Material from Future Sky Safety On Final Approach Conference

Salvatore Luongo (CIRA)

Short abstract: Future Sky Safety is a Joint Research Programme (JRP) on Safety, initiated by EREA, the association of European Research Establishments in Aeronautics. The Programme contains two streams of activities: 1) coordination of the safety research programmes of the EREA institutes and 2) collaborative research projects on European safety priorities.

The main objective is to present the main outcomes of the "Future Sky Safety on Final Approach" conference that has been held on the 6-7 of November, 2018 in Brussels, at Eurocontrol Headquarters. This dissemination event presented the results reached so far by all the projects within the Future Sky Safety programme.

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Acronyms

Acronym	Definition
ACARE	Advisory Council for Aviation Research in Europe
ANSP	Air Navigation Service Provider
ATM	Air Traffic Management
CAQ	Cabin Air Quality
EASA	European Aviation Safety Agency
EC	European Commission
ECAM	Electronic Centralized Aircraft Monitor
ECS	Environmental Control Systems
EFB	Electronic Flight Bag
EREA	European Research Establishments in Aeronautics
EU	European Union
FSS	Future Sky Safety
HMI	Human Machine Interface
HPE	Human Performance Envelope
INEA	Innovation and Networks Executive Agency
OM-B	Operations Manual part B
PFD	Primary Flight Display
R&D	Research and Development
R&TD	Research and Technology Development
RO	Risk Observatory
SESAR	Single European Sky ATM Research
SMS	Safety Management System
SPS	Safe Performance System
SRIA	Strategic Research and Innovation Agenda
WP	Work Package

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EXECUTIVE SUMMARY

Problem Area

Future Sky Safety is an EU-funded transport research programme in the field of European aviation safety, with an estimated initial budget of about € 30 million, which brings together 33 European partners to develop new tools and new approaches to aeronautics safety, initially over a four-year period starting in January 2015.

The two main objectives of Future Sky Safety are:

Coordination of institutional safety research programmes will connect and drive complementary in-house Safety R&TD in the European aeronautical research establishments to safety priorities established by the EC in the ACARE SRIA on Safety and Security. This will increase the leverage effect of safety research and innovation, performed outside Future Sky Safety, by the EREA institutes.

Collaborative Safety Research will be performed only on safety risk priority areas. The five associated objectives, each addressed in one Technical Research Project, are:

- Perform breakthrough safety research, in accordance with the EAPPRE priorities, to enable a significant reduction of runway excursion risk in the medium term.
- Reduce the likelihood of organisational accidents in aviation via development and implementation of a Safe Performance System (SPS).
- Develop a prototype risk observatory to assess and monitor safety risks throughout the Total Aviation System and allow frequent update of the assessment of risks.
- Define and apply the Human Performance Envelope for cockpit operations and design, and determine methods to recover crew's performance to the centre of the envelope, and consequently to augment this envelope, through HMI principles, procedures or training.
- Develop solutions to mitigate the risk of fire, smoke and fumes related (fatal) accidents.

Description of Work

The main objective of this document is to present the main outcomes of the "Future Sky Safety on Final Approach" conference, which has been held on the 6-7 of November 2018 in Brussels, at Eurocontrol Headquarters. This dissemination event presented the results reached by all the projects within the Future Sky Safety programme.

This report contains the presentations and posters produced to promote the conference and facilitate the transfer of information. This report also contains a summary of the questions raised and their answers.

As regards the questions and answers provided during the conference, it should be noted that the information contained in this report is the author's interpretation and reflection of the comments made.

Results & Conclusions

The "Future Sky Safety on Final Approach" conference has been held on the 6-7 of November, 2018 in Brussels, at Eurocontrol Headquarters. It focused on the presentation of the achievements and progress of the five technical projects (P3, P4, P5, P6, P7) in the programme. Presentations were well received by the participants, and fostered a fruitful discussion on research needs.

All FSS (Future Sky Safety) projects were properly represented at the event. Each presentation generated interesting and fruitful discussions, with several interventions from the participants to discuss both the technical aspects of the projects and the more theoretical/high level ones. Participants particularly appreciated the presentation of the main outcomes of each project, which matched the conference objectives to share the main achievements to improve the internal coordination and overall awareness. A guided tour of the poster exhibition complemented the presentations given, and was very well received by participants as well.

Overall, the conference fully reached its objectives, in terms of awareness of the full consortium about projects goals and activities and of awareness of programme technical progress up to date.

Applicability

This document supports the dissemination of FSS results, both internally within the Programme and with the European Commission and EU-related services. In particular, it provides insight into FSS research on:

- P3 Solutions for runway excursions
- P4 Total system risk assessment
- P5 Resolving the organizational accident
- P6 Human performance envelope
- P7 Mitigating the risk of fire, smoke and fumes

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1 INTRODUCTION

1.1. The Programme

FUTURE SKY SAFETY is an EU-funded transport research programme in the field of European aviation safety, with an estimated initial budget of about € 30 million, which brings together 33 European partners to develop new tools and new approaches to aviation safety, initially over a four-year period starting in January 2015. The two main objectives of Future Sky Safety Programme are:

- **Coordination of institutional safety research programmes**, funded by the EREA (European Research Establishments in Aeronautics) institutes;
- **Collaborative safety research** on safety risk priority areas (co-funded by the EC).

The Programme research focuses on four main topics:

- Building ultra-resilient vehicles and improving the cabin safety;
- Reducing risk of accidents;
- Improving processes and technologies to achieve near-total control over the safety risks;
- Improving safety performance under unexpected circumstances.

EU is funding specific **Collaborative Safety Research** projects:

- Perform breakthrough safety research to enable a significant reduction of runway excursion risk in the medium term.
- Develop a prototype risk observatory to assess and monitor safety risks throughout the Total Aviation System and allow frequent update of the assessment of risks.
- Reduce the likelihood of organisational accidents in aviation via development and implementation of a Safe Performance System (SPS).
- Define and apply the Human Performance Envelope for cockpit operations and design, and determine methods to recover crew's performance to the centre of the envelope, and consequently to augment this envelope, through HMI (Human-Machine Interface) principles, procedures or training.
- Develop solutions to mitigate the risk of fire, smoke and fumes related (fatal) accidents.

Coordination/cooperation of institutional safety research programmes connects and drives the complementary in-house Safety R&TD (Research and Technology Development) in the European aeronautical research establishments. This achieves significant leverage of the invested EU funding through a more efficient and effective use of resources.

The Programme will also help to coordinate the research and innovation agendas of several countries and institutions, as well as to create synergies with other EU initiatives in the field (e.g. SESAR – Single European Sky ATM Research, Clean Sky 2).

Future Sky Safety contributes to the EC Work Programme Topic MG.1.4-2014 Coordinated research and innovation actions targeting the highest levels of safety for European aviation in Call/Area Mobility for

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Growth – Aviation of Horizon 2020 Societal Challenge Smart, Green and Integrated Transport. Future Sky Safety addresses Safety challenges of the ACARE (Advisory Council for Aviation Research in Europe) Strategic Research and Innovation Agenda (SRIA).

1.2. Research objectives

The objective of this document is to present the main outcomes of the "Future Sky Safety on Final Approach" conference has been held on the 6-7 of November, 2018 in Brussels, at Eurocontrol Headquarters. This dissemination event presented the results reached by all the projects within the Future Sky Safety programme.

The document is intended for the conference participants as minutes of the event, and for interested parties not able to attend to provide the relevant information about the conference content.

1.3. Approach

Minutes of the event, presentations and dissemination material are all included in this report. The report also illustrates the main recommendations drawn from the event, which can be applied to improve the effectiveness and resonance of the last FSS Public conference.

As regards the questions and answers provided during the conference, it should be noted that the information contained in this report is the author's interpretation and reflection of the comments made.

The presentations of all speakers will be made publicly available through the website of Future Sky Safety.

1.4. Structure of the document

Section 2 presents an overview of the event held on the 6-7 of November, 2018 in Brussels, at Eurocontrol Headquarters.

Appendices include the list of participants to the conference (Appendix A), presentations given during the conference (Appendix B), the conference Posters (Appendix C) and photographs from the conference (Appendix D).

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2 FUTURE SKY SAFETY ON FINAL APPROACH CONFERENCE

The “Future Sky Safety on Final Approach” conference has been held on the 6-7 of November, 2018 in Brussels, at Eurocontrol Headquarters. This dissemination event presented the results reached by all the projects within the Future Sky Safety programme. The public conference provided the attendees the main technical and scientific results obtained so far within the five collaborative technical projects initiated within Future Sky Safety (P3, P4, P5, P6, P7).

2.1. Promotion of the conference

The event was promoted via email with more 330 invitations and through the project website, with a dedicated page. The event was advertised within EUROCONTROL via their internal weekly newsletter which should have reached most of our 1200 staff members.

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A save-the-date and later a final invitation (including agenda) were produced. Both of them were sent periodically via e-mail with more 330 invitations.

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Figure 1: Initial save-the-date for the "Future Sky Safety on Final Approach" conference

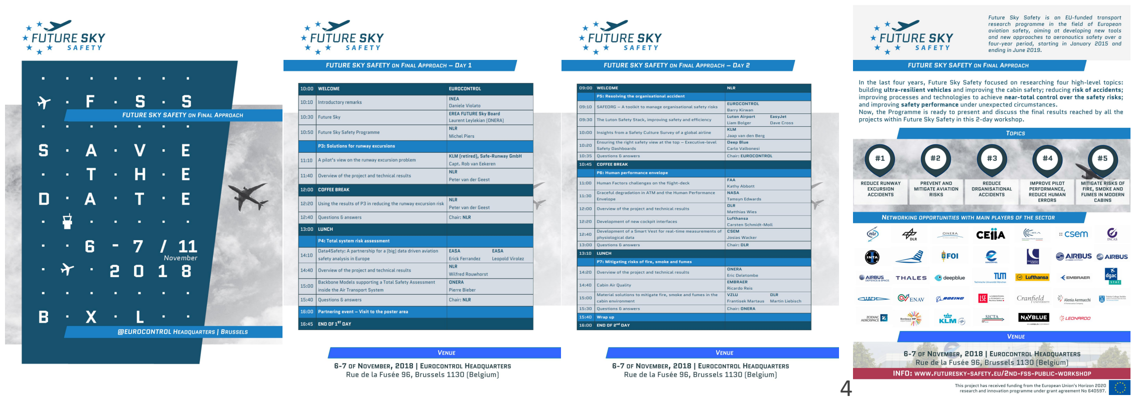

Figure 2: Final invitation to the "Future Sky Safety on Final Approach" conference

Figure 3: Players involved in Future Sky Safety

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2.2. Structure of the conference

The focus of the “Future Sky Safety on Final Approach” conference was to present, share and discuss the main results achieved by the EC funded technical projects (P3, P4, P5, P6 and P7). For this reason, room for discussion was left at the end of each presentation batch, with 10 minutes dedicated to the questions and answers between the Project Managers, other project participants and the conference audience. The technical presentations given by Project leaders during the conference are reported in Appendix B.

Invited speakers provided the institutional framework before the technical sessions:

- **Philippe Merlo** (Director European Civil-Military Aviation at Eurocontrol): What is Eurocontrol? The European Organisation for the Safety of Air Navigation
- **Daniele Violato** (Head of Sector Aviation Research at INEA – EU Commission): Welcome to the Future Sky Safety on Final Approach Conference
- **Laurent Leylekian** (EREA): Designing the future of aviation. Future Sky
- **Michel Piers** (NLR): Future Sky Safety. Programme Overview

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Table 1: Agenda of the "Future Sky Safety on Final Approach" conference

10:00	**WELCOME**	**EUROCONTROL**
10:10	Introductory remarks	**INEA** Daniele Violato
10:30	Future Sky	**EREA FUTURE Sky Board** Laurent Leylekian (ONERA)
10:50	Future Sky Safety Programme	**NLR** Michel Piers
	P3: Solutions for runway excursions	
11:10	A pilot's view on the runway excursion problem	**KLM (retired), Safe-Runway GmbH** Capt. Rob van Eekeren
11:40	Overview of the project and technical results	**NLR** Peter van der Geest
12:00	**COFFEE BREAK**	
12:20	Using the results of P3 in reducing the runway excursion risk	**NLR** Peter van der Geest
12:40	Questions & answers	Chair: **NLR**
13:00	**LUNCH**	
	P4: Total system risk assessment	
14:10	Data4Safety: A partnership for a (big) data driven aviation safety analysis in Europe	**EASA** Erick Ferrandez; **EASA** Leopold Virolez
14:40	Overview of the project and technical results	**NLR** Wilfred Rouwhorst
15:00	Backbone Models supporting a Total Safety Assessment inside the Air Transport System	**ONERA** Pierre Bieber
15:40	Questions & answers	Chair: **NLR**
16:00	**Partnering event – Visit to the poster area**	
16:45	**END OF 1ST DAY**	

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09:00	**WELCOME**	**NLR**
	P5: Resolving the organisational accident	
09:10	SAFEORG – A toolkit to manage organisational safety risks	**EUROCONTROL** Barry Kirwan
09:30	The Luton Safety Stack, improving safety and efficiency	**Luton Airport** Liam Bolger **EasyJet** Dave Cross
10:00	Insights from a Safety Culture Survey of a global airline	**KLM** Jaap van den Berg
10:20	Ensuring the right safety view at the top – Executive-level Safety Dashboards	**Deep Blue** Carlo Valbonesi
10:35	Questions & answers	Chair: **EUROCONTROL**
10:45	**COFFEE BREAK**	
	P6: Human performance envelope	
11:00	Human Factors challenges on the flight-deck	**FAA** Kathy Abbott
11:30	Graceful degradation in ATM and the Human Performance Envelope	**NASA** Tamsyn Edwards
12:00	Overview of the project and technical results	**DLR** Matthias Wies
12:20	Development of new cockpit interfaces	**Lufthansa** Carsten Schmidt-Moll
12:40	Development of a Smart Vest for real-time measurements of physiological data	**CSEM** Josias Wacker
13:00	Questions & answers	Chair: **DLR**
13:10	**LUNCH**	
	P7: Mitigating risks of fire, smoke and fumes	
14:20	Overview of the project and technical results	**ONERA** Eric Deletombe
14:40	Cabin Air Quality	**EMBRAER** Ricardo Reis
15:00	Material solutions to mitigate fire, smoke and fumes in the cabin environment	**VZLU** Frantisek Martaus **DLR** Martin Liebisch
15:30	Questions & answers	Chair: **ONERA**
15:40	**Wrap up**	
16:00	**END OF 2nd DAY**	

- Intro speech: **Philippe Merlo (Director ECTL DECMA)**
  - What is EUROCONTROL (corporate ppt)
- **Michel Piers**
  - Agenda
- **Daniele Violato (Head of sector aviation research INEA-EU Commission)**
  - Describes INEA (transport, energy, telecommunications), implementing parts of Horizon 2020 and the Connecting Europe Facility (CEF)
  - Provides high-level programme management
  - Supporting 1500 projects
  - INEA part of Flight Path 2050 and Aviation Strategy 2015

  - "Family" of INEA: CleanSky 2, EASA, SESAR, EUROCONTROL
  - FSS is the biggest aviation research programme supported by INEA (14,9 m€)
  - EUNADICS-AV: improve quality of data in disasters, facilitate coherent Pan-European risk and exposure assessment
  - Safeclouds.eu: big data mining for proactive safety.
  - SARAH: robust certification for ditching of aircraft and helicopters
  - MUSIC-haic: simulation tool for predicting Ice crystal icing in flight
- **Laurent Leylekian (EREA)**
  - The context: growing air traffic, Europe could lose the leading role in terms of connectivity, Asia Pacific to lead
  - Challenges: multimodality, noise, emissions, new a/c and usage
  - EREA presentation, FSS is EREA initiative
  - Future Sky to make aviation dream again, in line with FlightPath 2050
  - How Future Sky works:
    - Board of EREA members to identify challenges, needs and define programmes in dialogue with EU policy makers
    - Between demonstrators and prototypes, N+2 level, solutions beyond 2020 and 2025 > addressing 2050
  - Future of Future Sky:
    - enlarge and update scope
    - raise more and more awareness
    - develop roadmaps
    - match expectations of the new forthcoming Commission
    - Future Sky intends to remain THE Joint Initiative for green and seamless mobility
- **Michel Piers (NLR)**
  - Program Overview
  - Main data in a nutshell (48 to 54 months now, 25m€ budget)
  - Short description of Projects
  - **P1: coordination**
    - Research coordination, 180 PhD, 5000 employees in aeronautics, 6000 publications, 0,5 bln € annual research budget
    - Develop and share awareness of institutional research
    - The two approaches to collaboration: coordination & cooperation
    - Monitor funded research (2000 person months, 30m€ per year safety research)
    - Decline in stand-alone activities, tendency for more international research consortia
    - What: general coordination workshops, 14 workshops meetings organised on specific topics, 8 cooperation projects, 225 PM of institutional cooperative safety research outside EC funding for FSS

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- **P3: runway excursion**
  - EAPRRE as starting point
  - Braking on slippery surface
  - Shortcomings on aircraft ground models
  - Real test on wet/flooded runways
  - Improved model for braking performance
  - New algorithms to analyse flight data for runway veer-off risk factors
  - New concepts (CLAS, CORSAIR)
  - Results ready for application
- **P4: Total risk assessment**
  - Built on previous projects: ASCOS, IRP/AIP, FAA-ISAM, ASIAS, CATS-NL
  - Develop a risk assessment framework
  - Develop a risk observatory
  - Runway excursion and Mid-air collision backbone models for risk assessment
- **P5: solving the organisational accident**
  - Organizational factors as hazards for accidents
  - Intelligence, mindfulness, safety culture beyond Air Traffic Management (ATM), Agile response to crises, advanced Safety Management System (SMS)
  - The focus on middle managers
  - Interviews and training packages
  - Safety mindfulness app
  - Migration of safety culture from ATM to other aviation segments
  - P5 portfolio
- **P6: human performance envelope**
  - Develop the concept, verify its existence
  - Conduct experiments to select and assess physiological sensors
  - Validate Human Performance Envelope (HPE) and physiological measurements to identify limits of performance decrements
  - Determination of recovery measures
  - Validation of solutions for augmenting the envelope
  - Sensors validated, competency evaluation tool developed, prototype of tool for augmenting HPE developed
- **P7: mitigating the risk of fire, smoke and fumes**
  - Understanding behaviour of fire
  - Improving material to limit that
  - Experiments on new materials
  - New test protocols developed
  - Screening of new material solutions (resins, natural fibres…)
  - Developed design recommendation for dealing with on-board quality issues
- **2019: focus on exploitation actions**

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2.3. Presentations

2.3.1. P3 Solution for runway excursion

A pilot's view on the runway excursion problem (Copt. Rob Van Eekeren – Pilot KLM)

ICAO criteria are introduced to evaluate the dimensions of the runway necessary for a safe landing, and the mitigations that the runway must have to reduce the effects of an off-runway.

Over the years the cost of the off-runway has increased, in 2018 it should exceed 7 billion dollars, the probability of these events is low but they produce very serious effects, therefore the associated risk is not to be underestimated. Therefore mitigation actions are necessary, both airplanes and airports must be aligned with the ICAO RESA (Runway End Safety Area) directives.

