ISSN 2599-8293

European Commission

CORDIS Results Pack on

safer aviation

A thematic collection of innovative EU-funded research results

May 2019

Making EU skies the safest through innovative EU-funded research

Research and Innovation

NEW EDITION

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Editorial

Making EU skies the safest through innovative EU-funded research

More and more people are travelling by air. In 2017, 1 043 million people in the EU travelled by air, an increase of 7.3 % compared with 2016, according to Eurostat. Almost half of those flights were from one EU Member State to another. Given this rising trend of consumer preference towards air travel, safety remains a key consideration. This second edition of the Results Pack on aviation safety, introduces six new projects that are developing and pioneering innovative approaches and technologies to ensure that Europe's skies remain amongst the safest in the world.

Flying remains one of the safest forms of transport, with major air accidents within the EU being a very rare occurrence. This is especially reassuring as Europe is home to around 150 airlines, and 2016 saw an all-time record of just under 10.2 million flights over European skies, with average daily traffic being just under 28 000 flights – this surpassed the previous record set in 2008, just before the economic crisis unfolded. By 2035, it is estimated that aviation traffic will reach 14.4 million flights per annum.

Furthering the EU's commitment to aviation safety

While these figures (and the fact that aviation tragedies are very few and far between) are reassuring, complacency can never be allowed to overshadow a robust dedication to safety. Thus, the European Commission remains committed to developing and deploying new technologies to meet its aim to make EU skies the safest by 2050. This policy ambition is outlined in the FlightPath 2050 Vision.

From a research and development perspective, the EU's dedication to the highest standards of aviation safety is also reflected in dedicated funding through the Horizon 2020 programme, with more than EUR 60 million being committed to funding projects with a focus on aviation safety. This follows and builds upon substantial funding allocated during the previous Seventh Framework Programme (FP7). International cooperation is also a key component, leveraging additional resources. In fact, some of the projects featured in this Pack involve at least one non-European partner.

There are several key areas where EU-funded research and innovation efforts are concentrated. These include: addressing aspects of the design, manufacturing and operations of aircraft and infrastructures; mitigating the risks resulting from extreme weather conditions and other hazards; and reducing the impact of human factors and human errors on active and passive safety.

Another key aspect is the fact that the aviation industry, like many traditional industries, is rapidly digitising, offering both new challenges and solutions to high safety standards.

Introducing six new projects

Following the first six FP7 projects featured in our first edition Results Pack on aviation safety, this new edition introduces another six projects, this time all Horizon 2020-funded.

Making composite electrical aircraft a reality

Researchers with the EU-funded EPICEA project are developing computer tools that will help aircraft manufacturers better understand electromagnetic coupling mechanisms on composite electrical aircraft.

Today's aircraft manufacturers, along with their supply chain, are focused on decreasing energy consumption, improving safety, and reducing emissions. "To optimise the performance of both existing and future generations of aircraft, many manufacturers are turning towards Composite Electrical Aircraft (CEA)," says Jean-Philippe Parmantier, EU coordinator of the EU and Canadian-funded EPICEA (Electromagnetic Platform for lightweight Integration/Installation of electrical systems in Composite Electrical Aircraft) project. "These are essentially high-altitude, long distance aircraft made from lightweight composite materials that have airframes featuring a massive electrification of onboard functions and the deployment of low profile antennas generating less drag."

Despite their potential, composite materials do not provide the fuselage with the same level of conductivity as aluminium does. As a result, composite aircraft suffer from an increased risk of electromagnetic (EM) hazard from radio broadcasts, satellites, radars or atmospheric electricity. Moreover, when flying at a very high altitude, there is an increased probability of being exposed to cosmic radiation (CR). "Specific electromagnetic protection measures are therefore required to guarantee electrical system immunity and the safety of the aircraft," explains Parmantier. "However, such protective measures often result in an increase to the aircraft's weight, thus jeopardising the emergence of energy-efficient CEAs."

