Proving the future will work

It is one of the most complex and vital challenges facing air traffic management (ATM) today: how can we ensure that airspace design improvements, new concepts and tools will deliver the safety, capacity, flexibility, cost and environmental benefits research models suggest? The EUROCONTROL Experimental Centre in Brétigny, France, is helping to find the answers.

With billions of euros being invested in new ATM technologies and procedures – for both research and deployment – it is critical that once in operation they deliver the planned benefits. It is a complex challenge because a capacity or cost benefit in one area can reduce safety or environmental performance in another. A sector redesign in the upper airspace can reduce workload for one controller – but adds to another’s at lower levels. There is only one authoritative way of validating the benefits of new technologies and procedures and that is to simulate their introduction in the most realistic way possible: quite difficult when it comes to remodelling the airspace around an airport and extraordinarily difficult when the entire airspace of a functional airspace block (FAB) is involved.

Over the past 50 years the EUROCONTROL Experimental Centre (EEC) in Brétigny, south of Paris, has developed a suite of tools to simulate the deployment of a wide range of new procedures and technologies from very small to large multinational airspaces – and has developed the experience and independence to ensure that results will be accurate and timely.

“We are unique in that with our ESCAPE simulator (see box on page 42) we can simulate very large airspace changes,” said Philippe Debels, Airspace Simulation Manager. “We are also flexible – we can emulate almost any system in Europe. A recent simulation for the Functional Airspace Block Europe Central (FABEC) countries involved eight different types of human-machine interfaces (HMIs) for example; now we have basically no limitation in complexity and diversity of HMIs.”

With the first Single European Sky ATM Research (SESAR) programme in its deployment phase, the EEC has played a pivotal role in helping validate some of the initial SESAR concepts – and those that pre-date SESAR such as free route airspace – for a wide number of clients within and beyond the SESAR Joint Undertaking.

ESCAPE is also a vital component in enhancing the Network Manager’s European route network design function, by enabling a full cycle of new concept development. It allows researchers to plan the initial conceptual elements through detailed designs of airspace structures up to validation of new concepts via real time simulations before implementation.

The centre has recently completed a simulation exercise for Danube FAB clients, where it simulated the full airspace of Bulgaria and Romania, in a traditional, fixed-route structure and then a free-route structure to assess the potential benefits of free route in terms of kilometres flown, capacity and workload.

Clients include FAB partners, individual air navigation service providers (ANSPs), airports, airspace users and other stakeholders, covering all phases of flight and from a network – that is capacity demand and balancing – perspective.
They come to the EEC because the centre has a long and successful track record in validating new ATM concepts. It uses E-OCVM, the European Operational Concept Validation Methodology, a recognised validation process developed by EUROCONTROL and used in SESAR that gives solid guidelines on how to build a robust and convincing case, demanding evidence at every step. EUROCONTROL also has a unique combination of skills and experience in dealing with multi-cultural ATM issues and a reputation for impartiality.

“Our SESAR work has included prototyping simulations in an iterative cycle to develop or to fine-tune a certain concept like Point Merge, Short Term Air Traffic Flow Management, User Driven Prioritisation Process, Time-Based Separation or Extended Arrival Manager or for specific needs of specific airports,” said Philippe Debels.

OVER THE PAST FEW years, the EEC has introduced a range of inter-connectable simulator platforms including an aircraft cockpit, a Network Manager platform, the ATC system and the airport tower. This allows the centre to validate very complex concepts which have a multi-stakeholder, multi-national dimension. With a concept such as extended-AMAN (arrivals management), for example, the centre is ready to validate the procedure not just for one airport but across several ANSPs and different airports, looking at how the new traffic flows will impact flight operations in many States.

“We are unique in that with our ESCAPE simulator we can simulate very large airspace changes”

Philippe Debels,
Airspace Simulation Manager

While there is no ultimate substitute for live trials, platforms such as ESCAPE can be used to run preparatory exercises before the live trials take place – so they are less costly and more effective. Value for money is a key requisite in any platform validation trial. This is where complex tools and years of expert experience can prove invaluable.

