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The OPTICS2 Viewpoint

Is European Aviation safety and security research on the right track?

Top Ten Research Challenges for
European Aviation Safety and Security

Funded by the Horizon 2020 Framework Programme of the European Union.

OPTICS2 assesses the progress of European Aviation Safety and Security Research and Innovation (R&I) towards the goals of Flightpath 2050. OPTICS2 provides recommendations to help steer EU Aviation Safety and Security R&I in case certain research needs are not being met, or need 'course corrections', for example in case of the arrival of new disruptive technologies, or global events such as COVID-19.

OPTICS2 reviews the state-of-the-art in European Aviation Safety and Security R&I annually, via a core team of experts from across the entire aviation spectrum assessing literally hundreds of European and nationally funded projects, including major programmes such as Horizon 2020, CleanSky and SESAR. OPTICS2 reports to both the European Commission and ACARE, summarising the status of each safety and security 'Action Area', identifying the main performers, gaps and obstacles in the research landscape, along with strategic recommendations and priorities.
The backbone of OPTICS2 is the ten Action Areas, derived by ACARE WG4 (Safety & Security):

On the positive side, since OPTICS2 began in 2017, for Safety, certain areas which were under-researched are now being addressed, in particular a substantial number of new projects on Drones, but also advances in Governing Safe Performance, Resilience by Design, and attempts to get Human Factors right at the design stage in a multi-modal setting (aviation and maritime). For Security, there are research advances in building and exploiting Security Intelligence, for example in forensic methods and resolving incidents regarding terrorist attacks, early development of the Security Radar concept, and an attempt to develop a Security Baseline across all transport modes.
Despite these positive advances, several research priorities remain, which are formulated below as a top 10 for safety and a top 10 for security. Both are in order of the five Action Areas for Safety and Security.

THE TOP TEN
Safety Research
PRIORITIES

1 **Ensure the safety of the future aviation 'skyscape',** addressing the full future complexity of current and novel manned and unmanned vehicles, including drone fleets, personal vehicles and sky-taxis, as well as operations in Higher Airspace, including solar planes and hypersonic aircraft, and new aviation fuels and aircraft configurations for Clean Aviation. Safety risk modelling will need to raise its game to determine how these aerial systems can share the airspace safely, by using multi-actor risk modelling to inform the development of an all-inclusive CONOPS (Concept of Operations).

2 **Research is needed on new ways of organizing the air transport** system, together with new ways of communication, interaction and joint decision-making, to ensure the system is more resilient against emerging and sustained hazards such as the COVID19 pandemic.

3 **The future aviation workforce will be different from today**, with more automation, more distributed teams, and new roles and ways of working. To select and train this workforce we need to understand how work is really done today, across all aviation sectors, via 'open-book' task analysis, as well as develop an approach to wellbeing that ensures aviation continues to deliver high levels of performance and remains an attractive sector in which to work.

4 **Finding the right Human-AI partnerships will be key** to future aviation safety. The Intelligent Assistant in the cockpit and on the ground will be the crucial stepping stone toward fuller AI by 2050. Research is urgently needed to determine how humans and IAs can work together productively (e.g. IAs handling repetitive tasks in ATC) and safely (e.g. IAs assisting pilots during flight upsets or 'startle events'), including human supervision and recovery in case of 'aberrant behaviour' by AI systems.

5 **The 'promise' of Big Data and Machine Learning** has yet to deliver significantly in aviation safety. Research is needed on which safety-related use-cases should be prioritised by advanced analytics and data-mining, providing compelling demonstrations of the utility of the approach for safety, as well as guidance on how to install data-driven safety analytic processes into aviation businesses.

THE TOP TEN

Safety Research

PRIORITIES

6 **When it comes to safety intelligence and data analytics, size matters.** There is still insufficient sharing of data between the various stakeholders. Research is needed to determine how best to enable multiple actors to share their data confidentially, enabling benchmarking and safety insights that will lead to safer operations and better designs of aircraft, airports and air traffic systems. Such a data-sharing and safety-learning platform must also include new entrants (drones, sky taxis, etc.).

7 **Research needs to consolidate the safety of 'all-weather operations'** (e.g. clear air turbulence and thunderstorms), and extend the types of weather hazards or external hazards considered (e.g. long-term climate change).

