for a EUROCAE sub-group for real-time simulation interoperability. The EEC has been an advocate of this move. Presently, there is no effective and complete standard for enabling simulators to interface directly with each other (to allow more powerful and comprehensive simulations), and this facility is an important need within SESAR. The ambition is that the sub-group will act as a standing mechanism for forging agreement on the protocols, standards and interface definitions, which will permit interconnection between platforms. The early work has included participation in an interoperability sub-group with this aim.

Aircraft Performance Modelling

The Base of Aircraft DAta (BADA) is a real success story of the EEC. The BADA project started about 20 years ago and has grown substantially. BADA is an Aircraft Performance Model (APM) based on a 3-degree of freedom, mass-varying, kinetic approach. This approach models an aircraft as a point and requires the modelling of resulting longitudinal forces. APM is the core component of trajectory prediction tools, and accurate prediction of aircraft trajectory is at the heart of the future ATM system. BADA provides a number of aircraft performance parameters which are developed based on aircraft manufacturers' performance data. These are grouped in the data sets for each aircraft type, and - together with operation models - can be used for trajectory prediction. Version 3.6 accurately models 88 aircraft types under typical operational conditions. Thanks to advancing computer resources and increased reference data quality, substantial improvements are now possible. This was the focus of development in 2007, where in collaboration with Boeing Research and Technology Europe, the advanced version of the BADA APM was developed. The new version of BADA (named as family 4) caters for the increasing requirements for model completeness, accuracy and flight envelope coverage. In the last year, BADA counted 241 users worldwide.

BADA's use in ATC operational applications became more important in 2007. In addition to provision of the APM and corresponding data, a number of ANSPs requested from the EEC more service-oriented support to BADA in the context of its use for the new operational systems. This request was further investigated with key stakeholders to identify how BADA might be consolidated for its use in ATC operational applications in a way which fully takes into account the latest regulatory developments in Europe (Single European Sky). A draft proposal was developed at the end of 2007 with plans for a review by stakeholders and final release in the first half of 2008.

Developing the Fundamentals

The Centre has developed tools to support our research and validation, but this alone is insufficient. We must also develop methodologies and processes that when applied ensure the production of consistent and comparable results, not only within the EUROCONTROL Agency itself, but also across the entire ATM research community.

Safety

Safety continues to be the driving ethos of all work at the EEC. This is reflected in the expertise and capabilities of the Research Methods team, serving the interests and needs of the Agency, European stakeholders, and the wider aviation community beyond Europe. The cornerstone of these activities has been the continuous operation of, and enhancement brought to, the EEC Safety Management System (SMS). This led in 2007 to the development of a safety information and data exchange system referred to as the EUROCONTROL Safety Radar.

The major alignment effort of the EEC work with SESAR has been reflected in the Research Methods. In leading the development of the SESAR Safety Management Plan (SMP), this has been now fully aligned with the Episode 3 Safety Plan.

One of the key continuing themes for safety is learning from experience and this is embedded in the Centre's SAFLearn process. SAFLearn previously focused on En Route and TMA concepts. In 2007, the future Airport concepts were included in SAFLearn developments. SAFLearn has already been applied to ten operational concepts to improve their safety. During 2007, the resulting data was prepared for use in the Integrated Risk Picture (IRP), which aims to evaluate the safety of the total ATM system and identify vulnerabilities.

SAFLearn analysis examined different types of accidents covered by the IRP and the safety barriers that should have been effective against them. Showing how barriers sometimes fail help ensure that key strategic projects, such as IRP, remain closely connected with an understanding of current incidents in the real world.

Safety is a consideration which is not confined to Europe alone and is an area where international co-operation is crucial. This may be highlighted by the joint EEC-FAA paper presented at the International System Safety Conference (ISSC). The paper dealt with some of the future considerations in ATM Safety up to 2010 and won the award for best paper at the conference.

