AIR TRANSPORT

A research perspective on innovation management in air traffic management

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Air traffic management is regarded as highly innovative and applying modern technology. This is only partly true as it suffers from long innovation cycles and other blocking factors.

In the last two decades innovation mechanisms in air traffic management (Eurocontrol, 2011a) changed significantly in line with a shift of responsibility from individual states governance to a pan-European strategy. In 1999 the European Commission launched the 'Single European Sky' initiative, as a response to the dramatic growth in air travel witnessed over the previous two decades.

The amount of air traffic until the mid-1990s allowed for an *ad hoc* management based on very few planned data and position reports. The underlying rule system – derived from high safety standards – ensured passenger acceptance and supported the airlines' business models. The safety standards also led to long innovation cycles. However the system was not very flexible. Air Traffic Control (ATC) was and is still regarded worldwide as a sovereign task and, as such, is mainly organised by service providers owned by the State. The necessary harmonised technical and procedural standards are defined by the International Civil Aviation Organisation (ICAO), a United Nations organisation. They have to be approved by each Member State individually. As a consequence ATC providers operate different systems and airports regard themselves as individual organisms. A couple of other factors hamper broad innovative changes in Air Traffic Management (ATM), including market fragmentation and national regulation authority.

Examples of past ATM innovation

Air traffic increase required a more systematic planning to eliminate conflicts on flight routes and to limit the work load of controllers and pilots. Research institutes like DLR (Deutsches Zentrum fuer Luft- und Raumfahrt, German Aerospace center) invented in the 1980s assistance systems for ATC controllers. A first version of an arrival management system (AMAN), called COMPAS (Computer Oriented Metering Planning and Advisory System) was implemented in the Frankfurt Approach Control by Bundesanstalt für Flugsicherung (BFS), now DFS, the German ATC provider (Völckers, 1990). The implemented planning algorithms generated a sequence and time schedule for the approaching traffic. The logical step of reducing air traffic controllers' task by assisting them with planning advisories took several years of laboratory research and many consultation iterations with users of the technology. Besides the creation of the adequate planning algorithms the development of the optimal human machine interface was the main challenge which finally led to the controllers' acceptance. These ideas were invented in very few places and were implemented into the operations at only 2 or 3 airport approach centres at the beginning of the 1990s. It took another decade and a lot of additional investment from DLR and DFS until the innovative product AMAN became available from the industry.

In the community it is now well-known that this product is beneficial and that business cases exist for airports with a high traffic load. However the market is still limited, adapting the product to the specific airport and the special ATC working arrangements costs a lot of effort, such that one can talk of unique products. So the investment for the ATC provider is high and only a couple of companies are offering this AMAN product.

The Instrument Landing System (ILS) allows flight operations even under conditions of bad visibility. In 1989 DLR recognised that after the landing there were still problems in keeping the traffic at the same capacity level as in good visibility – even in normal situations aircraft taxiing was not always smooth and efficient. This led to an airport taxi management concept called the Advanced Surface Movement Guidance and Control System or A-SMGCS (Dippe, 1990; Klein, 1994a). The four main functionalities (i.e., surveillance, planning, guidance, and control together with the communication between aircraft and ground) were integrated into the system and the procedures. The refined concept was later on standardised by

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ICAO in DOC9830 (ICAO, 2004) and was used by technical harmonisation groups, other research organisations, ATC providers, industry and several European projects.

A couple of research projects in several countries as well as first installations of some of the mentioned functions pushed the innovation forward. A working group of the European Organization for Civil Aviation Equipment (EUROCAE) played a major role in defining the standard, balancing the different interests of the manufacturers and end users, and promoting a consistent concept for all airports. Not only was the system defined but test specifications were given such that installations from various manufacturers had to meet certain user requirements.

For the first time a European innovation strategy for airport operations was applied in ATM. The European Commission sponsored a sequence of big projects within the European research framework programmes. All stakeholders (ATC providers, airports, airlines, manufacturers, airframe integrators, universities, and research organisations) were involved and contributed to the results. Work was performed in many European countries and several airports hosted complete or components of A-SMGCS. These research activities followed a roadmap to validate the concept, the system components and the procedures at different sites. The standard could be finalised and the market became ready for the innovation. As a result a couple of firms were able to mature their products, to enter the market and ATC service providers or airports got reliable inputs for their investment decisions. As of today around 30 airports in the world are equipped with A-SMGCS. It is hoped that these systems will significantly contribute to airport safety and severe accidents like the one in Milano-Linate in October 2001 should be avoided in the future.

Higher levels of functionality (automatic guidance, etc.) are still under final validation and some standardisation is still necessary before mature products are installed at international airports and in many airlines' aircraft. This concept is built upon several functions and many technologies and affecting more than only one stakeholder. Even with the mentioned improvements in following a strategic approach such a complex system required more than 2 decades and the complete concept is not yet in operation.

More innovation obstacles

When air transportation became popular innovations were first applied on board. Technology push and market pull changed the aircraft cockpit, the airlines' business, and last not least the pilots' working environment and attitude to use modern technology. The above given examples are typical for the situation on ground at the end of the last century. The ATM system was built upon the situation awareness and on the trained skills of the human operator to control the traffic. As long as the performance of the air transportation system remained in acceptable limits there was no need for more automation and fundamental changes. In line with the ATC providers' set up along the countries a national industry existed delivering the special products for their national customers.

Europe changes the scene

The high traffic increase, non-acceptable delays and major disruptive events (e.g., 9/11, SARS crisis) affected the air transportation system worldwide and led to openly questioning the traditional ATM system.

The transportation network in Europe is recognised as one of the key factors of prosperity. In 1999 the European Union formulated a new goal with the Single European Sky as an answer to the deficiencies in air transportation. Its primary aims were to meet future capacity and safety needs through legislation.