8 **Research is needed on the adoption of electronic devices** with increasing automation capabilities and interactive modes into the cockpit (e.g. tablets, electronic flight bags, etc.). This research needs to encompass conventional airliners as well as GA aircraft and new vehicles (personal aerial vehicles, sky taxis, etc.).

9 **Survivability of aircraft needs to be drastically improved.** Already identified as a priority for rotor vehicles and small GA aircraft, this also needs to be extended to cover new aerial vehicles such as personal vehicles and sky taxis.

10 **Research is needed to develop more agile** and less fragmented certification methods (which are still fit-for-purpose) such as virtual certification, to maximise the implementation of safe innovations in the aviation sector, including Industry 4.0 technologies and new aerial systems.

THE TOP TEN

Security Research

PRIORITIES

1 **A more strategic and collaborative approach for biological threats** to an international air transport system needs to be researched and supported by policy/regulation, as required by the advent of the COVID-19 pandemic.

2 **A more strategic and collaborative capability-driven process for security** is required, backed by regulation and policy to provide a secure and resilient transport system through improved integration of systems and procedures across the four transport modes.

3 **Research is required to develop an Aviation-Wide Security Culture**, and provide associated validated, mature training material.

4 **A common framework is required to address legal, ethical and societal** concerns (e.g. over data privacy) that otherwise may prevent the deployment of novel technical and procedural solutions to improve security, nullifying the effort invested.

5 **A system-wide Horizon Scanning capability** is required that can anticipate the longer-term threats likely to emerge.

6 **Research is needed to develop more effective and coordinated tools** for real-time security incident management, including spill-over effects into other transport modes and coordinated multi-modal transport attacks.

7 **A more global and integrated approach to Security** is missing since most projects address the reaction towards a particular incident or threat. This can be brought about by having more aviation projects focus on operational security as their main line of research, since at the moment they typically address security as a secondary or indirect objective. This will help convince stakeholders to share security practices and operations.

THE TOP TEN

Security Research

PRIORITIES

8 **As yet, there is no common or compatible Security Baseline**, whether for aviation or across the four transport modes. This is required to build confidence between stakeholders, avoid weak links in the transport system chain, and facilitate the progression towards higher levels of intermodal transport security.

9 **Research is required on how to achieve Security Resilience in Design,** including aspects such as software and maintenance, covering the entire lifecycle from concept design through to deployment, operation and decommissioning.

10 **As demonstrated by the supply issues during the COVID-19 crisis** and Huawei 5G security risks, a strategic assessment needs to be conducted on future ATS operational security requirements to determine if there are critical technologies requiring European Technological sovereignty, which need to be supported through European research.

CONCLUSIONS

Improving the Return on Investment for European Aviation Research

As well as the above specific research avenues, which concern what needs to be researched, the OPTICS2 evaluation of research to date, including OPTICS1 (2013-17), highlights several transversal issues that need to be addressed to increase the uptake of research ideas by industry, thus generating a better return on investment for the research.

First, we need a better platform to bring Industry, regulators and researchers together, so that industry and regulators alike can see what is being developed, and researchers can better understand industry's operational needs and the regulator's certification requirements. A positive model for this is the DG HOME Community of Users.

Second, as already noted for security, ethical issues concerning the use of personal data need to be resolved, otherwise research advances in, for example, biometric performance monitoring of controllers or pilots for safety, and a host of security methods, will remain stuck in the laboratory.

Third, since aviation is a system-of-systems, safety and security research needs to have more coverage across all aviation segments (e.g. airports, manufacturing, ground handling, etc.) in a connected fashion, rather than focusing solely on Aircraft operations and Air Traffic services.

Fourth, safety and security performance of multi-modal transport needs to be developed across all four modes (air, sea, rail and road). Some recent projects have begun to address this, e.g. SAFEMODE, looking at safety cross-domain learning in aviation and maritime industries. Future cross-modal projects need to focus on common issues, whether threats such as cybersecurity, or how to invoke safety and security culture across all four domains (including passenger involvement), or more technological issues such as the use of AI for safety and security. Tackling common issues will be the best way to unite researchers and industry, and lead to truly effective multi-modal learning and research-driven, world-leading improvements in the European transport system.