To make CEAs a viable option for improving aircraft performance, safety and efficiency, the EPICEA project – a joint R&D initiative between the EU and Canada – is working to develop computer tools to validate and verify a cooperative and open computer environment (i.e., the EPICEA platform). By modelling interconnected systems, antenna electromagnetic performances and the effects of CR on electronics, the resulting EPICEA platform will help aircraft manufacturers better understand EM coupling mechanisms on CEAs. This in turn will result in the creation of effective design requirements for aircraft systems and their integration onboard the aircraft.

Important results achieved

Although the EPICEA project remains a work-in-progress, several important results have already been achieved. "First and foremost, we have successfully plugged existing software into an overall simulation platform for modelling scenarios of EM-coupling on the interconnected wiring systems and EM performance antennas inside a complex composite fuselage," says Parmantier.

To optimise the performance of both existing and future generations of aircraft, many manufacturers are turning towards Composite Electrical Aircraft (CEA).

"This gives us the capability to validate our simulation results with actual measurements on a full-scale composite barrel of a Bombardier Business Jet."

Project researchers have begun disseminating these initial results via scientific conferences, public workshops and a dedicated website. A second workshop will take place in July 2019, when the project closes, in Toulouse, France.

The EM tools and EM simulation platform are now being tested by two project partners: Bombardier Aerospace, a Canadian aircraft manufacturer, and Fokker Elmo, a European manufacturer of cables and harnesses. According to Parmantier, both companies are likely to adopt the project's computer tools and platform for future use in their respective aircraft design and development processes.

An international affair

With funding coming from both the EU and Canada, the EPICEA project is an excellent example of international cooperation in aviation research under the Horizon 2020 Programme. The project leveraged the competences and optimised the resources of both partners to jointly advance the development of the CEA. For instance, because of Fokker Elmo's expertise, the European side focused on the EM simulation issues, whereas the Canadians leveraged Bombardier's expertise to integrate the EM systems and harnesses into the composite barrel, as well as conduct electromagnetic and cosmic radiation testing.

"One of the things I am most proud of is the coherence of the consortium and how, even when separated by an ocean and cultures, we were able to work together as a single team," says Parmantier. "By bringing together EU and Canadian expertise, the CAE is now much closer to becoming a reality."

PROJECT
EPICEA – Electromagnetic Platform for lightweight Integration/Installation of electrical systems in Composite Electrical Aircraft

COORDINATED BY
ONERA, the French Aerospace Lab in France

FUNDED UNDER
H2020-TRANSPORT

CORDIS FACTSHEET
cordis.europa.eu/project/id/689007

PROJECT WEBSITE
epicea-env714.eu

Sharing data to improve flight safety

The EU-funded EUNADICS-AV project is improving flight safety by developing a unique system to provide consistent and coherent information in the event of a hazard affecting airspace.

Remember that volcanic eruption in Iceland that cancelled hundreds of flights and left thousands of passengers stranded? That happened nearly 10 years ago, but it wasn't an isolated incident. Due to a gap between available data and the information that Air Traffic Management (ATM) stakeholders need to manage flight safety, natural and manmade disasters such as volcanoes, forest fires, sand storms and nuclear releases can seriously affect global air traffic.

"Air traffic control, Eurocontrol, national authorities, airlines and pilots all share the same goal of ensuring safe flights," says Gerhard Wotawa, project coordinator of the EU-funded EUNADICS-AV (European Natural Airborne Disaster Information and Coordination System for Aviation) project. "This gap creates circumstances where the stakeholders in the ATM system may base their decisions on different data and information."

EUNADICS-AV, a collaborative effort between national weather service providers, measurement data specialists, aviation experts and flight planning service providers from 12 European countries, is working to close this gap. To do so, researchers are developing a data platform that, during an airborne hazard like a volcanic eruption, provides airspace regulators, managers and users with all necessary information as soon as possible.

Fast and consistent information

Currently, airspace authorities and stakeholders get information from several data channels, including different observational networks. However, these channels not only lack the ability to share information effectively, but there is also no standard procedure for sharing it between EU countries. The result is a fragmented European airspace ripe for cancellations and disruptions.

The end goal is to enable all stakeholders in the aviation system to obtain fast, coherent and consistent information.