The European ATM system currently handles around 26,000 flights daily. Forecasts indicate air traffic levels are likely to double by 2020. Moreover, the European ATM costs an additional €2-3 billion every year, compared to other similar systems in the world. This raised serious questions as to how the European airspace would accommodate increasing air traffic flows whilst cutting costs and improving performance.

The answer came with the initiative of organising airspace into functional blocks, according to traffic flows rather than to national borders. Such a project was not possible without common rules and procedures at the European level. The Single European Sky (SES) was born to meet this need (Eurocontrol, 2011b).

Furthermore it was recognised that overcoming the organisational fragmentation would not solve the problem completely. Technical harmonisation and innovations were also urgently required. In 2000 a high level group of personalities generated the Vision 2020 (ACARE, 2001) setting challenging performance targets for the air transport in Europe (in terms of capacity, safety, security, environment protection, affordability, etc.). The Transport Commissioner of the European Commission founded the Advisory Council for Aeronautic Research in Europe (ACARE) group to work out Strategic Research Agendas (SRAs). For the first time all stakeholders of the air transport system worked together to formulate a common strategy.

New instruments in Europe's research Framework Programme (FP7) were used to push research and development (R&D) and implement at least partly the aeronautics strategy through Joint Technology Initiatives (JTIs). For instance the Clean Sky JTI focuses on the green air transport system – based on adequate fixed wing and rotary wing airframes, engines, and aircraft systems.

The Single European Sky Air Traffic Management Research (SESAR) was launched to complement the new legislation on the operational side. SESAR represents the technological dimension of the SES initiative. It aims to develop the new generation ATM system capable of ensuring safety and fluidity of air transport worldwide over the next 30 years. It is composed of three phases (SESAR Joint Undertaking, 2011):

- The Definition phase (2004-2008) delivered the ATM master plan defining the content, the development and deployment plans of the next generation of ATM systems. Led by Eurocontrol and co-funded by the European Commission under the Trans European Network-Transport (TEN-T) programme it was executed by a large consortium of all air transport stakeholders;
- The Development phase (2008-2013) will produce the required new generation of technological systems, components and operational procedures as defined in the SESAR ATM Master Plan and Work Programme;
- The Deployment phase (2014-2020) will see the large scale production and implementation of the new ATM infrastructure, composed of fully harmonised and interoperable components guaranteeing high performance air transport activities in Europe.

ATM innovation management by SESAR

Not surprisingly the first phase resulted in a debate on how much innovation should be planned in the short and medium term part of the roadmap. Airlines were particularly interested in speeding up the R&D and making the best use of the already installed technology in the airframes. ATC providers were reluctant to follow as they are facing the biggest investments and organisational changes. The tight schedule of this phase led to a master plan building upon mature technologies.

In the researchers' view SESAR is implementing old ideas already elaborated by research in the 1990s. SESAR is more about development than research. It is nonetheless a big step forward as all stakeholders were involved and finally agreed to follow the SESAR path. Due to time pressure in the definition phase some unfilled gaps led the new ATM concept to remain incomplete and inconsistent.

The development phase is managed by the SESAR Joint Undertaking (SJU), a public private partnership organisation. It is financed partly through FP7, partly by the TEN-T programme, Eurocontrol and the industry. In addition to the SJU founding members, the European Commission and Eurocontrol, 15 companies (or industrial consortia) became full members and are executing about 300 projects. The SJU administration board is composed of these members together with representatives of the air space users (e.g., airlines, air forces), of the staff (e.g., controller organisations), of the research community, etc. Full members of the SJU are airborne and ground equipment manufacturers, an airport group, ATC providers, and an airframe integrator. Many other organisations (e.g., airlines, other ATC providers, research labs, small and big industrial companies) are involved via sub-contracts or via affiliation to members.

The work programme (content of the projects) was created through a bottom-up process in which all member candidates contributed with their ideas. Within one work package the SJU, with the help of Eurocontrol and some members, had then to structure the work and compose the overall system fitting into the master plan concept frame. Risks like leaving gaps open, not fitting interfaces and delays seem to be unavoidable.

Joining forces will improve the innovation process. However in the SESAR management real independent parties are the minority. Because for example public funded organisations (research labs, universities, non-profit entities, etc.) are not yet affiliated with the SJU level directly. The complex system is mainly designed by combining contributions from interested parties in order to ensure the buy-in of the main stakeholders.

Some other deficiencies of this approach have to be overcome to speed up and stabilise the innovation process and to shift paradigms in ATM where necessary. The creation of new organisations like the SJU, a new financing scheme and the new way of working together delayed the innovation process by several years. Furthermore successful working structures at the European level (e.g., integrated projects in the research framework) were dismantled. Many research units (research labs, universities, research departments of ATC providers) lost a big part of their funding and by that some creativity. Partly a brain drain took place as young scientists went to other disciplines or had no chance to join European ATM projects.

Conclusion

Air Traffic Management developed in the last century at different speeds on board and on the ground. Fragmentation throughout the industry and sovereign interests prevented the system from becoming efficient and cost effective.

The limitations discovered at the end of the century (delays, costs, noise, pollution, etc.) led to innovation in some system parts and regions. At the beginning of the 1990s the European Union took action and formulated goals for the air transport system and for the future ATM system. A strategic approach was implemented and the innovation management was reorganised by initiating SESAR. This process can be regarded as a quantum leap as it involves all stakeholders and leads to an innovation process on a pan-European scale. Some concerns nonetheless remain as to the risks of the chosen approach and the side effect of financially drying out the ATM research scene. There is still a need for a variety of other means to enable creativity, financial support and implementation strategies. ★

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