In the future, a broader analysis of the data could be envisaged focusing on analysis of the causes. The development of aircraft devices dedicated to address this problem, greater training of pilots, external parts of runways with systems to slow down aircraft, systems to absorb impact energy, runways wider than 75 meters to reduce the risk of side exits from the track, because this risk is relatively high. Mitigation actions can exploit new materials to be laid on the sides of the runway, an inexpensive solution that reduces risks in case of runway exit, the cost of adjustment of runways is only 2% compared to the total costs necessary to reduce this type of risk.

Overview of the Project and Technical Results (Peter Van Der Geest - NLR)

The European Action Plan for Prevention of Runway Excursions (EAPPRE) provides guidelines to reduce the risk of runway exit. P3 goals are to develop methods for analyzing aircraft control on the runway, assessing the impact of water on the runway on the aircraft and identifying risks.

One of the problems is due to the side wind on the runway that requires a landing with the axis of the aircraft not aligned with the runway; this requires pilots capable of handling these situations and who must be trained with simulators. In crosswind conditions the control of the aircraft is more difficult. Using new carts could reduce the effects of this problem. Another problem is caused by the presence of water on the runway. Flight tests have been performed in order to collect relevant data and validate aircraft performance models, this will allow to improve the models used.

A method (algorithm) and tool are necessary to calculate the risk associated with a landing, according to the different conditions, applying machine learning techniques, in order to evaluate the lateral dispersion on the runway with respect to its center during landing, in different conditions conditions.

Runway Excursion Analysis: Challenges and Opportunities for Large Transport Aircraft (Sara Lagunas Caballero - Airbus Defence)

To evaluate the friction capacity on the runway in case of surface contaminated by water, tests were performed with Cessna and A400M, considerations were made on the forces involved, in particular those of friction that were associated with deceleration. The two aircraft have different configurations in terms of wheels, weight and landing speed. The friction coefficient was evaluated by making acceleration and wheel speed measurements. Furthermore, the phenomenon of aquaplaning has been analyzed.

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Managing the risk of runway excursions (Stefanioros Vasileios - EASA)

A historical overview of the development of legislation to reduce the risk of runway excursions was given. First step is to know the conditions of the runway in order to assess the risk. Initially, the evaluations were subjective, there were no standard methods, friction coefficients were not evaluated based on the runway conditions. Often also the runway is not monitored with sufficient frequency to know the conditions of the runway.

Question / answers

Q: With regard to the change in runway surface friction in the event of a polluted runway, does this analysis concern all the wheels?

- **A:** The analysis of the contemporary effects on all the wheels will be analyzed in the future; this is a very complex analysis that for now has been performed on individual wheels.

Q: Are there rules to define the degree of contamination?

- **A:** There are some runway surface friction measurement scales to define the degree of contamination of the runway.

2.3.2. P4 Total system risk assessment

Data4Safety: A partnership for a (big) data driven aviation safety analysis in Europe (Erick FERRANDEZ, Leopold Virolez - EASA)

EASA supports interactions between states and expert industries, to identify safety priorities and identify possible mitigations to problems, and to monitor and evaluate safety performance. It supports the exchange of information in order to identify risks. It also involves data management organizations for big data analysis. D4S involves both government agencies and airlines.

So the data must be collected, organized, the metrics must be defined and they must be analyzed efficiently, all in order to indicate what are the actions to mitigate the risks and increase the safety.

- Collaborative work
- Identify safety priorities
- Connect safety intelligence with actions
- A process already established (ESRMC)
- D4S to enhance 3 steps: identification of safety issues, safety assessment and safety performance
    - Voluntary and collaborative
    - Independent governance (dual management)
    - Data Processing Organisation to manage big data solution
    - Outcome shared for the benefit of all the community
    - Linked with other initiatives
    - Need for proof of concept with a few stakeholders to test governance
- Output expected: metrics, blind benchmarking, directed studies, vulnerability discoveries.

Overview of the Project and Technical Results (Wilfred Rouwhorst - NLR)

One goal is to build a prototype for the Risk Observatory and develop a Risk Assessment Framework that uses a Risk Assessment model. We start from the requirements, we define the domain, we develop the model up to the analysis of the data and the results of the observatory. The observatory should help to reduce the number of occurrences of accidents, which in turn improves safety. We need to understand what the required system performance needs to be in terms of safety, assess the most dangerous events and understand the actions to be taken to improve safety. The collected data must be organized, merged and analyzed. For example, the touch-down data of the different aircraft, in terms of position error and speed, this allows for statistical analysis. So it will also be possible to make extrapolations on what could be expected values for the future.

- Goals
    - Prototype Risk Observatory
    - Develop risk assessment framework that integrates risk assessment models
    - Overview of project

Backbone Models supporting a Total Safety Assessment inside the Air Transport System (Pierre Bieber – ONERA)

We want to model the risk of the aviation system, then this model must be validated through case studies. A use case is that of collision avoidance, we must build the tree of events that then lead to the possible conflict situation. We consider the frequencies of occurrence of these events that are known and weights are based on the severity of the different events. Combining the probabilities of the different events leads to the risk assessment.

- Backbone model
- Contributing and Influencing factors (attributes, weight and rate of occurrence of the attribute)

Question / answers

- Q: Will the backbone model be accessible?
    - A: The intention is to make the model available at the end of the project. However, there are confidentiality arrangements regarding some data sources used to build the model.
- Q: Can the model be used to predict new risks? Collision of RPAS in controlled airspace?
    - A: Theoretically, it is possible.
- Q: Do models that were created include oceanic operations data? This of interest, because generally there is a data gap in this kind of operations.
    - A: We would need to check if oceanic operations data is included in the data sources.
- ii) Any idea of sharing/coordination among EU and US? In US there is Infoshare, a confidential meeting for sharing lessons learnt among operators.
    - A: We are in touch with FAA, but not institutionalised. May want to strengthen the links. FSS is not actively involved in that. There are similar events in Europe. The idea of EASA is to complement the D4S with expert knowledge, not everything is in the data. EASA is

trying to do that and organise an event for that in the 2nd quarter of next year. Lufthansa has meetings once per year, comparing FDM of different operators.

- Q: Do founding members of D4S play another role other than provide data and governance?
  - A: The founding members provide technical expertise to analyse the data, and have a say in everything. They are at every layer of the process. The focus for now is on demonstrating the concept, so it is currently limited to a few stakeholders.
- Q: There is some complementarity between D4S and the Risk Observatory. What about timing? How to facilitate the joining of D4S with the RO (e.g. handover of RO to EASA…)?
  - A: mid 2019 D4S should be comfortable with the technical solutions and that we are on the right track. From that point EASA could open, e.g. in the 2nd or 3rd quarter of 2019. The dialogue is ongoing between EASA/D4S and Future Sky Safety P4 and Safeclouds.eu.

2.3.3. P5 Resolving the organizational accident

Raising our game in organisational safety management (Barry Kirwan - EUROCONTROL)

Safety is at the top of Eurocontrol's priorities, this is also achieved through the exchange of information with the airlines. A safety culture is important, which must be taken from the ATM to the various aviation segments, such as airlines (pilots and companies from different countries), airports and engineering. The most critical points still today are the support to the organization and the fatigue of the pilots, the effort that makes the pilots make them less ready and can create problems of safety. EASA in August 2017 provided a practical guide to help prevent safety problems in organizations. A communication network, with a crisis team in place, is needed to manage crises. Military experience can help to organize the structure to support the safety to manage the circumstances of crisis that arise. See the website on FSS P5 tools: www.safeorg.eu.

The Luton Safety Stack, improving safety and efficiency (Liam Bolger - Luton Airport, Dave Cross - EasyJet)

The organization for dealing intelligently with safety should ensure sharing among all the parties involved, with an exchange of information in and out of all the partners. To this end, a series of actions must be implemented, including training in crisis situations, spreading safety culture, standardizing safety communications, through inspection, video production, identifying actors and responsibilities in case of safety problems. The controls on the aircraft are fundamental when it is on the ground (ground operations), all these checks must be documented on specific cards.

Insights from a Safety Culture Survey of a global airline (Jaap van den Berg - KLM)

KLM is one of the examples of high levels of safety in the world; this goes through an online surveillance, with questionnaires that go beyond those prescribed, for the different players in the aeronautical field, passengers, pilots, airport operators, traffic control operators, and KLM is ready to consider the feedback received, so online surveillance is used. The results of these analyzes are used to improve the knowledge of the operators and thus increase safety. These questionnaires are well received by the aeronautical community.

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Ensuring the right safety view at the top – Executive-level Safety Dashboards (Carlo Valbonesi - DBL)

A dashboard is a tool for analyzing and managing safety data, in order to identify safety problems. The data could come from the regulatory bodies. It shows a risk map, Key Performance Indicators of European safety, progress in disseminating the safety culture, people involved in safety in Europe, the impact of safety changes. This tool has been improved with feedback received in a special meeting. It requires an automatic evaluation, an interactive and intuitive visualization. This system can be improved in the future. The tool is available through web-browser access at **https://dashboard.dblue.it/** (note that a username and password are required to obtain access).

Question / answers

Q: What are the next steps to improve safety?

- **A:** Centralizing information and making it available via standardized reports; information should not be interpreted but collected in such a way as not to be confused.

Q: What is the short- and long-term strategy to increase safety?

- **A:** In the long term it is to teach the operator the culture of safety.

2.3.4. P6 Human Performance Envelope

Human Factors challenges on the flight-deck (Kathy Abbot - FAA)

The challenges related to human factors are due to the complexity, i.e. the diversity of the operators and the interactions between pilots and controllers. All operators must have certifications to operate based on the role, as well as the aircraft. Sometimes communications between pilots and controllers are complex and this can lead to misunderstandings. So information must be essential and simple. Every single incident requires changes to make it happen no longer. We need to change management, reduce operator fatigue and reduce risks. We must ensure that the introduction of novelties does not diminish the safety. One way is to simplify the information provided to pilots, as was done with the most recent cockpits, also introducing tools to support pilots. How to mitigate risks, improve procedures, eliminate risk conditions, improve design, provide alert and warning tools to improve safety.

Graceful degradation in ATM and the Human Performance Envelope (Tamsyn Edwards - NASA)

The future ATM will allow greater tolerances, more precise trajectories, greater strategic control, systems capable of tolerating malfunctions, greater automation to reduce human factors. We must understand what the causes are for the ATC degrades its performance and understand the actions necessary to recover from degraded situations. The causes of ATC degradation can be for example a bad communication or a malfunction of the radar, the weather, an emergency of the aircraft, requests to the pilot.

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Overview of the Project and Technical Results (Matthias Wies - DLR)

Objectives of the P6 project are to address safety and human performance, operating in an environment where the human factor is central, the workload, fatigue, attention, communication, situational awareness, stress, trust, vigilance, teamwork are all important factors. Situational awareness, stress, workload are three parameters that must be measured and characterize the situation in which the pilot operates. These aspects must be considered together to evaluate the safety. These aspects are important for designing the interfaces with which the pilot will have to interact that can be evaluated through the simulator.

Development of new cockpit interfaces (Carsten Schmidt-Moll - Lufthansa)

New cockpits provide more monitors than ever before, in order to show the pilot information more efficiently. The information must be such as not to present surprises to the pilot; especially in abnormal situations, it is important to focus the attention of the pilot on important information, this is even more important in a dangerous situation (example, fire on board and low fuel). Also important is how information is provided, for example how much fuel is left in terms of weight, more intuitive will be how many minutes of flight you can still fly with the remaining fuel.

Development of a Smart Vest for real-time measurements of physiological data (Josias Wacker - CSEM)

Stress from the response of the behavior of physiology in humans, these changes due to stress can be measured, measure the heartbeat, its variability, body temperature, posture, from the eyes an estimate of the pressure. All these parameters can be measured to evaluate the driver's status and try to make the pilots work the most manageable situations and reduce dangerous situations.

Question / answers

- **Q:** What is the price of the CSEM smart vest (manufacturing)?
    - **A:** around 200 euro.
- **Q:** Is it possible to expand the set of sensors mounted on the vest and add EEG?
    - **A:** Yes, it is modular and with only two wires all the current sensors are monitored
- **Q:** Pilots already have issues sometimes in making sense of the situations they face when things get critical; adapting the way automation works depending on physiological and other parameters could disorient the crew. Therefore, the way it changes should always be predictable in full.
    - **A:** Right observation, such considerations are kept for future work
- **Q:** Bit surprised to hear proposed solutions like “automation to take over if the pilot loses the picture”, as I think it should the opposite, i.e. try to keep as much as possible the pilot in the loop.
    - **A:** Good point, we will be exploring also this paradigm. “Automation-taking-over” is just one scenario.
- **Q:** How is physiological measurement correlated to pilot’s performance?

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  - **A:** There was no clear correlation emerging. Picture should be completed by considering other data like behavioural markers, but for the moment no clear link. However, physiological measurements and other measures of workload and stress were strongly correlated.
- **Q:** What about differentiating the Primary Flight Display (PFD) for the Pilot Flying (PF) and the Pilot Monitoring (PM)? In the proposed new HMI for the cockpit they remained the same.
  - **A:** Good point, but we must consider also the need for redundancy and cross-check of actions. At the moment, some airlines instruct the PF to keep the communication while the PM goes through the Electronic Flight Bag (EFB) to solve the abnormal situation(s).
- **Q:** What about the requirements for calibration of the vest?
  - **A:** Not much; it takes a few seconds to set it up.
- **Q:** Any use in operations of the vest was envisioned?
  - **A:** One possible application could be training, as it would allow to see better what is going on inside the pilot even if the performance is OK. A performance evaluation software tool, not based on physiological measurements, was developed by NLR to allow trainers to evaluate the performance of the pilots in real-time.
- **Q:** Which application of the project as a whole can be envisioned?
  - **A:** It is a step forward in the identification of key risks interactions. It will useful in guiding future research on how to make degradation of system safety graceful.

2.3.5. P7 Mitigating the risk of fire, smoke & fumes

Overview of the Project and Technical Results (Eric Deletombe - ONERA)

Objectives of the P7 project are to improve the materials used for the cabins to reduce the risk of fires and smoke production, and to evaluate the mechanical properties of these materials. Various types of materials including composite materials have been used. Several experiments were carried out, in particular a panel flame of different materials was struck with a flame, exceeding 500 kelvin temperatures, in addition to the experiments, simulations were also performed using a simulation tool. New materials were used such as geo-polymers (resins and foam), natural fibres (cellulose) and also combinations of these, fibres of metal laminates. This provides the opportunity to study emissions and cabin air quality.

Cabin Air Quality (Ricardo Reis - EMBRAER)

In the last 15 years, the number of passengers has doubled; more attention is paid to the quality of the air in the cabin to increase passenger comfort and safety. Aspects of physics, chemistry, smell, pollution, and air density, are considered more in aircraft cabin design. The air is polluted by the people themselves, by the engines, by the plastics; therefore it must be filtered, considering that it is combined with external air that is heated by exploiting the heat of the engines. In 2017, EASA has carried out preliminary studies on cabin air quality, but there are also other initiatives on this important problem. Questionnaires for passengers give excellent feedback in order to improve air quality, since the sense of smell is an excellent sensor.

Material solutions to mitigate fire, smoke and fumes in the cabin environment (Frantisek Martaus – VZLU, Martin Liebisch - DLR)

Materials that resist flame penetration to mitigate the effects of fires on board are sought. Tests and simulations were performed on some materials, reaching 1,100 degrees centigrade, in order to validate the behaviour of the materials, the temperature measurements were performed using two thermocouples.

Question / answers

- **Q:** Highlight the toxicology part of the materials on fire. Focus on difference between short term and long-term exposure.
    - **A:** OK. Long-term exposure to low concentration is interesting, but then you would need to cross many data. Also then comfort would have to be considered more.
- **Q:** Electric aircraft (bleedless) bring a new scenario concerning cabin air. Have you considered this?
    - **A:** The Boeing 787 is bleedless. So far, looks like there is no difference in air composition.
- **Q:** Geo-polymer material…is it gonna be heavier or more costly?
    - **A:** Geo-polymer can be compared to standard composite; it is heavier though, but if you create carbon composite you can reduce the weight down to present state.

2.4. Dissemination material

In order to raise participants' awareness on the status of the technical projects, a poster session was open to projects willing to contribute. In the afternoon of the first day of the conference, FSS Programme Manager Michel Piers guided a poster tour in collaboration with the authors, so that each poster received a fair amount of attention.

POSTERS

P1 – Coordination of Institutionally Funded Safety Research

- Coordination of institutionally funded safety research

P3 – Specific solutions for runway excursion accidents

- Improved operational capabilities on contaminated runways 1
- Improved operational capabilities on contaminated runways 2
- OPHELIA tool to predict runway water contamination
- Risk assessment of veer off during landing 1
- Risk assessment of veer off during landing 2

P4 – Total system risk assessment

- Enabling improved safety management

P5 – Resolving the organisational accident

- Safety Culture

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- A prototype interactive safety dashboard for ENAIRE
- Organisational capability of agile response to crises

P7 – Mitigating the risk of fire, smoke & fumes

- Improved material solutions to mitigate fire, smokes and fumes
- Mitigating risk of fire, smoke and fumes
- Understanding and characterizing the fire behaviour of primary structures composite materials
- Cabin air quality

Posters displayed during the conference can be found in Appendix C.