If the threat of a hazard is identified at an early stage, flight planners can adjust their routes well in advance and reduce the number of cancellations. The goal of this project is to support the flight planning and decision-making process by providing the most relevant data for a specific hazard and by producing tailored products for aviation stakeholders.

"The end goal is to enable all stakeholders in the aviation system to obtain fast, coherent and consistent information," adds Wotawa. "Doing so will greatly enhance our capability to respond to disasters effectively and efficiently, minimise system downtimes and economic damage and – most importantly – enhance the safety of millions of passengers."

Promising results

In March 2019, project researchers conducted a comprehensive testing of the EUNADICS-AV system in Salzburg, Austria. A range of scenarios with the potential to impact the aviation system were assumed, including a volcanic eruption in Italy and nuclear incidents in Germany and Austria. During each test, researchers integrated all available data, tailored observations, data analysis and modelling directly into the airline's flight planning software.

"Through these tests, we were able to demonstrate that route optimisation measures can be implemented at a very early stage," explains Wotawa. "This is important as it would allow the vast majority of flights to be conducted with few to no cancellations."

Based on these promising results, researchers are now developing a business case for seamlessly integrating EUNADICS-AV data analysis and modelling services into ATM, air traffic control, and flight planning software. So, the next time a volcano erupts, instead of being left stranded at an airport, thanks to EUNADICS-AV, ATM will be able to quickly reroute your flight – getting you safely to your destination with minimal delay.

PROJECT
EUNADICS-AV - European Natural Airborne Disaster Information and Coordination System for Aviation

COORDINATED BY
Central Institution for Meteorology and Geodynamics in Austria

FUNDED UNDER
H2020-TRANSPORT

CORDIS FACTSHEET
cordis.europa.eu/project/id/723986

PROJECT WEBSITE
eunadics.eu

Coordinating air safety research happening across the EU

By coordinating the air safety research and innovation happening across Europe, the EU-funded Future Sky Safety project aims to provide the aviation industry with an even stronger focus on safety.

With its FlightPath 2050 Vision, the European Commission aims to achieve the highest level of safety in air transportation ever – both for passengers and for freight. By 2050, Europe will have achieved unprecedented levels of safety, with manned, unmanned, legacy and next generation, autonomous aircraft and all types of rotorcraft operating simultaneously in the same airspace using state-of-the-art technology and training.

To achieve this ambitious vision in just over 30 years, the Future Sky Safety (FSS) programme is bringing together the vast amount of air-transport safety research and innovation happening across the EU. One of the largest EU-funded programmes in aviation safety research ever, FSS is comprised of various sub-projects, each of which is dedicated to making air transport even safer. "By bringing these various projects together, FSS is improving

cabin safety, reducing the risk of accidents, achieving near-total control over safety risks and enhancing safety performance under unexpected circumstances," says FSS Project Researcher Lennaert Speijker.

Already achieving results

Although the project remains a work in progress, important results have already been achieved. According to Speijker, just coordinating the diverse research happening across the EU is an achievement. "We first established a shared view on safety research and then jointly contributed to the EU aviation safety research agenda," he says. "Now we are creating new cooperative safety research projects in which we work together on a specific challenge with the shared goal of reducing duplication and fragmentation."

As a result of this coordination, a wide range of new, cooperative safety projects has materialised. For example, a dedicated project on runway excursions developed algorithms and monitoring techniques for reducing the risk of runway veer-offs. Following three successful flight tests, these tools can be used by both airlines and flight data monitoring software developers. Likewise, thanks to a pan-European safety culture survey of 7 239 European pilots and their perceptions on the safety culture in European aviation, FSS-developed guidance on advancing the safety management of organisations was adopted by the European Aviation Safety Association (EASA).

Another important result is the development of the Human Performance Envelope (HPE), a new concept for cockpit operations and design. Through flight simulations, researchers have shown how the HPE approach can contribute to safeguarding human performance in flight upset conditions. In another project, researchers tested the fire resistance of advanced composite materials in an aircraft. "This work has demonstrated the potential of geo-polymers for improving cabin air quality through continuous air quality sensing," explains Speijker.

