Cranfield University

Digital Aviation Research and Technology Centre

Addressing the digital aviation challenge

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Digital aviation – delivering customer needs?

Aviation is a major economic driver. The UK is Europe's largest aerospace manufacturer and globally, it is second only to the US.

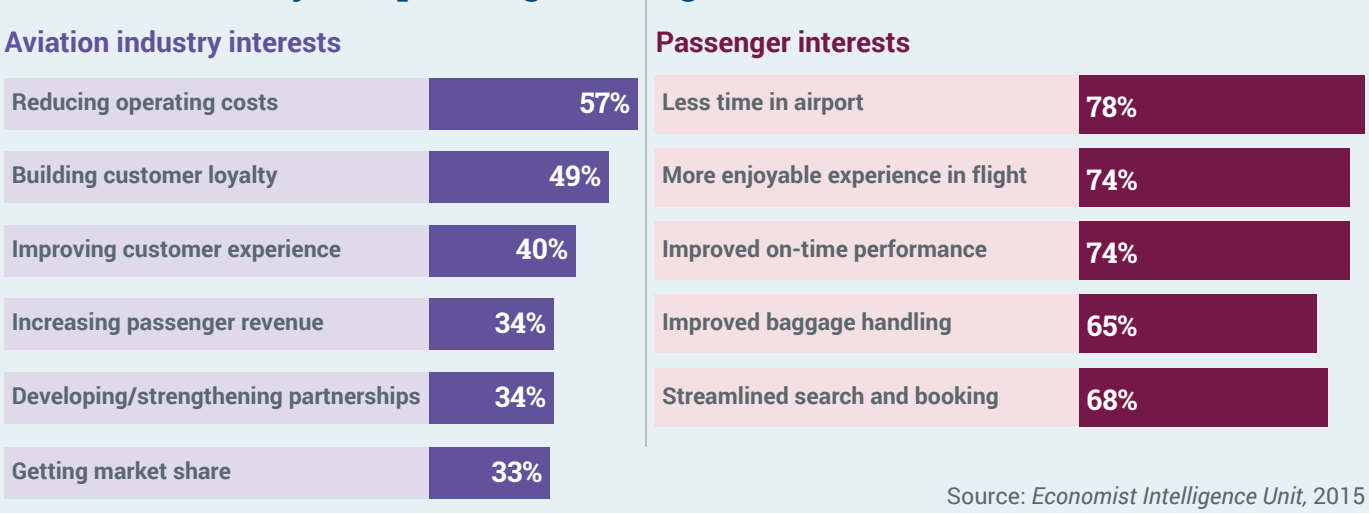
Aviation already contributes £52 billion to UK GDP, supports 961,000 jobs and generates £19.8 billion in tax revenues. UK passenger numbers are expected to increase by a further 49% by 2050 and a similar picture is echoed across Europe and the rest of the world. The pace of air travel growth is already causing strains across the sector. Since the launch of EU Regulation 261/2004 (common rules on compensation and assistance to passengers in the event of denied boarding and of cancellation or long delay of flights), compensation costs incurred by airlines have increased by an average of 20%, largely as a consequence of increased European air traffic density. An A320 flight within the EU that is delayed by 30 minutes would cost the airline typically €1,100; a five-hour delay would cost €65,020, significantly impacting on the economic viability of the flight. Without changes, the projected growth in passenger numbers will increase travel time losses and cause greater social dissatisfaction with the sector.

The planned expansion of EU airport capacity and ground infrastructure will not in itself be sufficient to have a significant and sustained impact on the reduction of delays. New multi cross-sector integrated systems will be required that are capable of providing high-quality, secure and high-speed digital data management across the full airspace, airport, airline and aircraft spectrum.

Although these system integration challenges have been variously recognised across the sector[1], the industry may not be prioritising the full range of desired customer-centric solutions. Unfortunately, evidence suggests that the priority business interests of the sector are still short-term and potentially becoming divergent from those of its customers[2].

Achieving the desired data flow capacity, connectivity and efficiency that meets both sector and customer needs will require significant technical, regulatory and cultural advancements. In turn, this will necessitate new cross-sector partnerships and business models, plus trusted data handling engagement with the public.

Aviation industry and passenger divergent interests



Source: *Economist Intelligence Unit,* 2015

[1] European Commission High Level Group on Aviation Research (2011) *Flightpath 2050 Europe's Vision for Aviation.* Luxembourg: Publications Office of the European Union; The International Air Transport Association's 'Four Pillar' technology strategy; and the European Union's SESAR 2020 programme.