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Appendix A LIST OF PARTICIPANTS TO THE CONFERENCE

N.	Surname	First name	Organisation
1	ABBOTT	Kathy	FAA
2	FIORE	Michele	Leonardo
3	HOFFMANN	Thomas	Austro Control
4	ISAMBERT	Emmanuel	EASA
5	KRASTEV	Alexander	EUROCONTROL
6	KURUCKI	Natasa	SESAR JU
7	MINGELS	Ronny	ARTTIC International
8	PEJOVIC	Tamara	EUROCONTROL
9	PEREZ-ILLANA	Pablo	European Commission
10	PERINI	Andrea	Toscana Aeroporti S.p.A.
11	SACK-NIRSCHL	Andrea	Austro Control
12	SMEULDERS	Willy	European Passengers' Federation
13	STEFANIOROS	Vasileios	EASA
14	VAN EEKEREN	Rob	safe-runway GmbH
15	BARRY	David	Cranfield University
16	BERTHE	Julien	ONERA
17	BETTIGNIES-THIEBAUX	Beatrice	EUROCONTROL
18	BIEBER	Pierre	ONERA
19	BIELLA	Marcus	DLR
20	BLANCHARD	Guilhem	DGAC/STAC
21	BOGOS	Stefan	INCAS
22	BOLGER	Liam	London Luton Airport
23	BOSCHIERO	Alessandro	ENAV
24	CARSTENGERDES	Nils	DLR
25	COHEN	Giel	Airbus Defence&Space
26	CROSS	David	easyJet
27	DEJEAN DE LA BÂTIE	Antoine	DGAC/STAC
28	DELETOMBE	Eric	ONERA
29	KHAIRULLIN	Nail	TsAGI
30	KIRWAN	Barry	EUROCONTROL
31	KOS	Johan	NLR
32	KRAJENSKI	Volker	DLR
33	LAGUNAS CABALLERO	Sara	Airbus Defence&Space
34	LIEBISCH	Martin	DLR
35	LUONGO	Salvatore	CIRA
36	MARTAUS	Frantisek	VZLU
37	MOISOIU	Catalin	INCAS
38	MOITAS	Mónica Patrícia	CEiiA
39	NIXON	Jim	Cranfield University

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40	OLIVEIRA	Fábio	CEiiA
41	PIERS	Michel	NLR
42	POZZI	Simone	Deep Blue
43	READER	Tom	London School of Economics
44	REIS	Ricardo	Embraer Portugal
45	RIBEIRO	Bernardo	CEIIA
46	ROUWHORST	Wilfred	NLR
47	SPEIJKER	Lennaert	NLR
48	STRELKOV	Vladimir	TsAGI
49	STROEVE	Sybert	NLR
50	VALBONESI	Carlo	Deep Blue
51	VAN DER GEEST	Peter	NLR
52	VERHOEVEN	Ronald	NLR
53	WACKER	Josias	CSEM
54	WANG	Chong	Technical University of Munich
55	WOLTJER	Rogier	Swedish Defence Research Agency (FOI)
56	HERRERA	Carlos	Colombian Air Force
57	VIDEAU	Eric	DGAC/STAC
58	ANDREEV	Evgeni	TsAGI
59	EDWARDS	Tamsyn	NASA
60	HARLOW	Simon	Babcock Aviation
61	KY	Grégoire	SESAR JU
62	LEYLEKIAN	Laurent	ONERA
63	MAKSIMOVIC	Danijela	EUROCONTROL
64	MILES	Paul	BAE Sytems
65	SPEYER	Jean-Jacques	Vrije Universiteit Brussel
66	STREQUE	Jean-Luc	Thales
67	VAN DEN BERG	Jaap	KLM
68	ALTIERI	Michele	ATCEUC
69	CAVKA	Ivana	Clean Sky 2 Joint Undertaking
70	KULAKOV	Evgenii	Trade representation of Russia
71	DIJKSTRA	Arthur	KLM
72	FERANDEZ	Erick	EASA
73	SCHMIDT-MOLL	Carsten	Lufthansa
74	VIOLATO	Daniele	INEA

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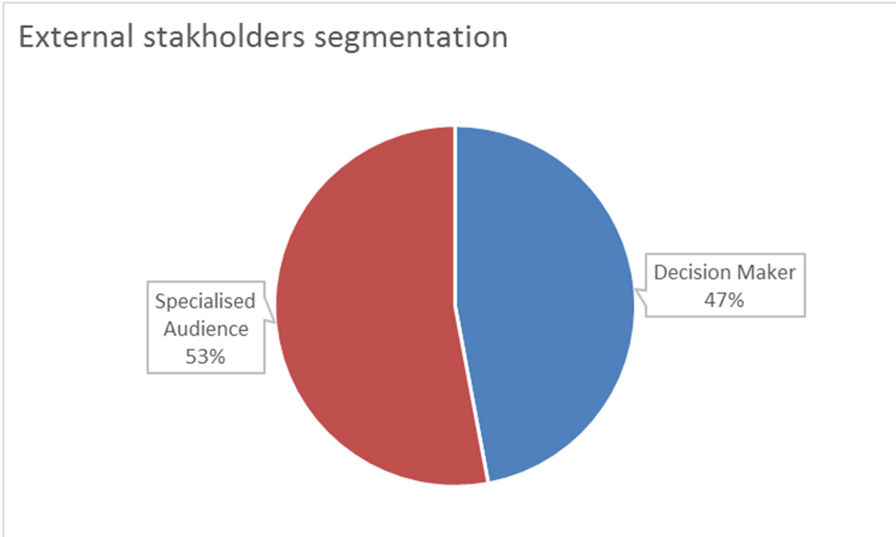
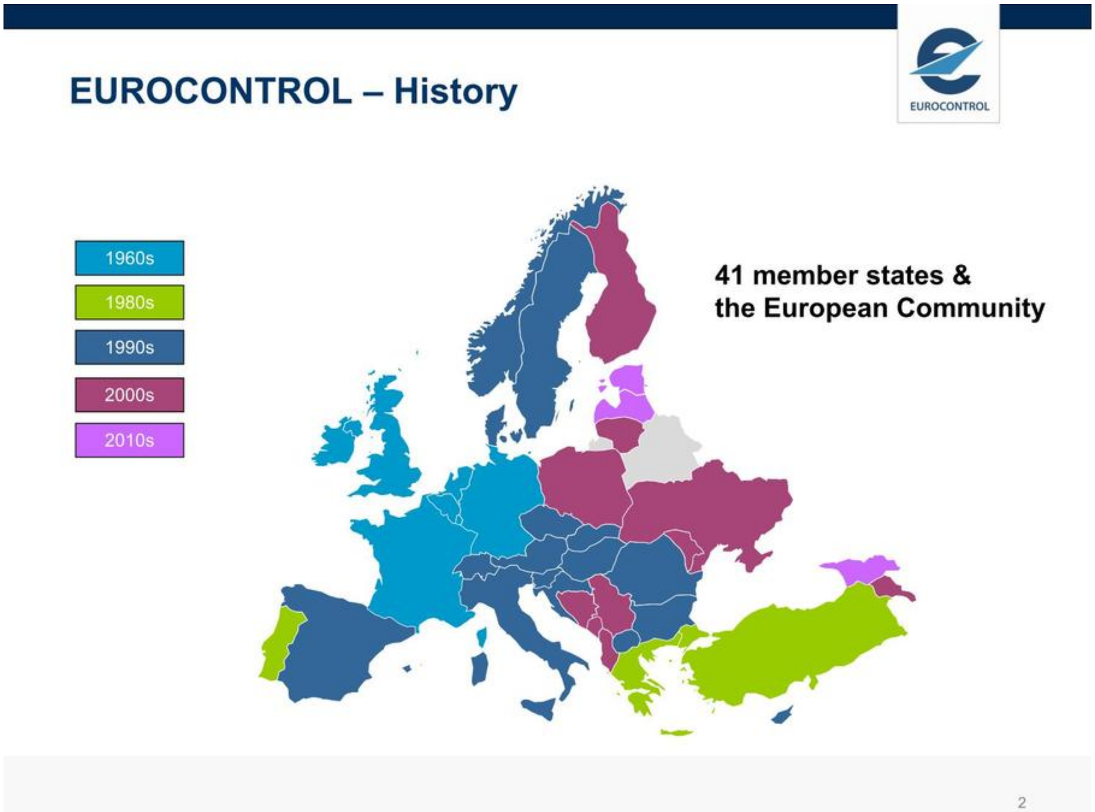


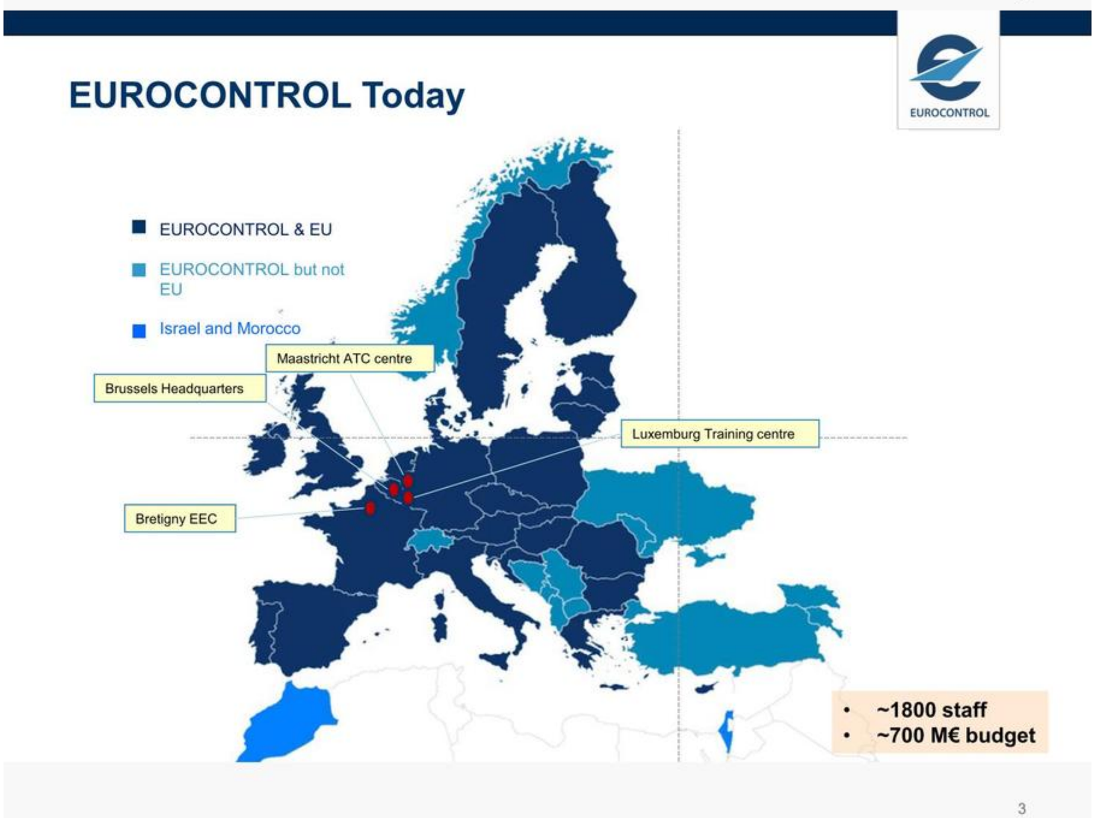
Figure 4: "Future Sky Safety on Final Approach" conference: External stakeholders segmentation

Future Sky Safety has received funding from the EU's Horizon 2020 Research and Innovation Programme, under Grant Agreement No. 640597.

Appendix B FSS On Final Approach Conference Presentations

Appendix B.1 "Welcome and introduction: What is Eurocontrol? The European Organisation for the Safety of Air Navigation" – Philippe Merlo, Director European Civil-Military Aviation at Eurocontrol





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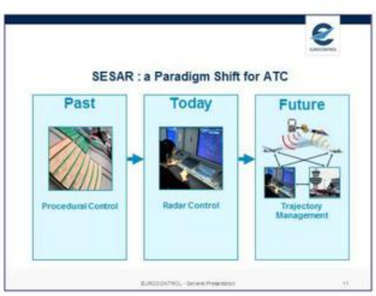
Maastricht Upper Area Control Centre

- 260,000 km² over Belgium, the Netherlands, Luxembourg and North-West Germany
- Densest airspace in Europe
- More than 1.5 million flights controlled (2013)
- Annual costs (2013): € 138 M
- 3rd largest control centre in Europe
- 6th largest ANSP in Europe
- Highest controller productivity in Europe
- One of the most cost-effective ANSPs

4

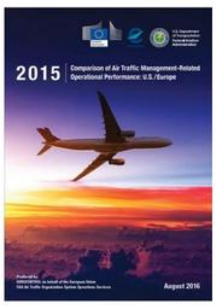
EUROCONTROL as main European R&D ATM centre

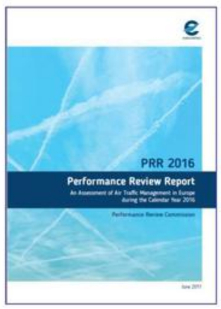


- Able to federate European ATM (ATM Master Plan)
- ATM expertise more efficient concentrated than scattered
- Sharing R&D costs (expert teams, validation tools)/Member States
- Leverage Network Manager and MUAC operational experience
- Enables to discuss with US/FAA on equal footing
- EUROCONTROL founding member and main contributor of SESAR JU

5

Route Charges System- Performance review Unit





Routes charges system :

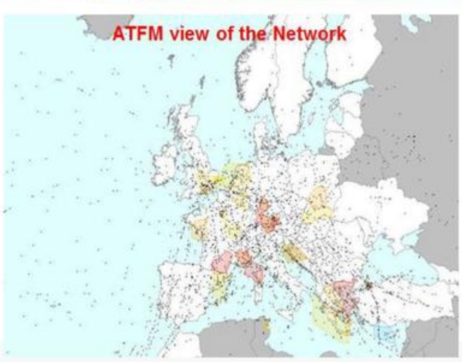
- 7,1 billion € collected annually
- Collection cost of less than 0.3%
- Support robust financing of European ATM
- Good knowledge of European ATM costs and efficiency

Performance Review Unit :

- Unique expertise in ATM performance assessment and benchmarking
- Publication of key reports on ATM performance

6

Network Manager



European ATM Network :

- 43 States (41+2)
- 1750 Sectors – 68 en-route centres
- 520 Airports
- 1940 Aircraft Operators
- 6,700+ connected end-users
- Peak traffic – 35,937 flights /day
- 10,600,000+ flights a year

Main functions :

- Manage Air Traffic Flows
- Develop integrated Route Network
- Coordination with other regions
- Management of crises (EACCC)

7

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Appendix B.2 "Welcome and introduction: Welcome to the Future Sky Safety on Final Approach Conference" – Daniele Violato, Head of Sector Aviation Research at INEA – EU Commission

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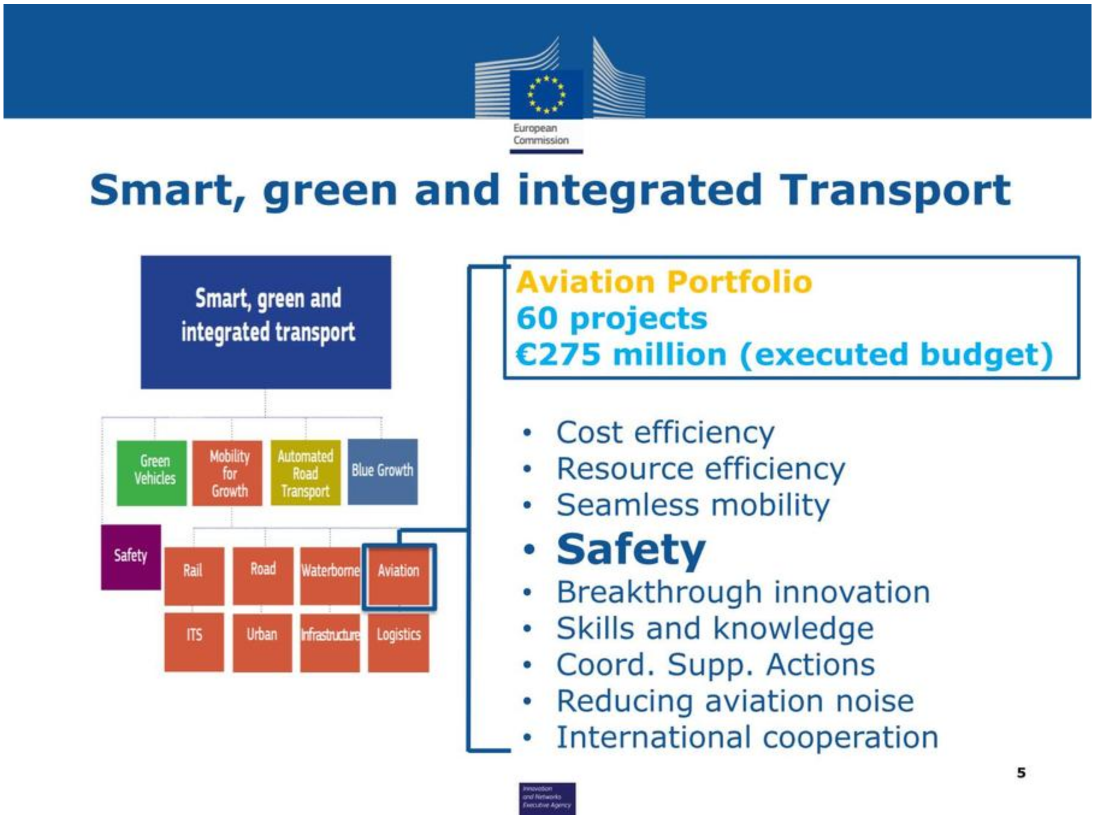
European Commission
Smart, green and integrated Transport
Smart, green and integrated transport
Green Vehicles
Mobility for Growth
Automated Road Transport
Blue Growth
Safety
Rail
Road
Waterborne
Aviation
ITS
Urban
Infrastructure
Logistics
Aviation Portfolio
60 projects
€275 million (executed budget)
• Cost efficiency
• Resource efficiency
• Seamless mobility
• Safety
• Breakthrough innovation
• Skills and knowledge
• Coord. Supp. Actions
• Reducing aviation noise
• International cooperation
5


European Commission
Open to the world
International Cooperation in Aviation Research
SAFRAN
AIRBUS
DASSAULT AVIATION
BOMBARDIER
NASA
BOEING
EMBRAER
COMAC
6

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European

SARAH

'Increased safety and robust certification for ditching of aircrafts and helicopters'

Objectives:

- to improve aircraft/ helicopter **certification tools**
- to deliver **simulation tools** for accurate loading information
- to derive a robust way to safely **design new configurations**
- to use **methods** obtained to analyse and optimise approach, landing and impact phases to **supporting the pilot in water landing**

11

European Commission

MUSIC- haic

Objectives:

- Develop a numerical simulation tools capable of accurately **predicting ice crystal icing** (ICI) in in flight conditions
- To **incorporate** in currently used industrial 3D multi-disciplinary tools a validated ICI capability that can be used for both design and certification of new engines, probes and aircraft

12

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European Commission

PHOBIC2ICE

'Super-IcePhobic Surfaces to Prevent Ice Formation on Aircraft'

Objective:

- to **design materials with anti-icing properties** suitable for the development of a more sustainable and energy-efficient coating systems that prevent ice accretion

13

Innovation and Networks Executive Agency

European Commission

VISION

'Validation of Integrated Safety-enhanced Intelligent flight control'

Objectives:

- to develop **smarter technologies for aircraft guidance, navigation and control** (GN&C) by integrating onboard vision system and advanced fault detection

- to contribute to the global civil aviation goal of the **aircraft accident rate reduction**

14

Innovation and Networks Executive Agency

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European Commission

Conference Programme

DAY 1

10:00	**WELCOME**	**EUROCONTROL**
10:10	Introductory remarks	**INEA** Daniele Violato
10:30	Future Sky	**EREA FUTURE Sky Board** Laurent Leylekian (ONERA)
10:50	Future Sky Safety Programme	**NLR** Michel Piers
	P3: Solutions for runway excursions	
11:10	A pilot's view on the runway excursion problem	**KLM (retired), Safe-Runway GmbH** Capt. Rob van Eekeren
11:40	Overview of the project and technical results	**NLR** Peter van der Geest
12:00	**COFFEE BREAK**	

European Commission

DAY 1

12:20	Using the results of P3 in reducing the runway excursion risk	**NLR** Peter van der Geest
12:40	Questions & answers	Chair: **NLR**
13:00	**LUNCH**	
	P4: Total system risk assessment	
14:10	Data4Safety: A partnership for a (big) data driven aviation safety analysis in Europe	**EASA** Erick Ferrandez **EASA** Leopold Virolez
14:40	Overview of the project and technical results	**NLR** Wilfred Rouwhorst
15:00	Backbone Models supporting a Total Safety Assessment inside the Air Transport System	**ONERA** Pierre Bieber
15:40	Questions & answers	Chair: **NLR**
16:00	**Partnering event – Visit to the poster area**	
16:45	**END OF 1ST DAY**	