Human Factors

Humans are integral to ATM. Therefore human performance and human factors are of prime importance within ATM. At the EEC, the aims of the Human Factors (HF) group within Research Methods is the continuous progression of HF knowledge, understanding and good practice in all projects both within EUROCONTROL and more widely across the ATM community. In 2007, HF guidance has been successfully integrated with two Airport projects – ITWP and CREDOS.

The EEC Human Factors team has also been able to assist in an advisory role for the resolution of an operational issue in a European ACC resulting from a number of minor incidents. The Human Factors investigation into these separate incidents produced a package of remedies at the individual controller, technology and organisational levels, many of which have now been implemented.

Environment

As the environmental impact of aviation becomes more urgent, the ability to deploy an impartial, objective and dependable toolset is an increasingly significant resource of the Centre.

The EEC has continued to extend its tools, methods and data for modelling and analysing the environmental impact of air transport. These now represent a unique European capability in this controversial area. The special value of this resource rests in the combination of the tools and expertise together with a uniquely comprehensive and authoritative data set. The consistency of the model known as TESA - Toolset for Environmental Sustainability Assessment - sets it in a new class whereby interdependencies between different local and global impacts can be assessed. For example, TESA allows assessment of either a policy scenario or airspace reorganisation with analysis by the different models (based on the same consistent data set and assumptions). This has simply not been possible until now. Much of the development of these models, data and methodologies takes place within ICAO-CAEP working groups, where in several areas the EEC provides leadership. Through this involvement, the models, data and methodologies developed within EUROCONTROL are peer reviewed by international experts and can truly be claimed to be “best in class”. In addition to the existing toolset for the assessment of local noise, air quality and global emissions, EUROCONTROL has been entrusted by the European Commission with the development of a new Strategic Tool for Assessing Regional Noise (STAPES).

The traffic dataset (WISDOM) already combines detailed trajectory data for the European and North American regions, together with operations data for the other regions of the world. WISDOM is being further extended through developing data exchange agreements with these other regions in collaboration with ICAO.

2007 was largely devoted to advancing the “industrialisation” and deployment of the tools and data. For example, the Advanced Emissions Model (AEM) is now used at EUROCONTROL headquarters to produce daily fuel and emissions statistics for European air traffic through the PAGODA portal. In another example, at the request of DG-TREN, EUROCONTROL was tasked to lead the development of an environmental impact decision-support tool. Based on actual and future traffic, this tool will support the Commission's efforts in assessing the environmental impact of its air transport policy in terms of fuel burn and related emissions. The prototype developed, integrated AEM within an ATM simulator tool.

These examples, together with significant interest from ANSPs, airlines, airports and other research centres, are indicative of the need for “industry strength” tools to support future work. The collaborative network of expertise that has made this unique European capability possible is being evolved toward a “Virtual Centre of Excellence” model. In this framework, expert resources will be able to work more freely in the development of tools and data. Also envisaged is the application of this resource to the environmental impact assessments of the SESAR concept.

Beyond 2025

In the 2020 through 2025 timeframe, the SESAR operating system is set to become a reality. Before then, there is a vast amount of work to be done: validation, integration, education and communication for the many users. At the same time, the implementation of SESAR processes must allow a safe, orderly and interruption-free migration from the processes now in use. Achieving all of these goals will be challenging. On the way to implementing SESAR, many new technologies will be used but others will inevitably be put to one side and judged to represent a risk too great to take in the SESAR main programme. During the development of SESAR many new technologies and concepts will also come to attention and they too will represent a growing accumulation of potential for the years beyond 2025. To these will be added those that come forward in the years when SESAR is in use and, if forecasts of traffic growth are proved correct, by the middle of the century we shall again be looking for a new ATM operating system. This process will continue for as long as aviation and the growth of knowledge will continue; no system will ever represent the last word.