[2] Eliot Lees, Stephen Freibrun, and Mark Drusch (2017) *Reimagining the Passenger Experience: The Importance of Building a Customer-Centric Strategy.* Fairfax, VA: ICF.

Digital aviation (or 'Aviation 4.0') has been variously commentated upon as being the next significant business transformation event of the sector, and one which can support the industry towards delivering greater customer satisfaction whilst addressing efficiency, cost and capacity issues.

Digital aviation can mean many things. At its simplest, it is about harnessing and processing data through increasingly autonomous, connected and intelligent systems to improve efficiency, capacity, safety, cost and other service targets. Digital technologies and connectivity are creating new opportunities that benefit the full value chain from manufacturing to operations and from major corporates to individual passengers.

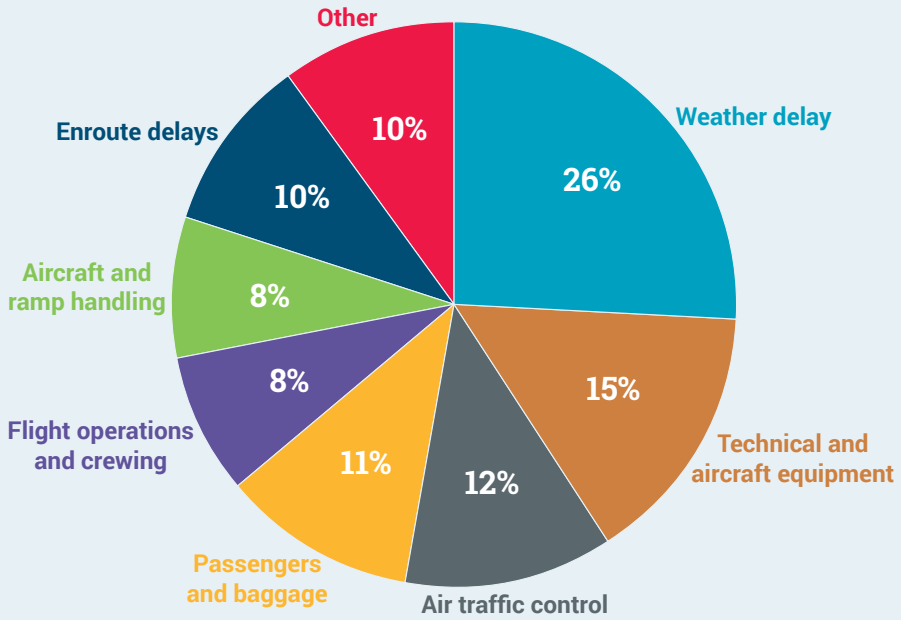
At a European level, the Single European Sky Air Traffic Management Research (SESAR) 2020 Joint Undertaking programme is committed to modernising air traffic management and to creating the "digital European sky" that will support the development of business processes to create a more connected aviation system. SESAR acknowledges that the next ten years will be a critical period in terms of the digital transformation of aviation with the potential to unlock €10 billion in additional revenue per annum by 2035, and three times that amount by 2050.

On a local scale, remote digital towers are beginning to deliver air traffic control solutions by digitising and integrating airport functions. Such concepts potentially enable the management of multiple regional airports through one central Air Navigation Service Provider (ANSP), offering efficiency and resilience.

On the ground, the Maintenance, Repair, Overhaul and Logistics (MROL) sector is also addressing the digital agenda. For example, the International Air Transport Association (IATA) is championing the MROL of the future and digital cargo – both relying on a full paperless process and smart data sharing. The sector leaders are swiftly growing their digital services with systems that are capable of providing predictive maintenance services currently being rolled out to their customer bases. For passengers, digital innovation is already enhancing the customer experience on many levels ranging from the way passengers choose, tailor and book their journeys through to innovations along the journey such as wayfinding using augmented reality in airport terminals, in-flight connectivity and increasing personalisation.

Any digital aviation initiatives that are undertaken need to deliver benefits that are clearly understood by the end users – passengers or freight forwarders. One such significant benefit is on-time performance. An analysis of contributions to journey delays has shown that over 60% of the factors that have caused delays in the past have a digital (data flow) connection[3] and that no one part of the sector is the dominant root cause.

Analysis of flight delay contributions



The conclusion is that to make a step change in addressing the on-time performance challenge, then not only should new digital solutions be developed, but they must be fully integrated across the entire aviation spectrum. It is in solving this digital systems integration challenge where the greatest benefits might be realised.