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DAY 2

09:00	**WELCOME**	**NLR**
	P5: Resolving the organisational accident	
09:10	Raising our game in organisational safety management	**EUROCONTROL** Barry Kirwan
09:30	The Luton Safety Stack, improving safety and efficiency	**Luton Airport** Liam Bolger **EasyJet** Dave Cross
10:00	Insights from a Safety Culture Survey of a global airline	**KLM** Jaap van den Berg
10:20	Ensuring the right safety view at the top – Executive-level Safety Dashboards	**Deep Blue** Carlo Valbonesi
10:35	Questions & answers	Chair: **EUROCONTROL**
10:45	**COFFEE BREAK**	
	P6: Human performance envelope	
11:00	Human Factors challenges on the flight-deck	**FAA** Kathy Abbott
11:30	Graceful degradation in ATM and the Human Performance Envelope	**NASA** Tamsyn Edwards
12:00	Overview of the project and technical results	**DLR** Matthias Wies
12:20	Development of new cockpit interfaces	**Lufthansa** Carsten Schmidt-Moll
12:40	Development of a Smart Vest for real-time measurements of physiological data	**CSEM** Josias Wacker
13:00	Questions & answers	Chair: **DLR**
13:10	**LUNCH**	

European Commission

DAY 2

	P7: Mitigating risks of fire, smoke and fumes	
14:20	Overview of the project and technical results	**ONERA** Eric Deletombe
14:40	Cabin Air Quality	**EMBRAER** Ricardo Reis
15:00	Material solutions to mitigate fire, smoke and fumes in the cabin environment	**VZLU** Frantisek Martaus **DLR** Martin Liebisch
15:30	Questions & answers	Chair: **ONERA**
15:40	**Wrap up**	**NLR** Michel Piers
16:00	**END OF 2nd DAY**	

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European Commission
Important info
EU Commission will be present with a stand at
• Aero Days 2019
• Paris Air Show 2019
Looking for experts
(proposal evaluation, project assessment).
– enrol via the Participant Portal
WE WANT YOU!
19


European Commission
Thanks for sharpening the focus of
aviation safety research!
FUTURE SKY SAFETY
20

Appendix B.3 "Welcome and introduction: Desgning the future of aviation. Future Sky" – Laurent Leylekian, EREA

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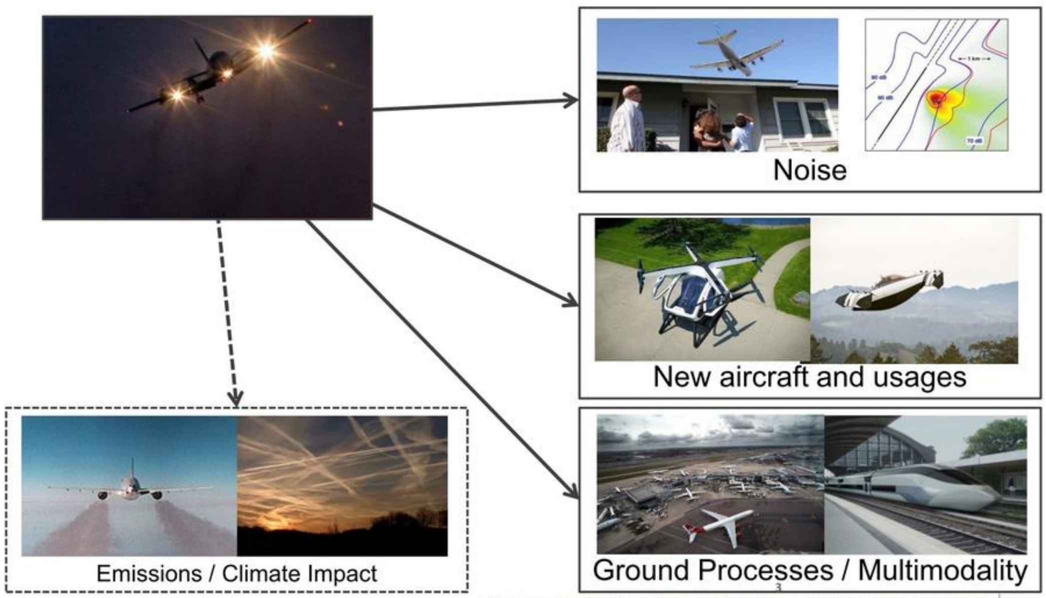
Challenges linked to Aviation Growth



FSS Final Conference – *"FSS on final approach"*, 6-7 November 2018, Eurocontrol HQ, Brussels | 3

Future Sky, an EREA initiative

- Future Sky is an EREA initiative started in 2014
- It aims at addressing the main challenges of EU Aviation toward 2050

- Future Sky
  - ✓ Provides recommendations to the European policy-makers and associated bodies
  - ✓ Coordinates the research effort of its members toward a greater efficiency
  - ✓ Initiates and bridges research projects between academics and the industry

FSS Final Conference – *"FSS on final approach"*, 6-7 November 2018, Eurocontrol HQ, Brussels | 4

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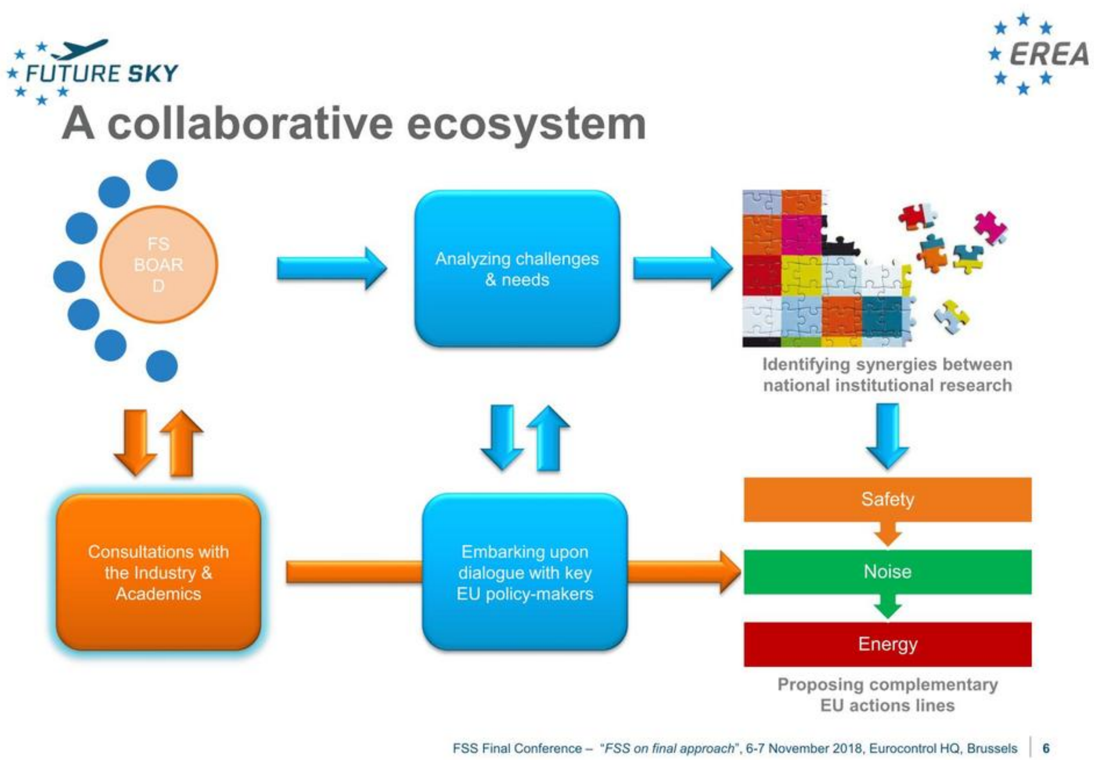

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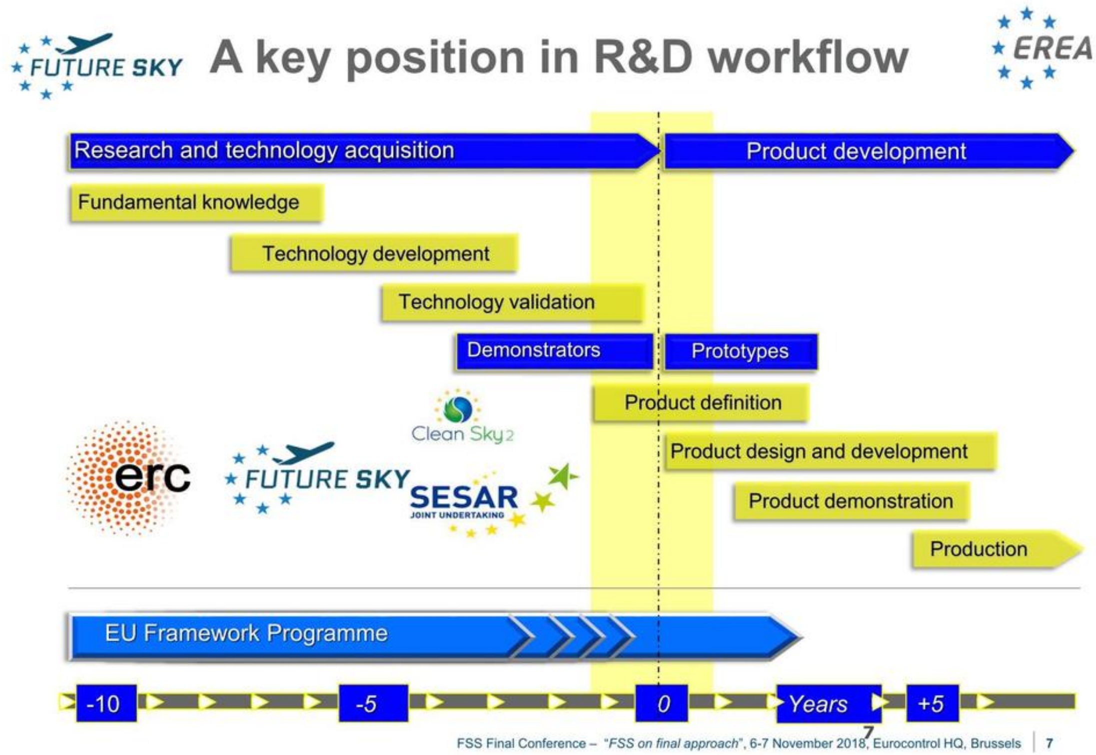

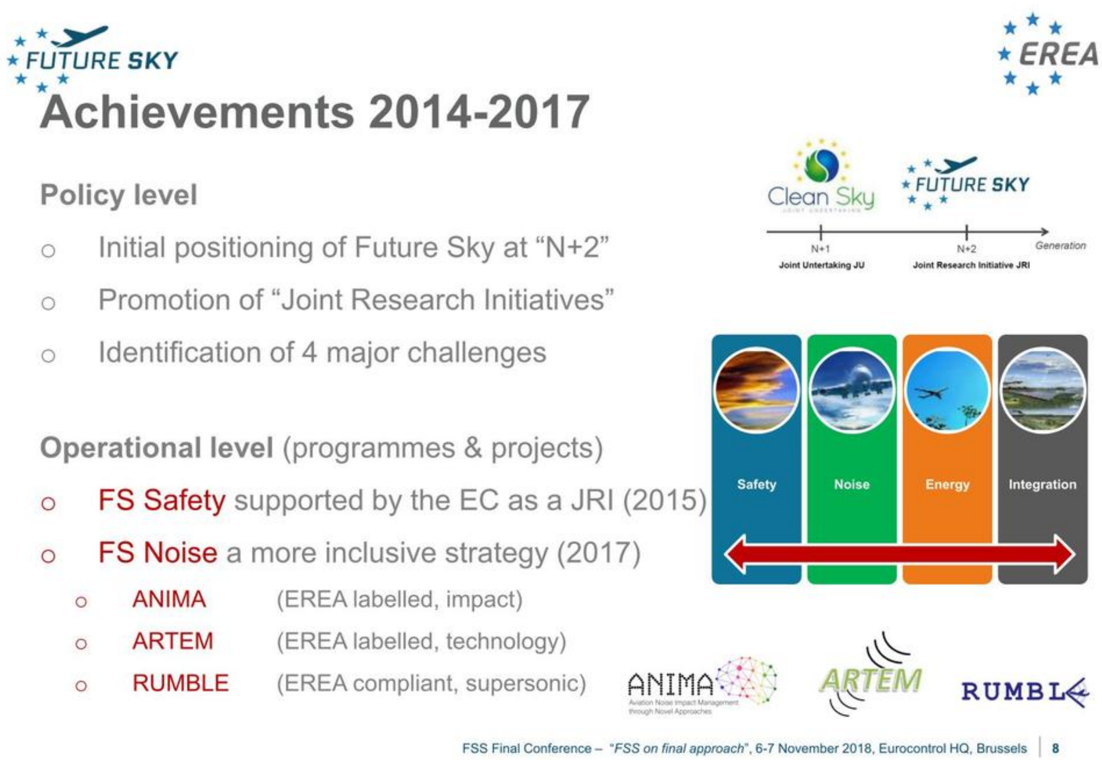

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Current developments (2018 – 2019)

Proposing new innovative RIAs in line with the EC WP and FS priorities

- FS Energy **MACBETH**
  "Multidisciplinary And Collaborative Boosting of Electric Thrust for Hybrid-electric aircraft"
- FS Energy **IMOTHEP**
  "Investigation and Maturation Of Technologies for Hybrid Electric Propulsion"
- FS Noise & Energy **DELPHINE**
  Distributed ELectric Propulsion integrated tecHnologies - pollutINg Emissions reduction"

Contributing to a shared vision of EU Research priorities with **roadmaps**

FSS Final Conference – "*FSS on final approach*", 6-7 November 2018, Eurocontrol HQ, Brussels | 9

The Future of Future Sky

Enlarging and updating the scope with new challenges

Pending talks are considering several options which ought to be discussed and considered with other key players

- Security for Aviation
- Circular Aviation
- Mobility *(under consideration)*

Enlarging and updating the role of Future Sky

- Roadmaps, a positive momentum for Vision and Competitiveness
- Educational and Training initiatives likely to be fostered for Knowledge and Attraction
- "*Let my people know*" – Need to raise further awareness about Future Sky

Adapting Future Sky in the renewed context of **Horizon Europe**

- Reconsidering Future Sky to match the expectations of the forthcoming Commission
- Securing a dedicated governance for upstream research oriented onto disruptive and applied bottom-up ideas

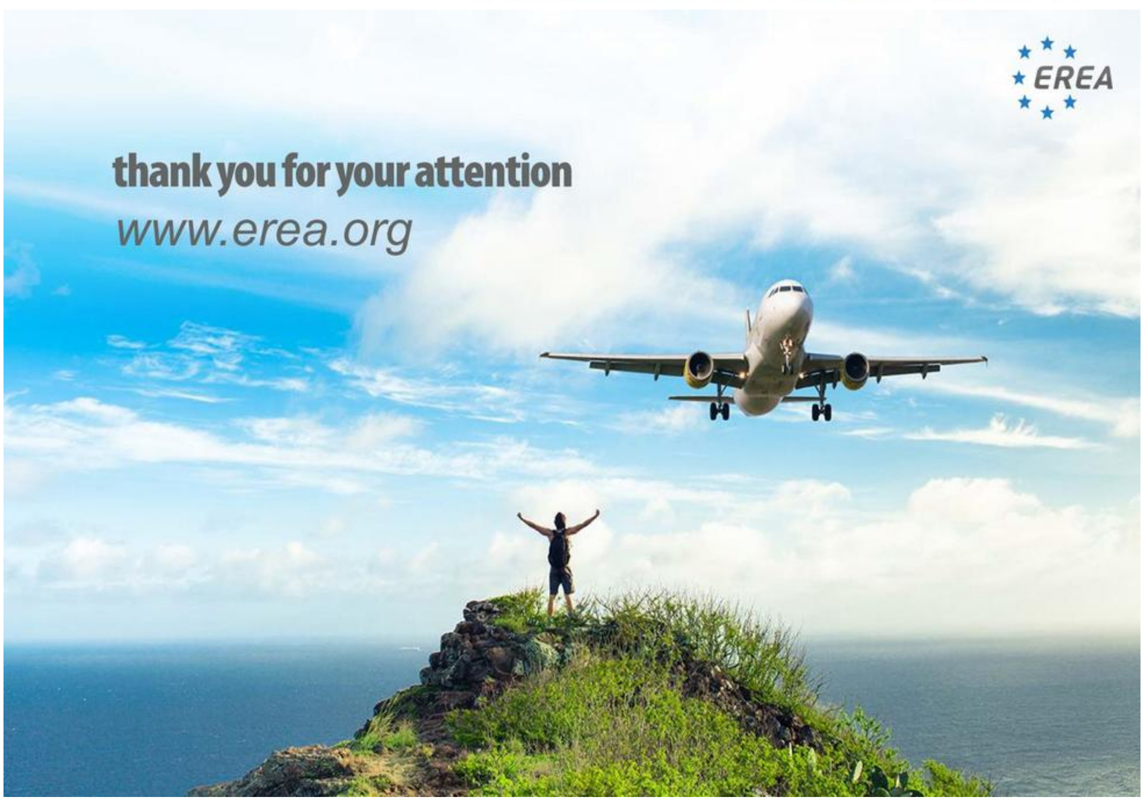
FSS Final Conference – "*FSS on final approach*", 6-7 November 2018, Eurocontrol HQ, Brussels | 10

Future Sky Safety has received funding from the EU's Horizon 2020 Research and Innovation Programme, under Grant Agreement No. 640597.

More than ever, Future Sky intends remaining ….

the Joint Research Initiative for green and seamless air mobility

FSS Final Conference – *"FSS on final approach"*, 6-7 November 2018, Eurocontrol HQ, Brussels | 11



Future Sky Safety has received funding from the EU's Horizon 2020 Research and Innovation Programme, under Grant Agreement No. 640597.

Appendix B.4 "Welcome and introduction: Future Sky Safety. Programme Overview" – Michel Piers, NLR

Future Sky Safety has received funding from the EU's Horizon 2020 Research and Innovation Programme, under Grant Agreement No. 640597.

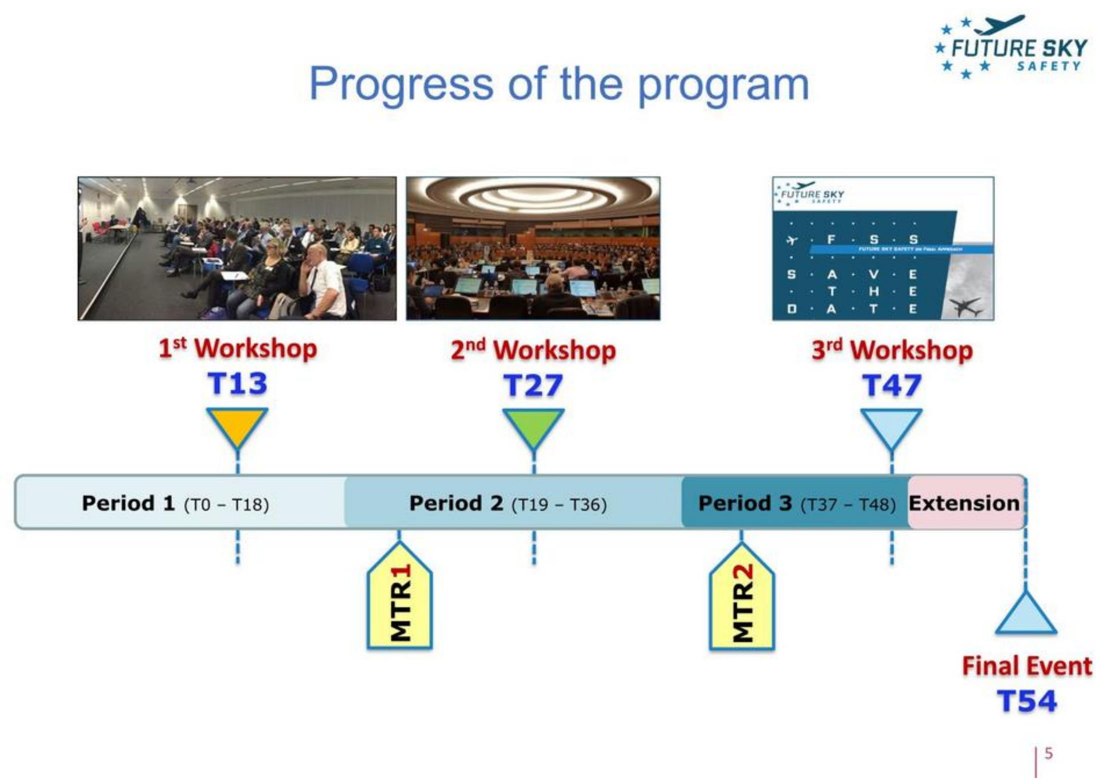
Future Sky Safety in a nutshell

- H2020 –Coordinated research & innovation for aviation safety
- EREA Future Sky Initiative
- Two main activities:
  1. *Research into specific safety topics*
  2. *Research coordination*
- 33 partners – research, industry & academia
- Duration: ~~48 months~~ 54 months
- Budget: 25M€ budget (15 M€ EU)

Connecting to European Safety Strategies

Future Sky Safety has received funding from the EU's Horizon 2020 Research and Innovation Programme, under Grant Agreement No. 640597.