Even with the inevitable concentration on the immediate aims of SESAR, work goes on at the EEC to think about the future. The determining parameters of the future ATM system can be forecast to some extent but, much can happen in the next forty years, and the overall character of the ATM and its constituent systems might be very different. Traffic will certainly be greater, aircraft types will have changed, and there may be much larger aircraft and much smaller ones all using the ATM system. UAS will perhaps be commonplace. Business traffic from small aircraft on point-to-point routes will be considerably greater than at present and will present substantial but unpredictable loads upon the ATM system. Given its present accelerating trend the generality of technology will also have advanced enormously, especially in computationally related parts of the system and this will feed into and enable new ATM applications. But ATM will also change conceptually with open questions still to be addressed about the integration of travel by land, sea and air. Business models will develop so that entirely new forms of business will be serving the needs of passengers. Without even attempting a scenario for the future, one can see that very many aspects of ATM may well have changed in quite fundamental ways.

New Frontiers – Developing the Long Term View

A significant achievement at the Centre during 2007 was the first complete draft of the Long Term Investigation (LTI) Programme resulting from a co-operative process with partners from the industry. The programme is developed from the baseline created by the SESAR target concept, providing an initial vision for the future time horizons. The vision was presented at a number of conferences and taken as a reference by the ACARE group for the development of SRA-3. The LTI will investigate the whole of the Air Transport System, including ATM and Airports, but will also look at the transport inter-modality challenges and the integration of new classes of air vehicle such as UAVs and small air vehicles. LTI is positioned as a supporting task helping SESAR to develop its post-2025 concept.

Project topics being studied within the Long Term group include: the Airport of the Future, Airspace design, Automation of future ATM concept elements, and the impact of greatly increased numbers of flying machines including small aircraft and Unmanned Aircraft Systems (UAS). ERASMUS concept elements (see above) are also included within the SESAR concept for 2020-2025.

The EEC in Evolution

As SESAR affects the Agency and within it, the EEC, it is inevitable that the latter will change. In part, this will be achieved over time, but specific actions are already taking place or are planned to encourage and enhance the deeper sense of alignment with SES and SESAR. EUROCONTROL plans to extend its strategic pillar for Cooperative Network Design (CND) to encompass the entire Agency effort devoted to this area – including probably virtually all of the EEC's work. This will allow the process of adapting organisations, projects and people to be taken further and to be more effective in meeting the needs of SESAR.