“One of the major constraints when running real-time simulations is the limited availability of experts and air traffic controllers. In order to make best use of their time and effort we build experiments that are a grouping of many possible scenarios, which remain realistic, even if in real life they are unlikely to occur at the same time. This is very much appreciated by our clients,” said Philippe Debels.

“Before running a large simulation we suggest a simplified (and less costly) prototyping simulation, with a reduced set of airspace configurations and potential new tools. So if, for example, a service provider wants to introduce free route airspace and a set of controller decision support or safety tools, not all yet fully adapted to their own needs, we can use the prototyping simulations to reduce the number of options and fine-tune the tools before going through a larger (and more expensive) simulation.”

As the ATM system of the future will involve more integrated operations between airspace users, airports, Network Manager and ANSPs, the validation platforms will become more complex and networked. The centre has recently installed an Airbus A320 cockpit, a 3D tower simulator and an Airport Operation Centre (APOC) simulator. When integrating the cockpit, tower and ATC platforms it is now possible to simulate time-based separations on final approach and assess the benefits for all stakeholders. Within a networked concept of operations even a simple concept can have a complex series of consequences on other stakeholders, so it is important to understand whether an ATC improvement in one small area, for example, could result in increased fuel burn or workload in another. It is also increasingly important to assess the overall performance impact of specific concepts or combination of concepts on the Network.

These capabilities underpin some of the EEC’s main contributions to the SESAR programme, not just in developing very large-scale demonstrations, but also assisting the Deployment Manager with the implementation of concepts that are mature, either for individual States or FABs or the Network Manager.

“Further down the road we will increasingly support validation of integrated network, ATS and airport operations with the newly deployed network management platform and the airport operations platform,” said Philippe Debels.
Platforms to cover every step of the future

The Brétigny EUROCONTROL Experimental Centre features a large number of different types of simulator platforms and various tools for validation.

The largest one is the air traffic control simulator ESCAPE, the EUROCONTROL Simulation Capability and Platform for Experimentation. ESCAPE is a vital component in enhancing the Network Manager’s European route network design function, by enabling a full cycle of new concept development. It allows researchers to plan the initial conceptual elements through detailed designs of airspace structures up to validation of new concepts via real-time simulations before implementation. It is built around major components such as the EUROCONTROL air traffic generator (eATG); the flight data processor (ground); the human machine interface (with a vast library of existing interfaces); the data preparation module and the Base of Aircraft Data, which is a database of aircraft performance models. It comprises several ATC simulation rooms: two large rooms with up to 40 controller positions each and a smaller one, accommodating up to 16 positions. A further room with 46 piloting positions can simulate realistic aircraft operations for the ATC simulations.

For network issues and planning there is the EUROCONTROL Network Management Validation Platform (NMVP), a clone of the NM operational system, and the Innovative Network Operations Validation Environment (INNOVE), which supports hybrid validation exercises where either humans are in the loop, or models emulate behaviours and operational processes. For airports, the centre hosts the airport operations centre gaming platform (APOC) and the combined eDEP and UFA 3D visualisation tower simulator. For the cockpit, the centre has installed the EUROCONTROL Cockpit Simulator (ECS), based on the ECA Faros Airbus A320 cockpit simulator and for measuring the environmental consequences of new tools and procedures the IMPACT suite of simulators allows for emissions and noise assessment studies.

The centre also houses a variety of mathematical simulators such as AirTOpSoft, CAST (a comprehensive Total Airport simulator) RAMS (ATC fast-time simulators), SAAM (System for traffic Assignment and Analysis at Macroscopic level) and R-NEST (an integrated validation tool combining advanced dynamic air traffic flow and capacity management capabilities with powerful airspace design and capacity planning analysis functionalities) for airspace and network studies.