Great support from stakeholders

Researchers have now turned their focus towards developing and exploiting the aforementioned results. This includes ensuring their findings have a positive impact in terms of future changes to regulations, standards and guidance for aviation safety – particularly for the braking performance of aircraft on contaminated runways, safety management of service providers and the use of advanced composites in aircraft.

This work has demonstrated the potential of geo-polymers for improving cabin air quality through continuous air quality sensin.

"FSS benefits from the great support of its involved stakeholders," adds Speijker. "With two airlines, the largest aircraft and aerospace manufacturers, two national authorities and a strong link with EASA, the uptake and use of our project's main results by both the industry and government regulators is virtually ensured."

PROJECT
Future Sky Safety

COORDINATED BY
Netherlands Aerospace Centre in the Netherlands

FUNDED UNDER
H2020-TRANSPORT

CORDIS FACTSHEET
cordis.europa.eu/project/id/640597

PROJECT WEBSITE
futuresky-safety.eu

How Big Data and AI can be deployed for better aviation safety

Promoted by the complete spectrum of top European aviation, safety and ICT entities, the EU-funded SafeClouds.eu project is working to improve flight safety using Big Data tools.

If current techniques are not updated, the rapid increase in air traffic could compromise aviation's high level of safety. According to the EU-funded SafeClouds.eu (Data-driven research addressing aviation safety intelligence) project, one cost-effective way of making the necessary updates is with Artificial Intelligence (AI).

A collaboration between airlines, air navigation service providers (ANSPs), safety authorities, academia and SMEs, the project applies data science and machine learning approaches to generate new knowledge on how to help aviation stakeholders further improve safety. "SafeClouds.eu is demonstrating how data analytics, state-of-the-art ICT and safety

intelligence can be used to accommodate higher levels of traffic, increase safety and reduce costs," says Project Coordinator Paula Lopez-Catala.

AI for predicting safety hazards and precursor analysis

Today's aviation system is structured around a number of isolated 'data silos'. Due to legal, technical and commercial issues, these silos have limited – if any – interaction. The SafeClouds.eu project aimed to change this and, in doing so, pave the way for a new paradigm where aviation is primarily based on actively shared data.

SafeClouds.eu is demonstrating how data analytics, state-of-the-art ICT, and safety intelligence can be used to accommodate higher levels of traffic, increase safety and reduce costs.

For SafeClouds.eu, this change begins with AI. According to Lopez-Catala, AI techniques, including deep learning and artificial neural networks, allow one to analyse the precursors of safety events. "Understanding the precursors and potential risks that may lead to a safety incident is critical to complementing the traditional methods of monitoring safety, reviewing accidents and incidents and extracting lessons learned," she says.

As AI can automatically predict potential safety hazards in real time, it is a key tool in supporting timely reactions. "The techniques and algorithms are tailored, customised and tested to be effective in every safety scenario, from unstable approaches to terrain warning, mid-air losses of separation and runway safety," adds Lopez-Catala.

One of these tailored algorithms is Smart Data Fusion (SDF). By consolidating different confidential data sources into single data frames, analysts can focus on the analytic development instead of the data engineering. "As a result, SDF provides a 360-degree view of safety scenarios, even when different stakeholders own different parts of the data and each wants to maintain the data's confidentiality," adds Lopez-Catala.

DataBeacon: infrastructure for AI applications in aviation

To convert these AI techniques and algorithms into actual applications, the SafeClouds.eu project developed the state-of-the-art DataBeacon platform. Stakeholders and researchers can use the platform to quickly develop and deploy AI applications for aviation. "The scalable, on-demand computing platform can fuse datasets securely and run computations over private data isolated from the rest of the platform," explains Lopez-Catala.

DataBeacon has a variety of applications, including data analytics, distributed applications and multi-party computation. It also uses three computing layers to ensure security, scalability and flexibility for a variety of big data and AI applications in aviation.

"DataBeacon, which was originally created to enable the project by supporting data protection and computing requirements, has in fact become the key outcome," says Lopez-Catala. "We think it has a huge potential that the team would like to explore beyond the SafeClouds.eu project by making it available to airlines, airports and ANSPs."