Consortium
FUTURE SKY SAFETY
7 November, 2018 4


Progress of the program
1st Workshop
T13
2nd Workshop
T27
3rd Workshop
T47
Period 1 (T0 – T18)
Period 2 (T19 – T36)
Period 3 (T37 – T48)
Extension
MTR1
MTR2
Final Event
T54
5

Future Sky Safety has received funding from the EU's Horizon 2020 Research and Innovation Programme, under Grant Agreement No. 640597.

P1 Research Coordination

- Develop and share **Awareness** of the content, results and ambitions of the institutional RE programmes in safety (*Document & platform*)


EREA Aviation Safety Research Plan 2016

Maik Friedrich and Nils Carstengerdes

- **Coordination** of institutionally funded research of the participating Research Establishments in field of safety (*Aviation Safety Research Plan*)
- **Cooperation** in newly initiated institutionally funded projects (*incl. cooperation agreement*)

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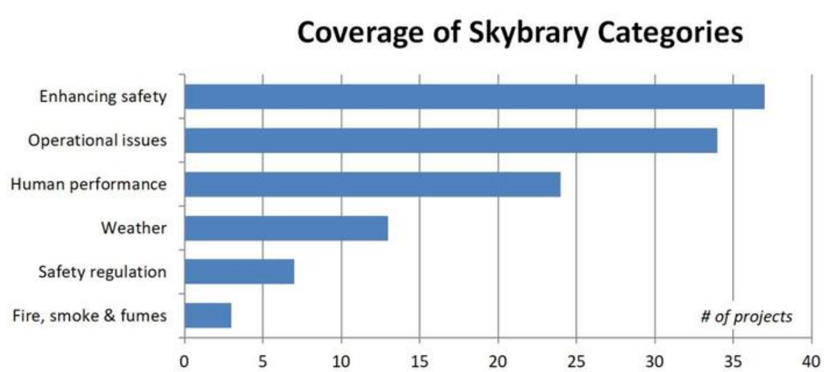
P1 – Results

Monitoring of institutionally funded RE research activity:

- 2000 person months (30 M€) per year in safety research




Institutionally funded safety research activities

Dominik Rutka, Volker Krajenski, João Pedro Mortágua, Marcello Amato, Ana Maria Madrigal, Stefan Bogos, Alfonso Barrado Costa, Alex Rutten, Philippe Novelli, Josef Katzpar

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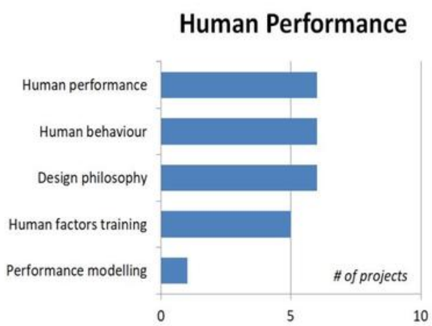
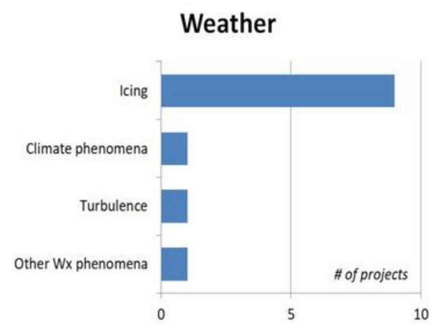
P1 – Results





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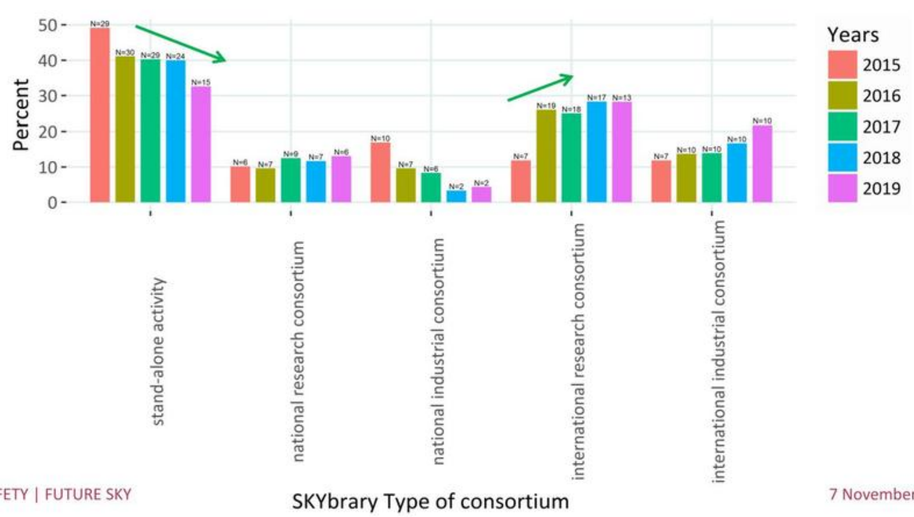
P1 – Results

Decline in stand-alone activities
Tendency for more international research consortia

= goal of P1!



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P1 – Results

- **3 General Coordination Workshops** (with nearly 100 scientists)
- **14 Workshops / Meetings** organised on specific topics
- **8 cooperation projects** running or already finished
- **225 PM of institutional cooperative safety research** outside EC funding FSS
- **Exchange of personnel** between multiple Research Institutes

1st Future Sky Safety Coordination Workshop in Brussels

2nd Future Sky Safety Coordination Workshop at ONERA

3rd Future Sky Safety Coordination Workshop at NLR

Resulting in Coordinated Institutional Activities

2015 and ongoing
- **DLR-ONERA**: HOTAS
- **DLR-ONERA**: ADAWI
- **DLR-NLR**: multiple works

2016
- **DLR-ONERA**: Modelling of operator's behaviour
- **DLR, NLR, ONERA, CIRA**: Aircraft Wake Turbulence
- **DLR-CSEM**: Human Performance Envelope in the ATC Context

2017
- **CEIIA, CIRA, DLR, ILOT, NLR, ONERA & VZLU**: Safety embedded in aircraft design and operations
- **CEIIA, CIRA, DLR, NLR & ONERA**: Helicopter safety
- **CIRA, CSEM, DLR, INCAS, INTA, ONERA & VZLU**: Icing
- **CIRA, DLR, INTA, NLR & ONERA**: Remotely Piloted Aircraft Systems (RPAS) safety (excl. ATM)

2018
- **CIRA, DLR, INCAS & ONERA:** Volcanic ash
- **CEIIA, CIRA, DLR, INTA, NLR & ONERA:** Remotely Piloted Aircraft Systems (RPAS) safety (excl. ATM)
- **CEIIA, CIRA, CSEM, DLR, INCAS, NLR, ONERA & VZLU:** Health monitoring

2019
- Small autonomous electric AC
- Advanced flight envelope protection
- Human Performance envelope
- Mitigating the risk of fire, smoke and fumes
- Remotely Piloted Aircraft Systems (RPAS) safety (excl. ATM)

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P3 Specific solutions for runway excursion accidents

- The European Action Plan for the Prevention of Runway Excursions (EAPRRE) has identified research needs to further reduce risk:
  1) Flight mechanics of slippery runway ops in crosswind,
  2) Impact of fluid contaminants on stopping performance,
  3) Advanced methods to monitor risk factors in flight data.

* Other than ROPS

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P3 Objectives

- Improve methods for analysing aircraft ground control on slippery runways under crosswind;
- Quantify impact of water/slush covered runways on braking performance for modern tires and anti-skid systems;
- Develop new methods to identify veer-off risk using operational flight data;
- Explore new concepts* for prevention of excursions and reduction of consequences of runway excursions.

* Other than ROPS

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P3 Main Results

- Identification of shortcomings in aircraft ground models
- Real tests on wet/flooded runways (yawed tyre, Citation, Airbus A400)
- Improved models for braking performance
- New algorithms to analyse flight data for runway veeroff risk factors
- New Concepts (CLAS, CORSAIR)
- Several results ready for application

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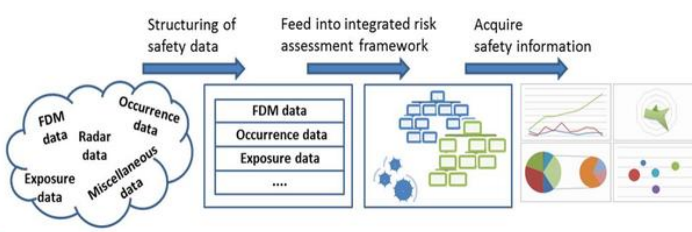
P4 Total system risk assessment

- Adequate means for safety risk assessment and safety performance monitoring of large, complex and dynamic systems of sufficient accuracy and depth not yet available.
- Project builds on progress made in several programs (ASCOS, EUROCONTROL IRP/AIP, FAA-ISAM, ASIAS, CATS-NL) and could develop knowledge in support of Data4Safety initiative.



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P4 Objectives

- Develop a risk assessment framework that integrates risk assessment models from different domains.
- Develop a prototype risk observatory as an enabling tool for safety management:
  - Identify business requirements
  - Define user, functional and system requirements
  - Develop preliminary architecture
  - Develop early “look-and-feel” prototype
  - Stakeholder review of early prototype
  - Deliver first total aviation system risk picture

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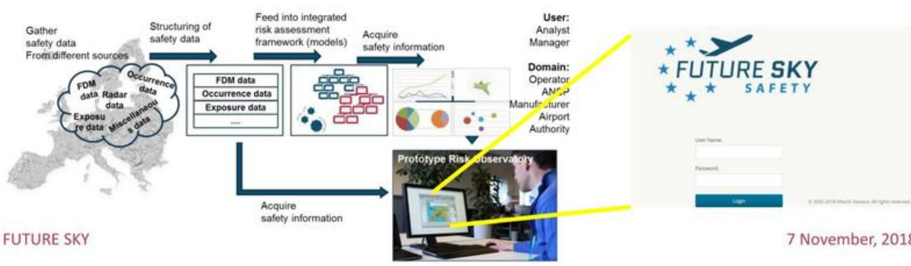
P4 – Main results

- Developed the business model for a risk observatory with stakeholders
- Developed integrated risk assessment framework
- Delivered the RE (Runway Excursion) and MAC (Mid-Air Collision) backbones models
- Integrating building blocks into a Proof of Concept Risk Observatory:
  - Providing an integrated (aviation) risk picture
  - Showing the contribution to risk from several domains
  - Supporting the safety impact assessment of changes within several domains

(full implementation, maintenance and operational use are beyond program horizon)



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P5 Resolving the organizational accident

- Many accidents in complex systems have their roots in organisational factors.
- With increasing cost pressures, more agile business models, new entrants…
- How do we support aviation organisations in managing this source of risk?

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P5 - Objectives

- Develop Safety Intelligence at the Top
- Consider how Safety Dashboards are utilised
- Begin Safety Intelligence for Middle Managers
- Develop and test Safety Mindfulness Concept
- Conduct safety culture surveys
- Develop Agile Response approach
- Integrate these concepts into an an organisational risk management capability within the SMS framework


The Economist
Waking up to fatigue
Pilots are too often flying when tired
Airlines should not lose sight of the things that make them so safe
Gulliver
A RARE tragedy came to pass on December 7th: a fatal crash at a European airport. As it came into land at a foggy Basel airport in France, a light aircraft narrowly missed a British Airways jet on the runway. The smaller plane

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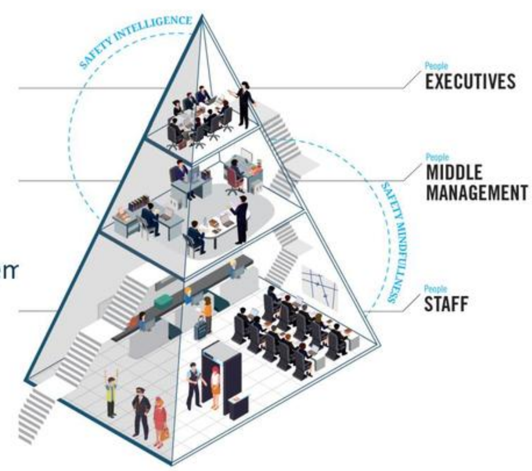
P5 Main Results

A Portfolio of Tools for Organisational Safety Management

- Safety Wisdom
- Safety Dashboard

- Safety Blueprint
- Safety Dashboard
- Agile Response
- Safety Culture
- Safe Performance System

- Safety Culture
- Safety Stack
- Mindfulness App



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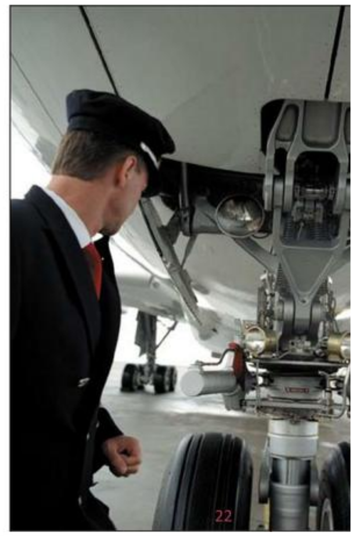
P6 Human Performance Envelope

Objectives



- Develop definition of the Human Performance Envelope
- Conduct preliminary experiments to select and assessment of physiological sensors and fine-tune simulation scenario's
- Conduct flight simulator experiments to validate the HPE and physiological measurements and to identify performance decrement limits
- Determination of recovery measures
- Evaluation and validation of solutions for augmenting the envelope

FUTURE SKY SAFETY

P6 Results

- HPE concept defined
- Sensors selected and assessed to measure the HPE
- First flight simulator experiments conducted in an A320 full flight simulator:
  - HPE concept validated
  - Sensors validated
  - Competency evaluation tool developed and applied to assess situation awareness, problem solving and decision making of the pilots
  - Cognitive walkthrough performed to analyse mental representation of the pilots before, during and after a critical situation
  - Necessary recovery measures determined

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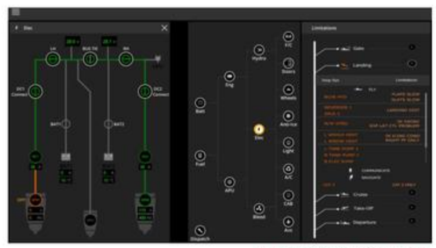
P6 Results

- New HMI developed based on results and analyses of first flight simulator experiments
- Second flight simulator experiments conducted in the Avionics 2020 Cockpit Simulator
- New HMI validated



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P7 Mitigating the risk of fire, smoke & fumes

Objectives

- Understanding and characterising the fire behaviour of primary structure composite materials.
- Improving material solutions to mitigate fire, smoke and fumes in the cabin environment.
- Study the effects of new materials, technology and fuel systems on the on-board air quality

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P7 Main expected results

- Contribution to test standards and new test protocols
- Sharing of experimental data and scientific results for future modelling purposes (expensive tests)
- Establishing/giving design recommendations
- Methodological guidelines to deal with onboard air quality issues

Glass/Phenolic


Carbon/Polysialate

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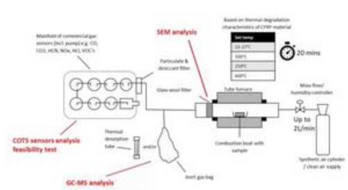
P7 Main Results

- Contribution to test standards and new test protocols: BLADE (laser heating), CuFeX (compression under fire), AFNOR NF X70-100-2 (OBAQ)
- Sharing of original experimental data and scientific results on T700/M21 for modelling purposes (development and validation)
- Screening of new material solutions (GeoPolymer resin, natural fibres, recycled carbon fibers, and combinations thereof)
- Developed design recommendations for dealing with onboard air quality issues

DLR CuFeX test facility for mechanical load under fire



Air quality test procedure for composite materials (based on AFNOR standard

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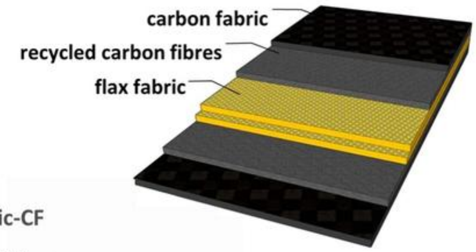
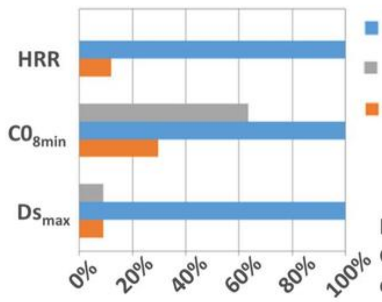
P7 – Main Results

Development and characterization of new material combinations for improved fire behaviour :

Layup of Geopolymer panel demonstrator with natural fibres and recycled carbon fibers





Improved FST behavior of GP laminates compared to common phenolic laminates

Focus in 2019 on exploitation actions

- Workshop/trial with airlines & FDM
- Risk Observatory trial with airline
- Safety dashboards for ANSPs
- Smart Vest for real-time physiological data
- Structural prototype new material solutions