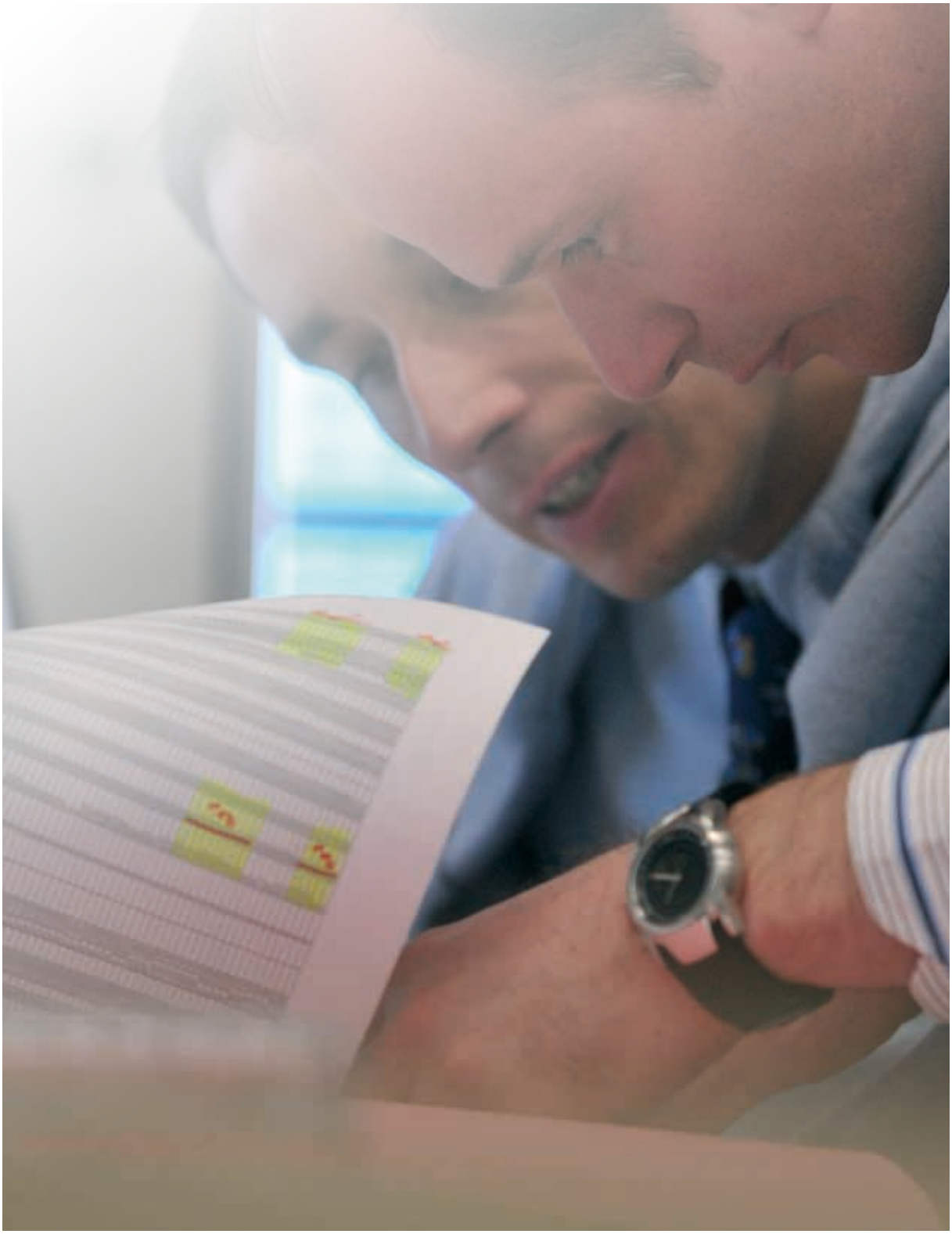
The repercussions of these changes are not yet clear. What is clear is that the values of the Centre which address and enhance our sense of Excellence, Commitment, Objectivity, Partnership and Delivery will remain central to the effectiveness of all the Experimental Centre's activities. For this to be true, it is neither necessary nor desirable that the Centre should aspire to lead all aspects of the R&D work which it performs. The EEC clearly does not do so. We recognise and respect the work of others, their expertise, and the contribution they make to the common endeavour. Our best contribution will always be in situations where we can deploy a high level of expertise, impartially, with excellence, and at an appropriate level for the contribution to be most effective. We continue to see, year by year, new examples, where this approach brings benefits to our partners and the ATM community (see "Partnerships" section).

Although SESAR is not yet in operation, the EEC has seized upon its virtues of integrated R&D, planned delivery, co-ordinated cross-system collaboration, and the ability to manage R&D in totally new ways. Even in the present evolution of SESAR, the impact is visible at the EEC: all the technical staff are now part of the same endeavour; every potential or actual contribution can be located on a map of SESAR's necessary accomplishments. Every small element of research, method definition or process integration can be mapped to its likely position; and importantly, to its likely timetable, as the detail of the SESAR Master Plan is developed. This has already made profound changes to the way the Centre works - and these changes are ongoing.

In many ways, the EEC approaches a pivotal period in its development. But this could be said of the Agency itself and many other parts of the ATM system. The leverage is caused by the scale and reach of the European vision for a new ATM system. This enormous undertaking is bound to bring about change in the organizations that will work together to create and support the future ATM system.