PROJECT
SafeClouds.eu - Data-driven research addressing aviation safety intelligence

COORDINATED BY
Innaxis Foundation and Research Institute in Spain

FUNDED UNDER
H2020-TRANSPORT

CORDIS FACTSHEET
cordis.europa.eu/project/id/724100

PROJECT WEBSITE
safeclouds.eu

Innovative simulation tools promise a softer landing during aircraft ditching

The EU-funded SARAH project is using simulation tools to help increase the safety of airplanes and helicopters in an emergency ditching situation.

Ditching, or the controlled emergency landing of an aircraft on water, is a rare event. But, as the 2009 landing of an Airbus A320 on the Hudson River in New York City made clear – it does happen. Although that event may forever be remembered as the 'Miracle on the Hudson', a successful ditching event does not require divine intervention.

As the EU-funded SARAH (Increased Safety and robust certification for ditching of aircrafts and helicopters) project is demonstrating, having good simulation tools and understanding all elements of water impact can go a long way towards increasing the safety of airplanes and helicopters in a ditching situation. "Our aim is to develop more robust and reliable ditching simulations for aircraft and helicopters based on improved methodologies and technologies," says SARAH project coordinator Stephan Adden.

Experiments and simulations

As a consortium of experts from aircraft manufacturers, SMEs focusing on software solutions, and research institutions supported by the European aviation certification authority, the SARAH project aims to establish holistic, simulation-based approaches to the analysis – and improvement – of aircraft ditching. "Using experiments and high-fidelity simulations, we are working to simulate a ditching event and better understand its impact on aircraft and helicopters," explains Adden.

In terms of experiments, to better understand the mechanics of helicopter emergency landings, researchers are physically ditching helicopter models in different configurations over the large ocean tanks located at the Centrale Nantes research facility. On the simulation side, researchers are creating innovative methods that precisely capture and simulate all the physical phenomena involved in emergency ditching.

"These efforts will influence the design of the next generation of aircraft and helicopters, improve ditching procedures for pilots and support European regulations in the area," says Adden.

Defining conditions, improving capabilities

Needless to say, conducting such complex experiments is an achievement in itself. When it comes to water impact simulation, there is a significant lack of available test-data, proper testing facilities are rare, scaling is difficult, and conducting full-scale tests is next to impossible. This meant the SARAH project had to start by upgrading and improving existing facilities so they could accommodate the project's required testing activities.

"Activities like these are difficult to plan up front, and unforeseen problems arise during the work," explains Adden. "But thanks to the agility of our consortium, the project was able to define the necessary test conditions and improve our simulation capabilities, meaning we will soon be able to deliver robust results to the aviation community."

Although due to finish in September 2019, the project is already delivering considerable results. In October 2018, researchers inaugurated a high-speed ditching facility at CNR-INM in Rome, and in December 2018, a dissemination event was organised to show the capabilities of the helicopter drop test facility in Nantes. Both facilities are available for use by the aviation industry and academia – with several ditching demonstrations and technical workshops having already taken place.

Our aim is to develop more robust and reliable ditching simulations for aircraft and helicopters based on improved methodologies and technologies.

"Thanks to the information coming out of the SARAH project, aircraft manufacturers will improve aircraft and rotorcraft design against controlled water impact events," adds Adden. "Furthermore, the technical advances delivered by the SARAH project will make it possible to minimise the risk of injury to passengers and crew and enable safer evacuation of the aircraft."

PROJECT
SARAH – Increased Safety and robust certification for ditching of aircrafts and helicopters

COORDINATED BY
IBK-Innovation GmbH in Germany

FUNDED UNDER
H2020-TRANSPORT

CORDIS FACTSHEET
cordis.europa.eu/project/id/724139

PROJECT WEBSITE
sarah-project.eu

Enhancing flight safety during near ground operations

To help reduce the number of civil aviation accidents, the EU/Japan jointly-funded VISION project is developing – and testing – smart technologies for aircraft guidance, navigation and control.