[3] Original data from US Bureau of Transportation Statistics.

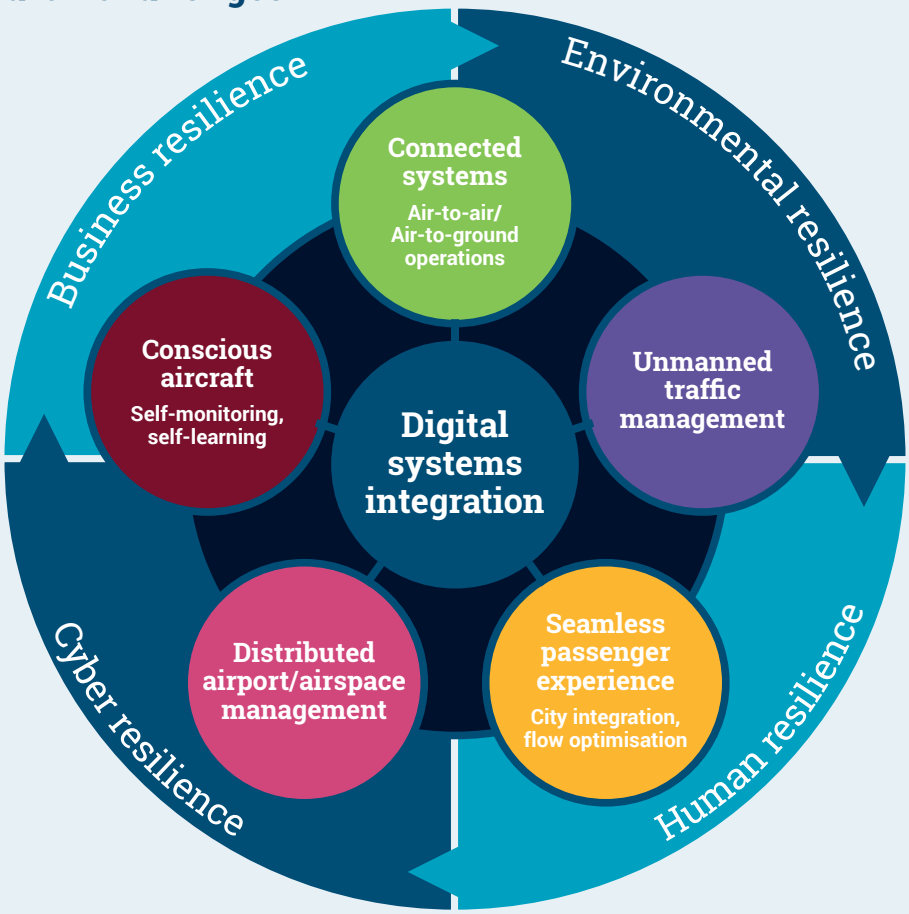
The Digital Aviation Research and Technology Centre (DARTeC)

There is an exciting opportunity to bring together sector leads from across the aviation industry (airspace management, airport, airline and aircraft) within a collaborative research environment to create, experiment and challenge the digital status quo through accelerating digital systems integration.

DARTeC, located at Cranfield University, the number one university in Europe for aerospace, is a world-class centre for the research and development of cross-sector digital integration solutions. DARTeC, co-funded by Research England, an industry consortium of leading aviation organisations and Cranfield University, is a £67 million investment in state-of-the-art facilities that will leverage both the University's airport and its newly opened autonomous vehicle research facility.

DARTeC will initially focus on five primary research challenges within an organisational resilience framework that individually have direct relevance to the digital agenda, and collectively provide the opportunity to explore and address systems integration challenges through advances in technology, intelligence, regulatory frameworks and business models:

DARTeC research challenges



DARTeC research challenges

The research challenges are generally well understood individually – DARTeC provides the opportunity to address them simultaneously within a collaborative research and technology environment.

Connected systems

Air traffic management modernisation, coupled with the data-centric architectures being incorporated into modern aircraft, will create this same concept in the sky of the future. Aircraft, which are already becoming nodes within airborne networks, will need to be sharing data with other aircraft, ground-based operational teams and air traffic controllers at speeds that the current Aircraft Communications Addressing and Reporting System (ACARS) and the Aircraft Condition Monitoring System (ACMS) are not capable of producing. As the aviation industry is expanding, changing, and becoming increasingly connected, it is now dependent on information and communications technology (ICT) to operate the global air transportation system.