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Agenda

Five Technical Sessions

DAY 1

1. Runway Excursion

2. Total aviation system risk prevention and mitigation

Poster session & Partnering Event

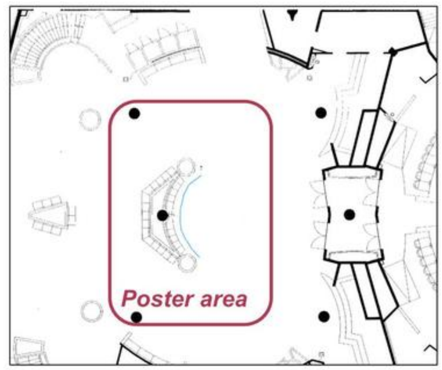
DAY 2

3. Resolving the organisational accidents

4. Human Performance Envelope

5. Mitigating the Risk Of Fire Smoke & Fumes

Posters & Partnering



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FSS on Final Approach

Program Overview

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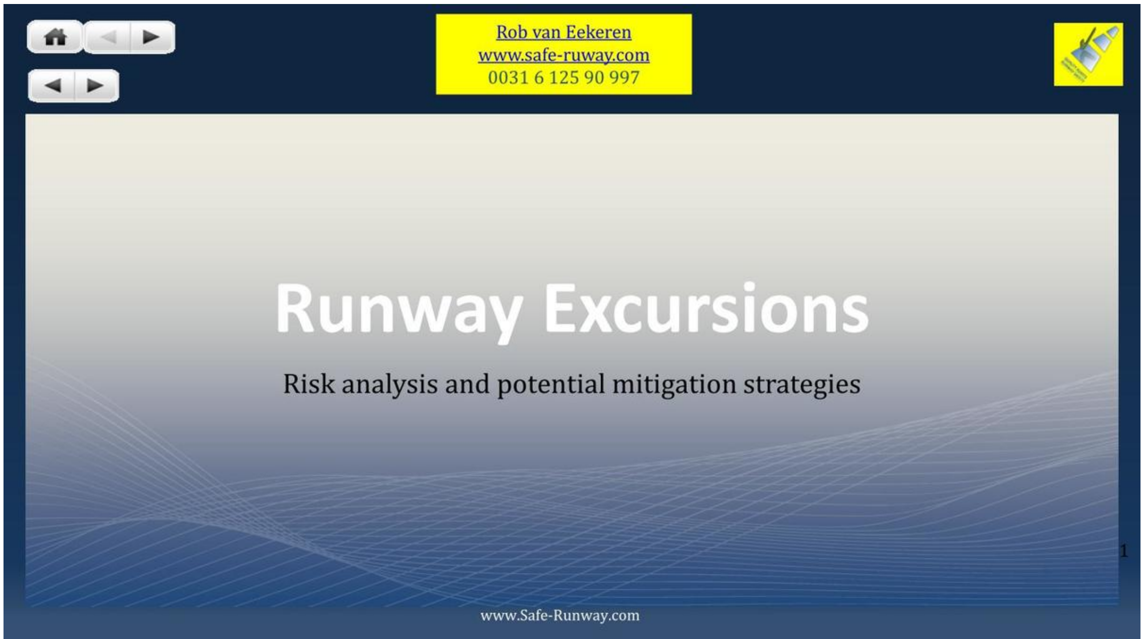
Appendix B.5 “P3: Runway Excursions. Risk analysis and potential mitigation strategies” – Rob van Eekeren, Safe-runway



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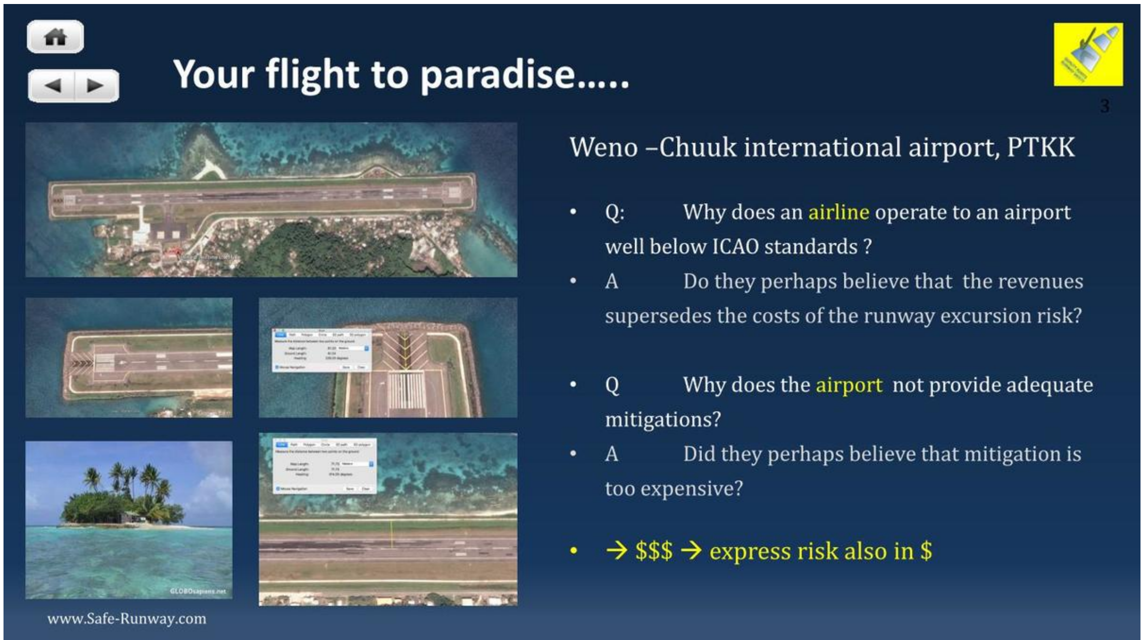
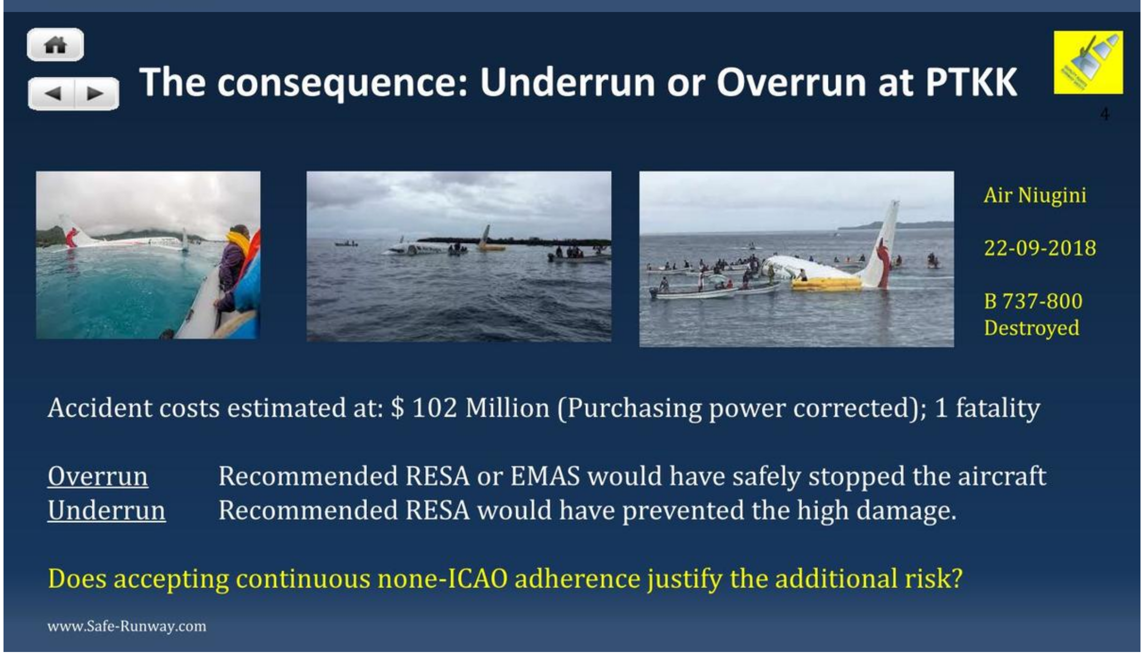
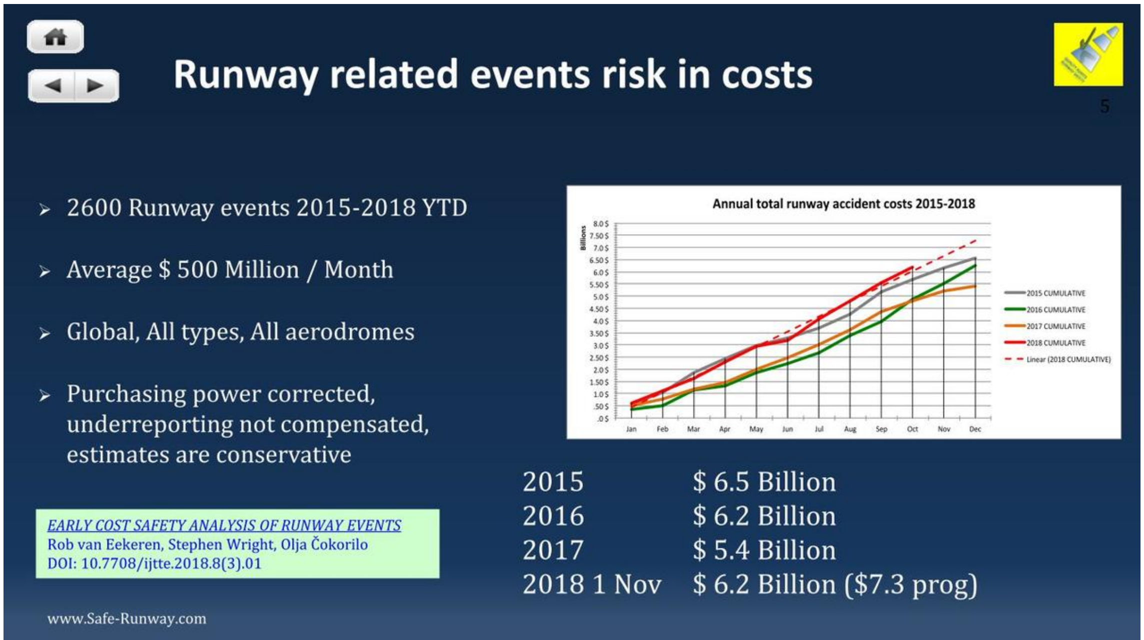
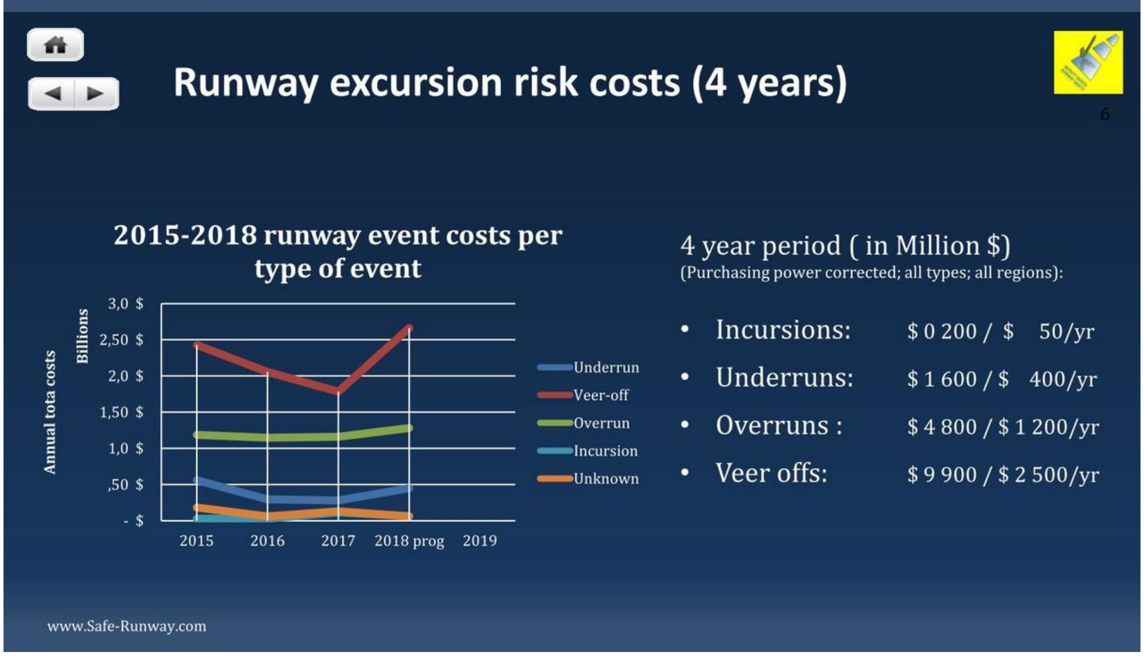

Your flight to paradise…..
Weno –Chuuk international airport, PTKK
Q: Why does an airline operate to an airport well below ICAO standards ?
A Do they perhaps believe that the revenues supersedes the costs of the runway excursion risk?
Q Why does the airport not provide adequate mitigations?
A Did they perhaps believe that mitigation is too expensive?
→ $$$ → express risk also in $
www.Safe-Runway.com


The consequence: Underrun or Overrun at PTKK
Air Niugini
22-09-2018
B 737-800
Destroyed
Accident costs estimated at: $ 102 Million (Purchasing power corrected); 1 fatality
Overrun Recommended RESA or EMAS would have safely stopped the aircraft
Underrun Recommended RESA would have prevented the high damage.
Does accepting continuous none-ICAO adherence justify the additional risk?
www.Safe-Runway.com





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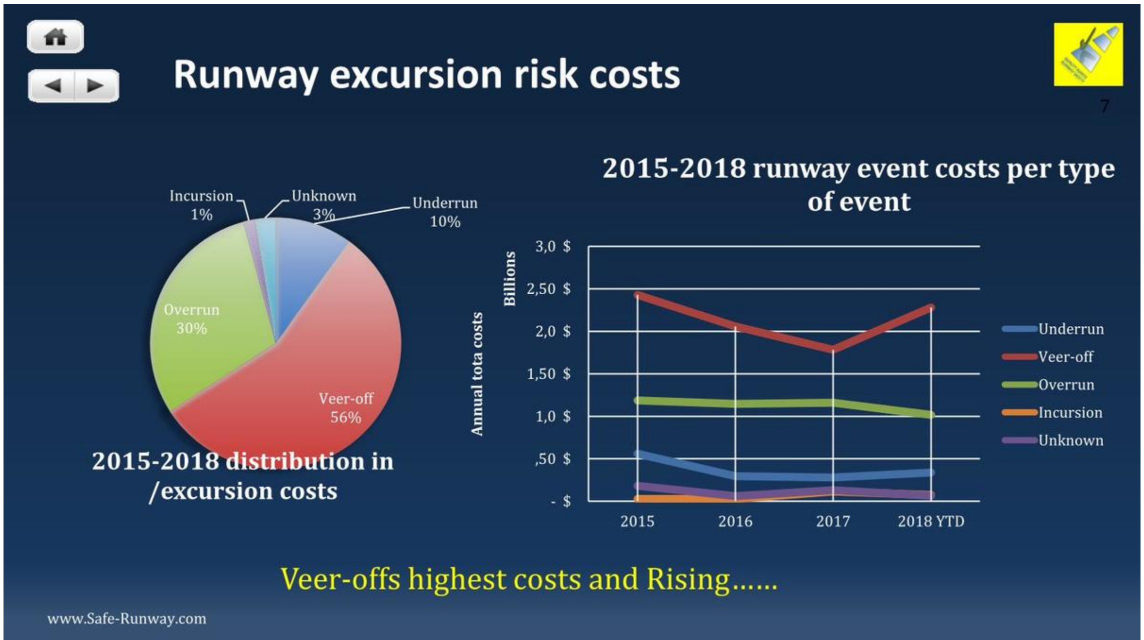

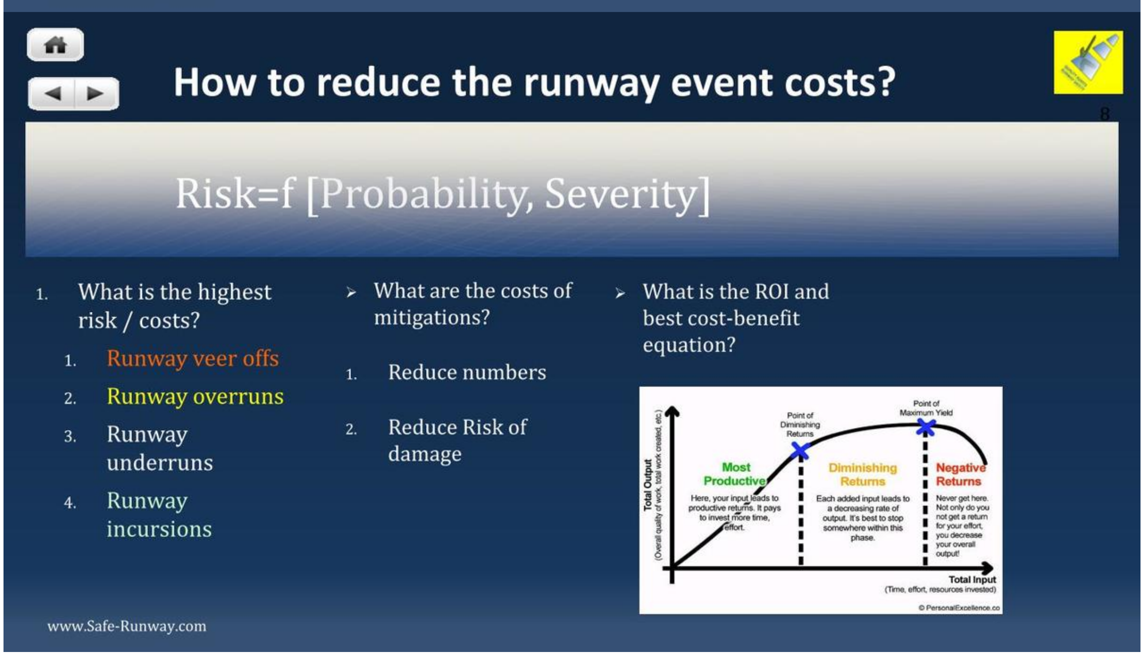

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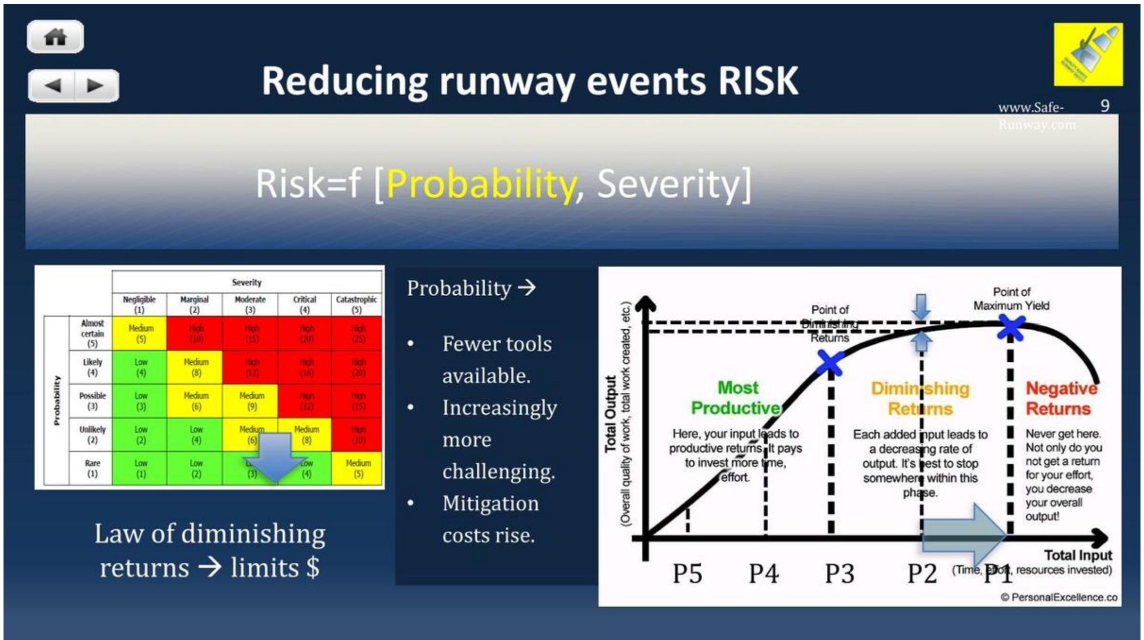