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More than half of fatal commercial airline accidents occur during near ground operations, such as take-off, final approach and landing. These near ground accidents can be caused by flight control performance failure due to bad weather or mechanical issues or by failure of the navigation and guidance performance due to, for example, poor visibility.

"Enhancing flight safety during such critical operational phases is an important key to reducing the number of aviation accidents," says Yoko Watanabe, Project Coordinator of the VISION (Validation of Integrated Safety-enhanced Intelligent flight cONtrol) project, a jointly funded initiative of the EU and Japan.

The VISION project is helping reduce the number of civil aviation accidents by developing smart technologies for aircraft Guidance, Navigation and Control (GN&C) and, more importantly, by conducting in-flight evaluations. Although previous projects have evaluated advanced GN&C solutions to detect flight anomalies, their uptake has been slow due to a lack of flight validations. The VISION project aims to overcome this hurdle by conducting flight validations on real aircraft platforms, including the JAXA MuPAL-alpha in Japan and the USOL K50 in Europe.

Impressive results

Although the project is ongoing, researchers have already achieved some remarkable results, including the flight validation of Fault Detection and Diagnosis (FDD)/Fault Tolerant Control (FTC) designs.

"Whilst there has been extensive academic research in the area of model-based FDD and FTC designs, most of the resulting ideas have only been tested in simulation," explains Watanabe. "In this project, FDD/FTC control designs are being flight-tested onboard a full-scale, two-engine research aircraft, where they accommodate failures in real-time."

Researchers also developed two vision systems. One involves control surface monitoring in conjunction with the FDD function in auto-pilot, while the other is a long-range stereo vision system for runway feature detection and to aid aircraft during final approach. Both patent-pending systems have been successfully flight-tested on real aircraft.

Enhancing flight safety during critical operational phases is an important key to reducing the number of aviation accidents.

Another key outcome is the development of a vision-integrated navigation system augmented with an integrity monitoring function. The design was evaluated in simulations with real sensor data taken on a K50 UAV platform, with the results confirming an improvement in both navigation performance and fault detectability. The design is now being prepared for flight testing.

Towards certification

These validations are the first step towards raising the technology readiness levels (TRLs) of the state-of-the-art, advanced FDD/FTC techniques being developed by the project. This is a necessary step before flying them on real test planes developed by such leading manufacturers as Dassault, Airbus and Mitsubishi.

"To our knowledge, this is the first time advanced FDD/FTC flight control designs have been flight-tested on a full scale, real aircraft – a result that we are particularly proud of," says Watanabe. "These outcomes will contribute to raising the TRL of the advanced aircraft GNC techniques, which will reduce a pilot's tasks during critical situations and enhance the overall flight safety of civil aircraft operations."

The next task for researchers is to work on providing the theoretical proof of the flight controller stability and the navigation integrity of the methods – both essential steps towards having the project's advanced GNC solutions certified for use in civil aviation aircraft.

PROJECT
VISION - Validation of Integrated Safety-enhanced Intelligent flight cONtrol

COORDINATED BY
ONERA, the French Aerospace Lab in France

FUNDED UNDER
H2020-TRANSPORT

CORDIS FACTSHEET
cordis.europa.eu/project/id/690811

PROJECT WEBSITE
w3.onera.fr/h2020_vision

CORDIS Results Pack

Available online in six language versions: cordis.europa.eu/article/id/401449

Published
on behalf of the European Commission by CORDIS at the
Publications Office of the European Union
2, rue Mercier
L-2985 Luxembourg
LUXEMBOURG

cordis@publications.europa.eu

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This Results Pack is a collaboration between CORDIS and the Directorate-General for Research and Innovation (DG RTD)

PRINT	ISBN 978-92-78-41975-2	ISSN 2599-8285	doi:10.2830/86892	ZZ-AK-19-012-EN-C
HTML	ISBN 978-92-78-41774-1	ISSN 2599-8293	doi:10.2830/282169	ZZ-AK-19-012-EN-Q
PDF	ISBN 978-92-78-41974-5	ISSN 2599-8293	doi:10.2830/673700	ZZ-AK-19-012-EN-N

Luxembourg: Publications Office of the European Union, 2019

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