Unmanned traffic management

The unmanned aerial vehicle (UAV) market is growing exponentially (currently £1.6 billion; estimated £100 billion by 2020) and such growth is putting further pressure on airspace management. International initiatives are seeking airspace management solutions that will bring higher levels of system resilience, safety and security, but such solutions will need to adapt to competition from UAVs to operate in the same airspace, often using “pop-up” airfields, and at the same time deal with new cyber-security threats.

Seamless passenger experience

With a focus on a seamless passenger experience, the role of the airport, airlines and their relationship with their passenger customer base is being fundamentally reconsidered. Airlines are already embracing social media and app-based notifications to enhance the flight booking process, and both airlines and airports are seeking to provide a more personalised, intuitive and less stressful passenger experience whilst reducing processing time in the terminal. Topics such as unified security, the elimination of triple waiting areas, optimised passenger flows and baggage separation are already being discussed. Similarly, the whole role of the airport and its relationship to the wider environment is under closer examination; should airports grow or shrink, what is their connectivity to urban environments (city boarding, for example) and how are they going to be configured for future personal air traffic and drones? From the airlines’ perspective, operations, disruption and revenue management are all key areas of interest.

Distributed airport/airspace management

Delays caused by the fragmentation of the European airspace costs at least £4 billion a year. Capacity constraints alone in European airports could cost up to 818,000 jobs by 2035, according to the Aviation Strategy for Europe[4]. Delayed and cancelled flights caused by both airspace and ground congestion have a negative impact on passenger experience and airline/airport efficiency. The next generation of air traffic control will require automation in order to meet safety, reliability, flexibility, and robustness demands in an environment of steadily increasing air traffic density and 'on-demand' requests. There will be a need for distributed air traffic flow management strategies to minimise departure and arrival schedule deviations based on en-route air traffic system models consisting of air routes, waypoints, and airports.

Conscious aircraft

The concept of 'conscious aircraft' is emerging. Using an understanding of human consciousness plus the latest developments within the fields of Integrated Vehicle Health Management (IVHM) and Artificial Intelligence (AI), a 'conscious aircraft' can be conceived. Such an aircraft would monitor current platform health, reliably predicting the remaining useful life of components and systems, then automatically reconfiguring them to optimise remaining life. Data would be further synchronised with ground-based systems to optimise how the aircraft is managed through its lifecycle. Future Maintenance Repair Overhaul and Logistics (MROL) actions would be minimised thereby reducing operational costs and moving towards a 'zero maintenance' platform within a 'hangar of the future' with no surprises for the operator.

What applies to all of the above areas of research is the need to ensure system resilience. Achieving stable operations over both short and long duration time horizons helps to provide business stability and support future planning. Recent high profile disruptive incidents demonstrate how organisations can overlook signals, normalise problems and habitually do what they have always done without stopping to challenge themselves. Such organisations are effectively sleepwalking into disaster. Innovation is often inhibited when an organisation feels the threat of an impending crisis. Organisational resilience is not only about avoiding or responding to adverse events but also changing before the cost of not changing becomes too great, leveraging opportunities and driving innovation to remain competitive in the face of challenging conditions.

[4] European Commission (2015) *An Aviation Strategy for Europe*. Brussels: European Commission, Directorate-General for Mobility and Transport.

Opening 2020

The DARTeC facility is scheduled to be completed at the end of 2019 and will be formally opened in early 2020. The facility will provide a research environment which is protected from, and yet accessible to, a live aerodrome that allows research at a variety of technology readiness levels.

The facility consists of a central building containing a suite of digital aviation research laboratories, a partially covered 'hangar laboratory', a 737-400 aircraft, an intelligent movement area, and a remote air traffic control centre with conventional and advanced holographic radar systems capable of monitoring and controlling the airspace around Cranfield's aerodrome.

Located adjacent to the DARTeC central building, the hangar laboratory will house Cranfield's 737-400 aircraft which will be connected through an airport-style air-bridge. The hangar laboratory will include aircraft sensing equipment, visual, thermal and load distribution, for digital maintenance, repair and overhaul (MRO) studies and markings for an airport gate. The laboratory will house airport ground handling vehicles where assistive digital technologies will be researched and integrated to improve ground operation efficiency and safety. In addition, the facility will enable research into the development of fully-autonomous ground handling vehicles and the application of UAVs for remote inspection concepts.

The Digital Aviation Research and Technology Centre is a unique opportunity to bring together sector leads from across the aviation industry (airspace management, airport, airline and aircraft) within a collaborative research environment to create, experiment and challenge the digital status quo through accelerating digital systems integration.

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