The EEC in Evolution

At the Experimental Centre, we are ready for these changes, whatever their detailed form, secure in the knowledge that however they evolve there will be a need for the values of the Centre, and for their continued expert and impartial application. These changes will be achieved not only by the institution of the Centre but also by its people; they are the heart and spirit of the EEC and its work. Through their expertise, non-partisan contributions, and most of all their commitment to see a better ATM system working for the safety and convenience of all users, operators and passengers, the Centre will continue to contribute to the mission of the Agency.



Glossary

A

ACARE	Council for Aeronautics Research in Europe
ACC	Area Control Centre
AEM	Advanced Emissions Model
AENA	Aeropuertos Españoles y Navigación Aerea
AMRUFRA	Amsterdam Ruhr Frankfurt
ANSP	Air Navigation Service Provider
APM	Aircraft Performance Model
ASAS	Airborne Separation Assurance Systems
A-SMGCS	Advanced-Surface Movement Guidance and Control Systems
ATC	Air Traffic Control
ATFCM	Air Traffic Flow and Capacity Management
ATM	Air Traffic Management

B

BADA	Base of Aircraft performance Data

C

CAEP	Committee on Aviation Environmental Protection
CARATS	Comprehensive Assessment and Restructure of the Air Traffic Services
CARE	Co-ordinated Actions for Research in EUROCONTROL
CDG	Charles de Gaulle Airport
CFMU	Central Flow Management Unit
CND	Co-operative Network Design
CPDLC	Controller / Pilot DataLink Communications
CREDOS	Crosswind-reduced Departure Concept of Operations

D

DFS	Deutsche Flugsicherung GmbH
DOD	Detailed Operational Description
DoW	Description of Work
DSI	Denmark Sweden Interface

E

EEC	EUROCONTROL Experimental Centre
EC	European Commission
EMMA	European Airport Movement Management by A-SMGCS
ENAV	Società Nazionale per l'Assistenza al Volo
E-OCVM	European Operational Concept Validation Methodology
EP3	Episode 3
ESCAPE	EUROCONTROL Simulation Capability and Platform for Experimentation
EUROCAE	European organization for Civil Aviation Equipment

F

FAA	Federal Aviation Administration
FAB	Functional Airspace Block
FANSA	Federal Air Navigation Authority
FP6	Sixth Framework Programme

G

GBAS	Ground-Based Augmentation System
GNSS	Global Navigation Satellite System

H

HF	Human Factors
HMI	Human Machine Interface

I

IANS	Institute of Air Navigation Services
ICAO	International Civil Aviation Organisation
IFR	Instrument Flight Rules
IRP	Integrated Risk Picture
ISSC	International System Safety Conference
ITWP	Integrated Tower Working Position

L

LIDAR	Light Detection And Ranging
LFAA	Logical Functional ATFCM Areas
LTI	Long Term Investigation
LVNL	Luchtverkeersleiding Nederland

M

MUAC	Maastricht Upper Airspace Control Centre
MTV	Mid-Term Validation

N

NE	North-East
NextGen	Next Generation Air Transportation System

O

ODID	Operational Display and Intput Device
OSED	Operational Services and Environmental Description

P

P-RNAV	Precision Area Navigation
PAGODA	Profile Alignment Group for ODA (Open Document Architecture)

R

R&D	Research & Development

S

SAFLearn	Safety Learning for R&D
SES	Single European Sky
SESAR	Single European Sky ATM Research Programme
SICTA	Sistemi Innovati per il Controllo del Traffico Aero
SMP	Safety Management Plan
SMS	Safety Management System
SRA	Strategic Research Agenda (ACARE)
STAPES	Strategic Tool for Assessing Regional Noise
SW	South-West

T

TBS	Time-based spacing
TC-SA	Trajectory Control by Speed Adjustment
TESA	Toolset for Environmental Sustainability Assessment
TMA	Terminal Manoeuvring Area
TsAGI	Central Aerohydrodynamics Institute

U

UAS	Unmanned Aircraft Systems
UAV	Unmanned Aerial Vehicles

W

WISDOM	World Interconnected Sources Database of Operational Movements

EUROCONTROL