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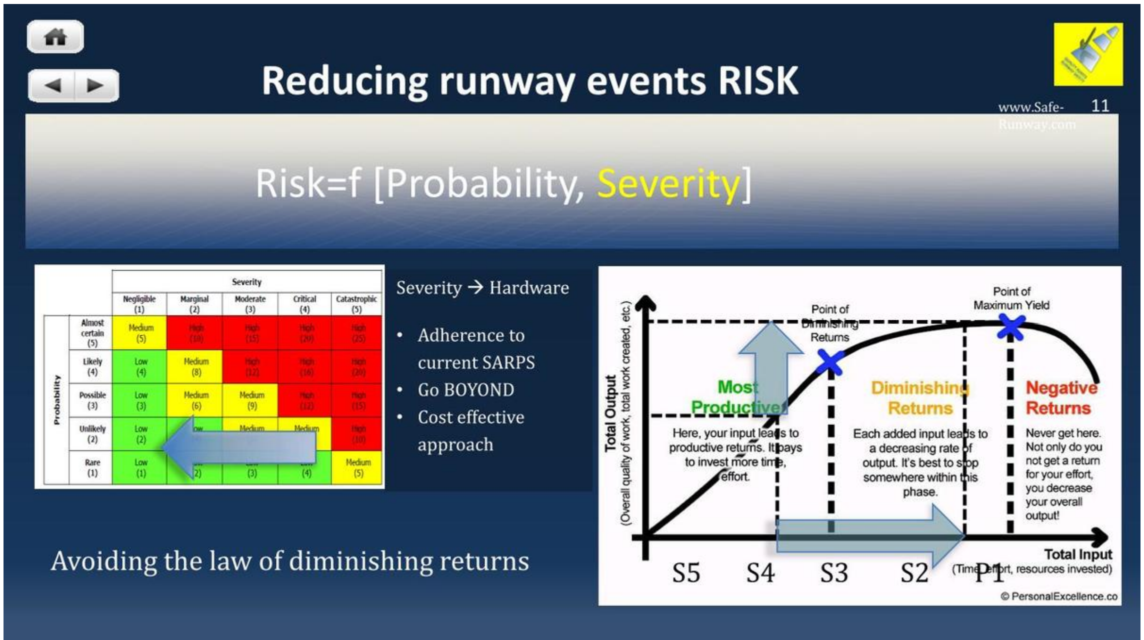
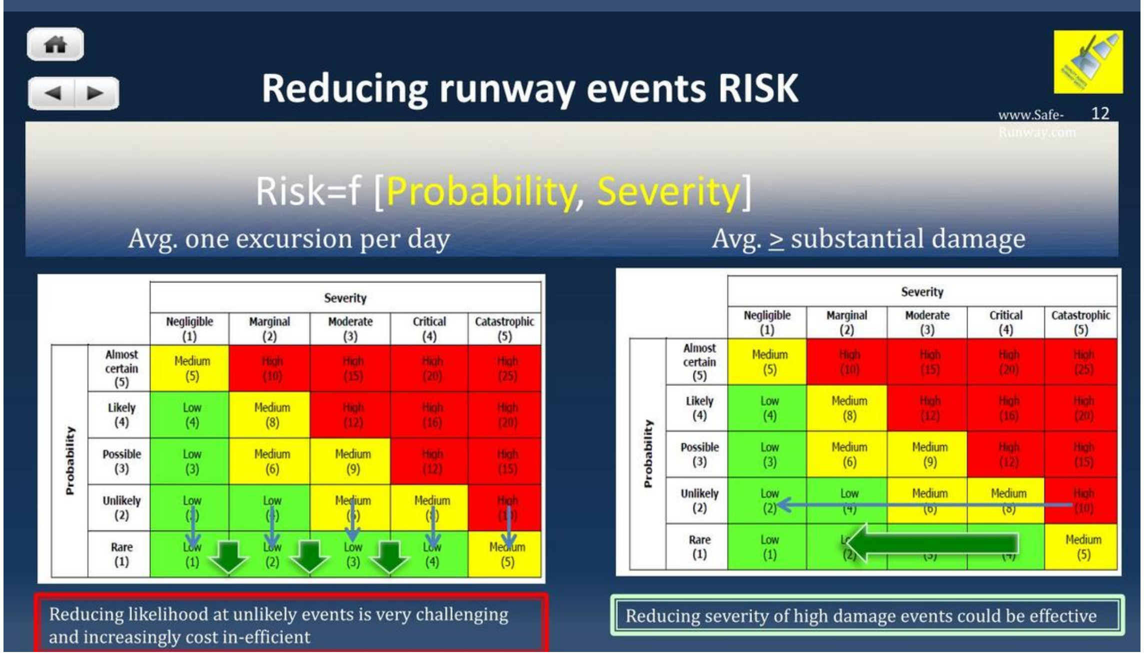
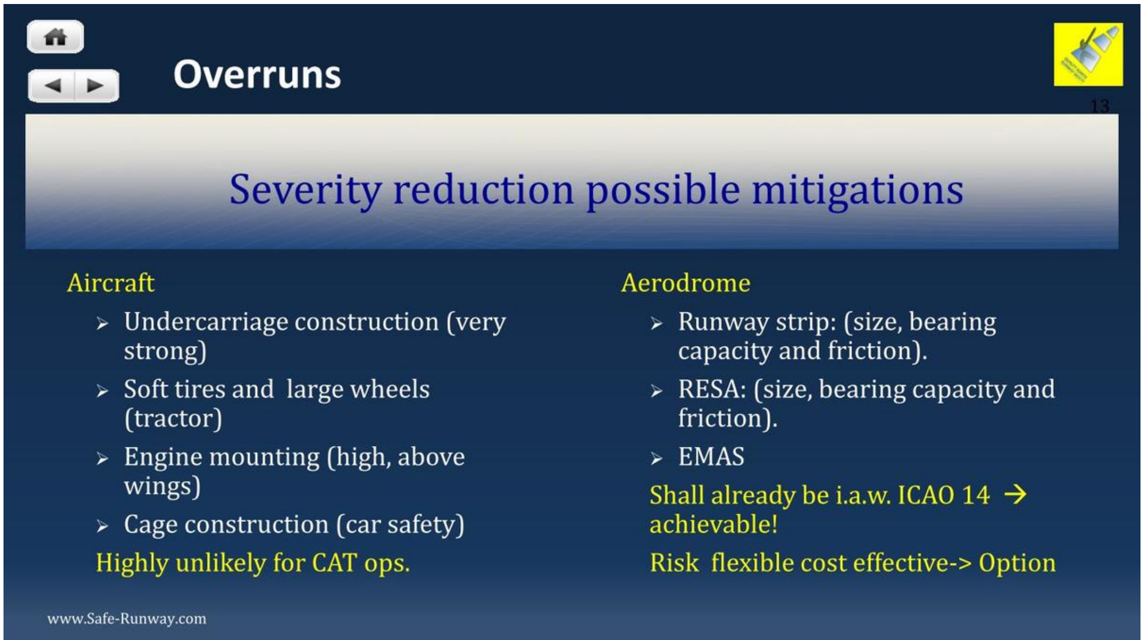
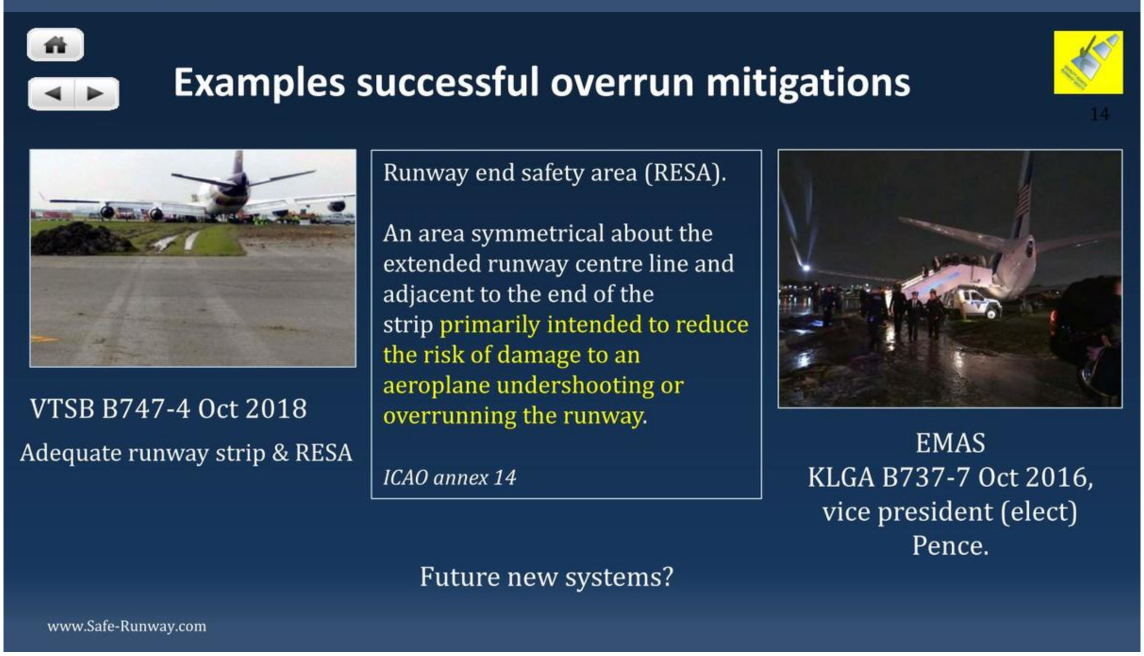
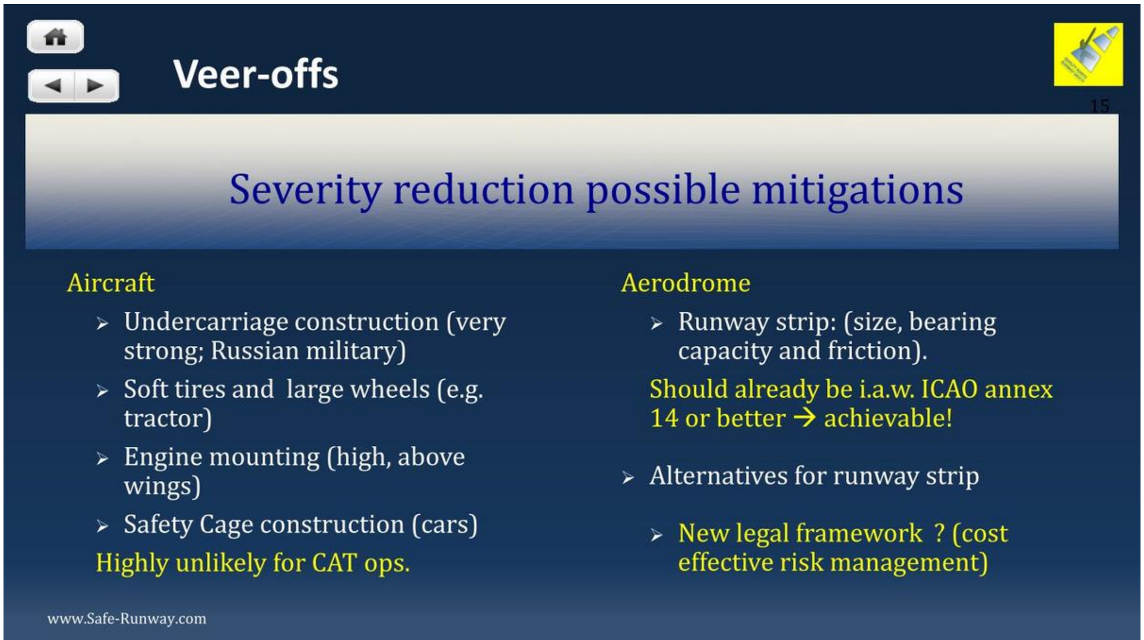
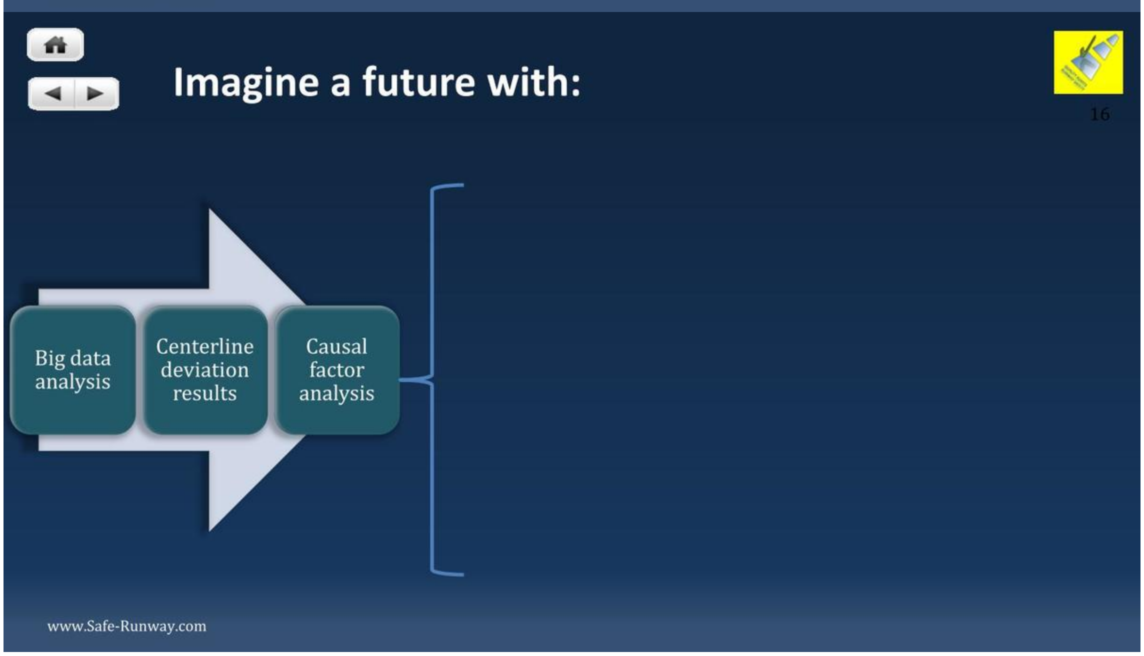

Reducing runway events RISK
www.Safe-Runway.com
11
Risk=f [Probability, Severity]
Severity → Hardware
• Adherence to current SARPS
• Go BOYOND
• Cost effective approach
Avoiding the law of diminishing returns
Point of Diminishing Returns
Point of Maximum Yield
Most Productive
Diminishing Returns
Negative Returns
Here, your input leads to productive returns. It pays to invest more time, effort.
Each added input leads to a decreasing rate of output. It's best to stop somewhere within this phase.
Never get here. Not only do you not get a return for your effort, you decrease your overall output!
Total Output (Overall quality of work, total work created, etc.)
Total Input (Time, effort, resources invested)
S5 S4 S3 S2 P1
© PersonalExcellence.co


Reducing runway events RISK
www.Safe-Runway.com
12
Risk=f [Probability, Severity]
Avg. one excursion per day
Avg. ≥ substantial damage
Severity
Negligible (1)
Marginal (2)
Moderate (3)
Critical (4)
Catastrophic (5)
Probability
Almost certain (5)
Likely (4)
Possible (3)
Unlikely (2)
Rare (1)
Reducing likelihood at unlikely events is very challenging and increasingly cost in-efficient
Reducing severity of high damage events could be effective


Overruns
13
Severity reduction possible mitigations
Aircraft
Undercarriage construction (very strong)
Soft tires and large wheels (tractor)
Engine mounting (high, above wings)
Cage construction (car safety)
Highly unlikely for CAT ops.
Aerodrome
Runway strip: (size, bearing capacity and friction).
RESA: (size, bearing capacity and friction).
EMAS
Shall already be i.a.w. ICAO 14 → achievable!
Risk flexible cost effective-> Option
www.Safe-Runway.com


Examples successful overrun mitigations
14
VTSB B747-4 Oct 2018
Adequate runway strip & RESA
Runway end safety area (RESA).
An area symmetrical about the extended runway centre line and adjacent to the end of the strip primarily intended to reduce the risk of damage to an aeroplane undershooting or overrunning the runway.
ICAO annex 14
EMAS
KLGA B737-7 Oct 2016, vice president (elect) Pence.
Future new systems?
www.Safe-Runway.com





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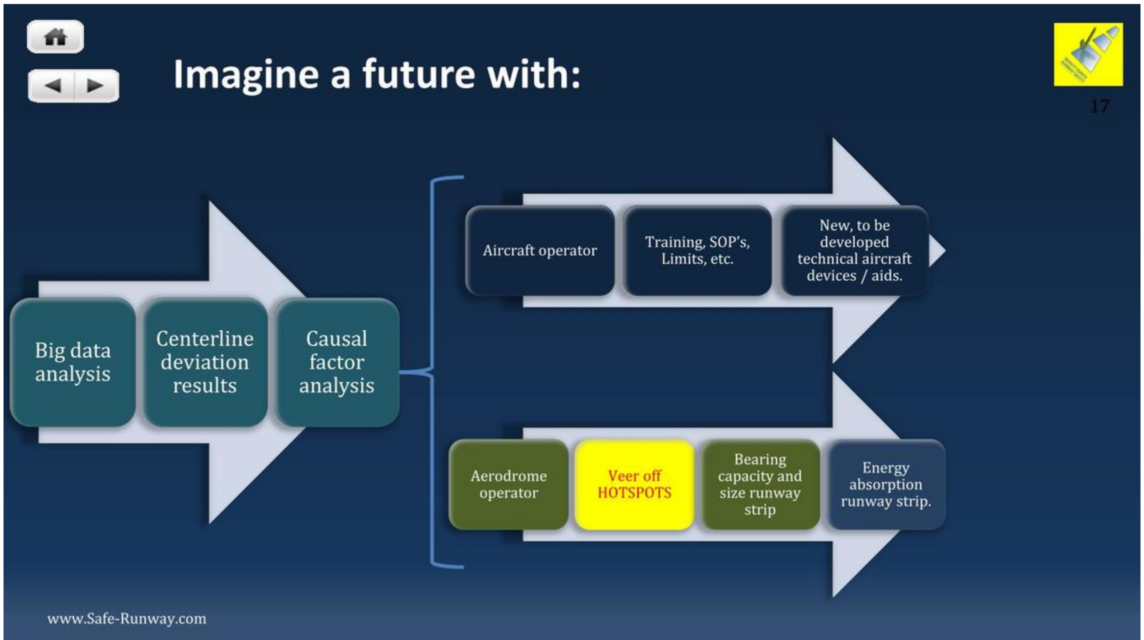

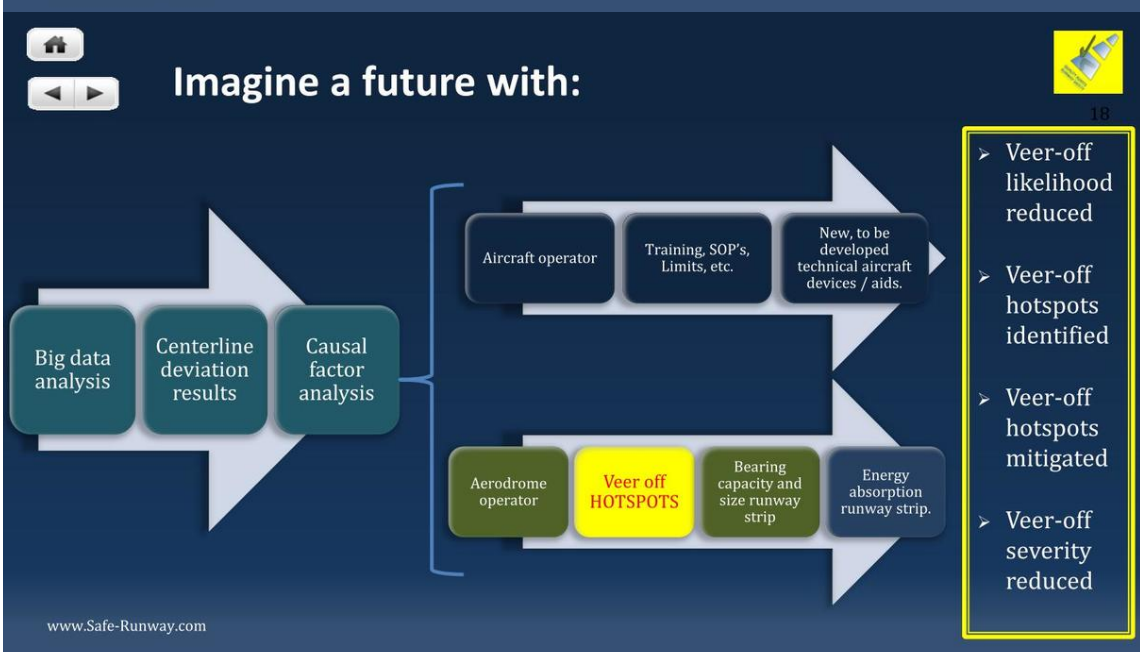

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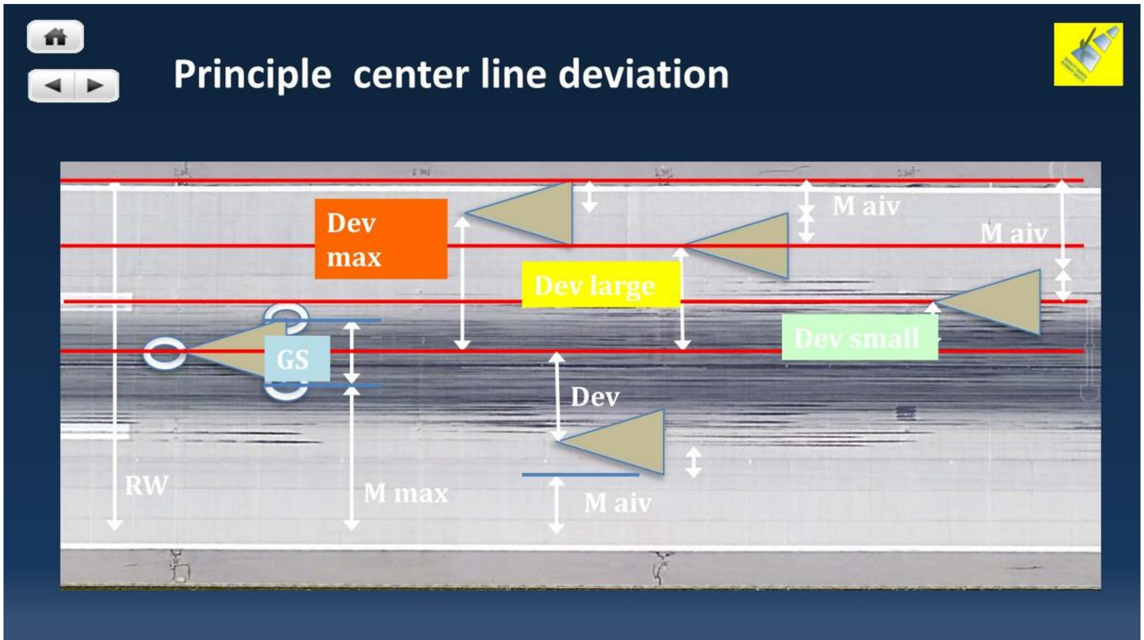

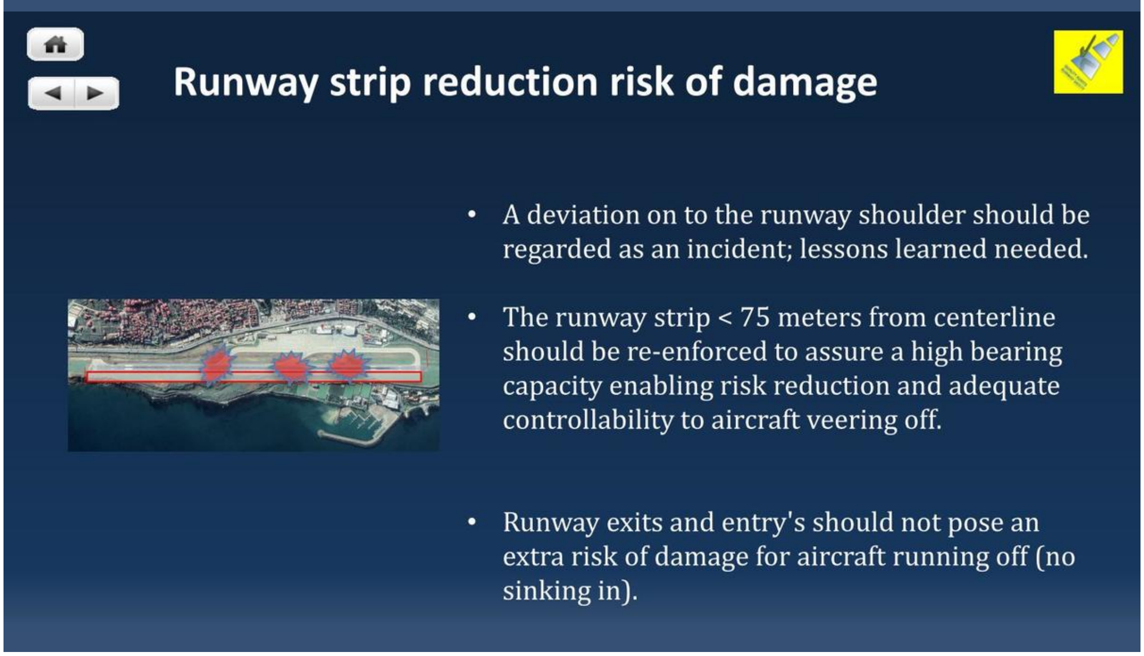

Future Sky Safety has received funding from the EU's Horizon 2020 Research and Innovation Programme, under Grant Agreement No. 640597.

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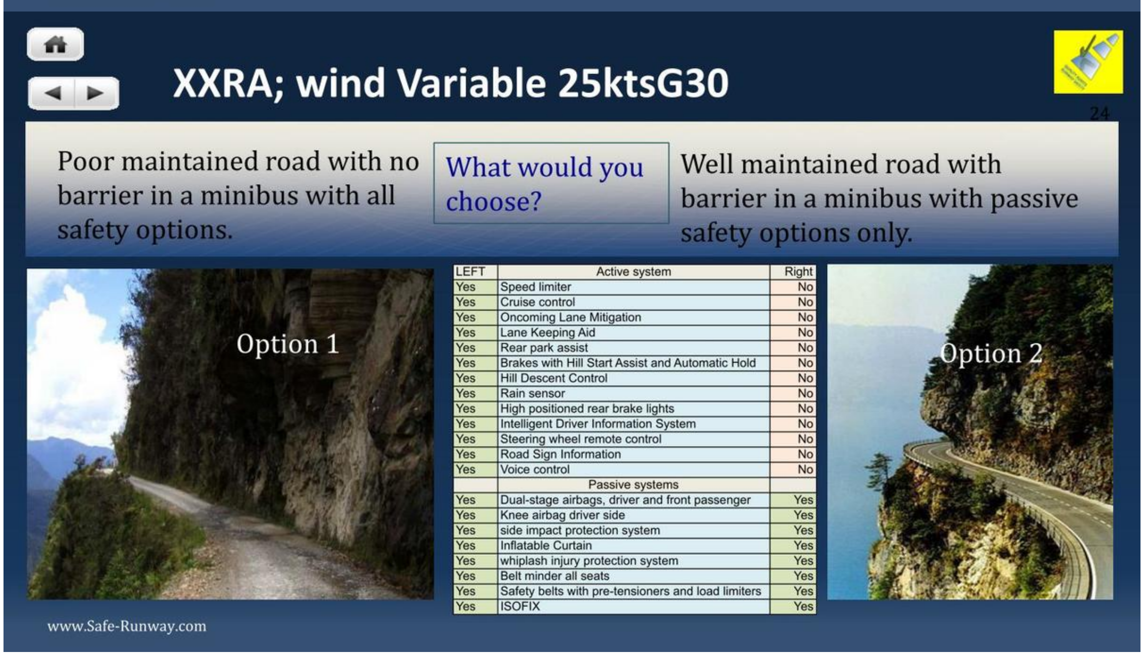

LEFT	Active system	Right
Yes	Speed limiter	No
Yes	Cruise control	No
Yes	Oncoming Lane Mitigation	No
Yes	Lane Keeping Aid	No
Yes	Rear park assist	No
Yes	Brakes with Hill Start Assist and Automatic Hold	No
Yes	Hill Descent Control	No
Yes	Rain sensor	No
Yes	High positioned rear brake lights	No
Yes	Intelligent Driver Information System	No
Yes	Steering wheel remote control	No
Yes	Road Sign Information	No
Yes	Voice control	No
	Passive systems	
Yes	Dual-stage airbags, driver and front passenger	Yes
Yes	Knee airbag driver side	Yes
Yes	side impact protection system	Yes
Yes	Inflatable Curtain	Yes
Yes	whiplash injury protection system	Yes
Yes	Belt minder all seats	Yes
Yes	Safety belts with pre-tensioners and load limiters	Yes
Yes	ISOFIX	Yes

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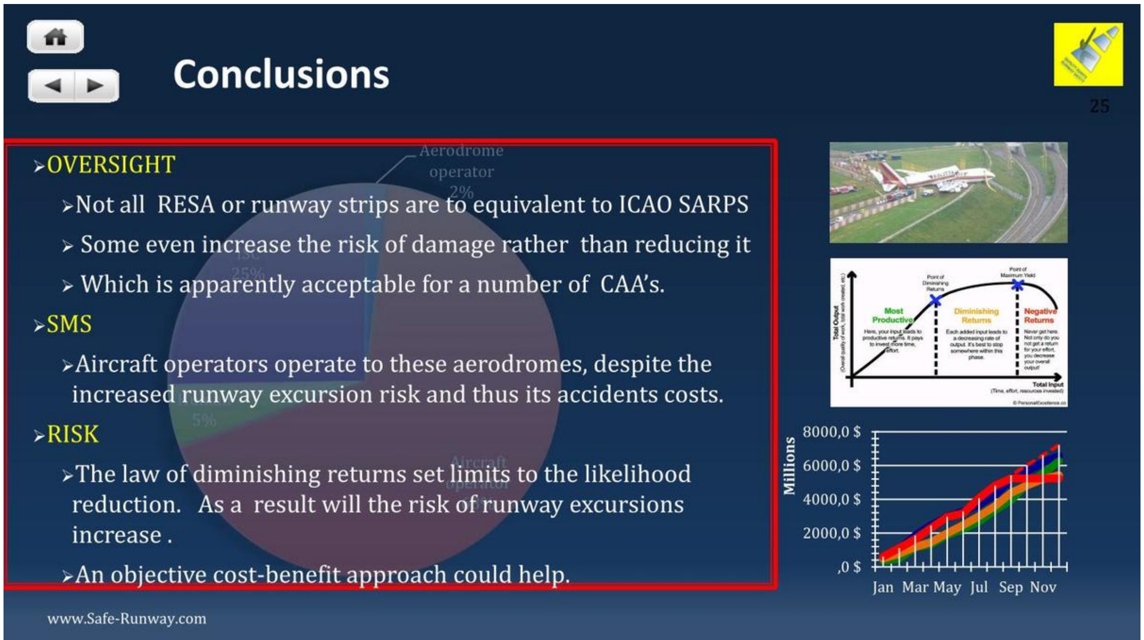

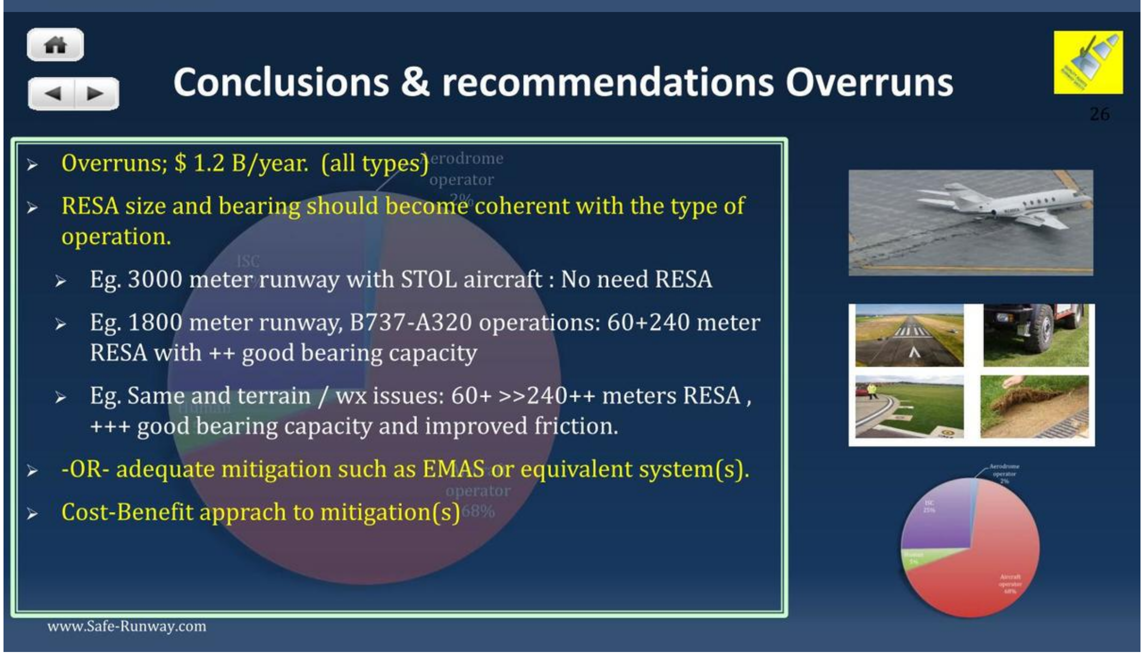

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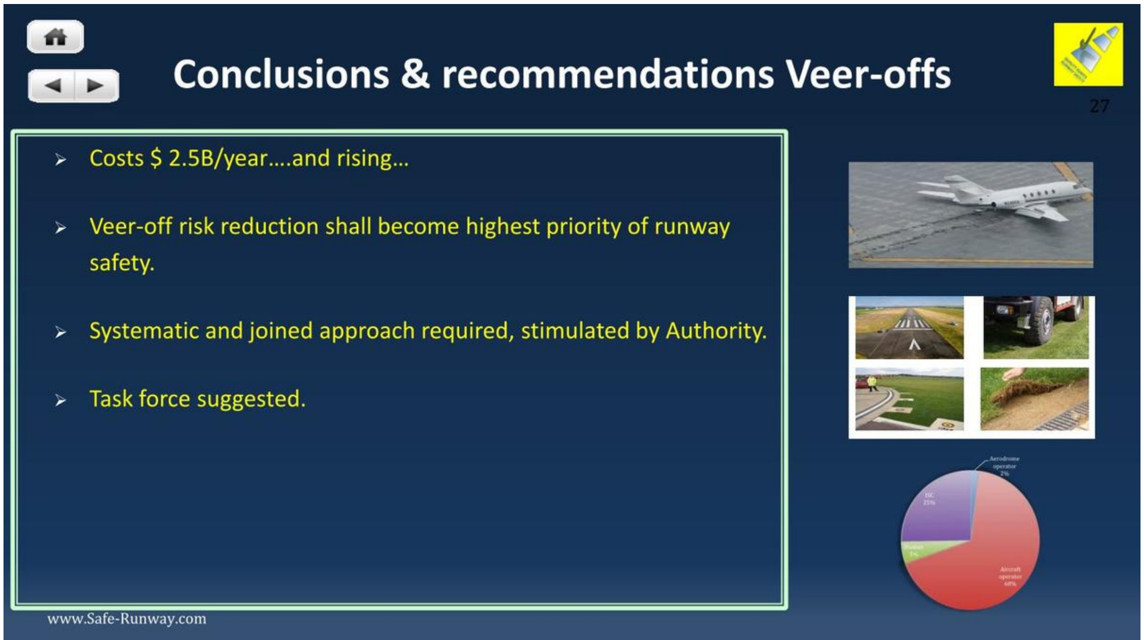

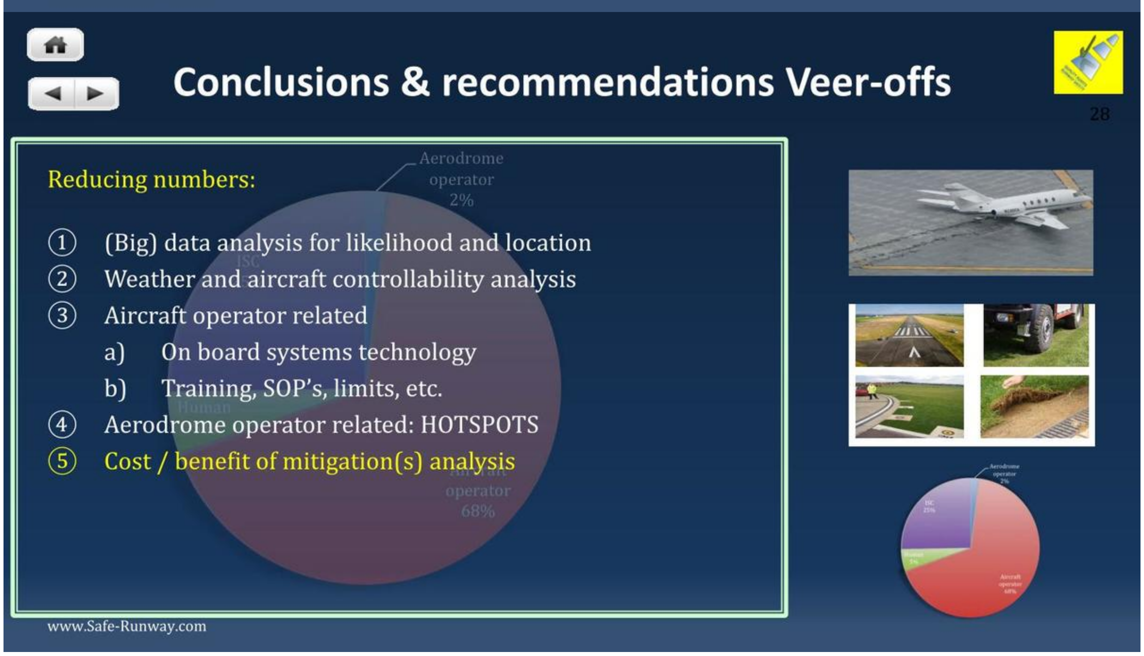

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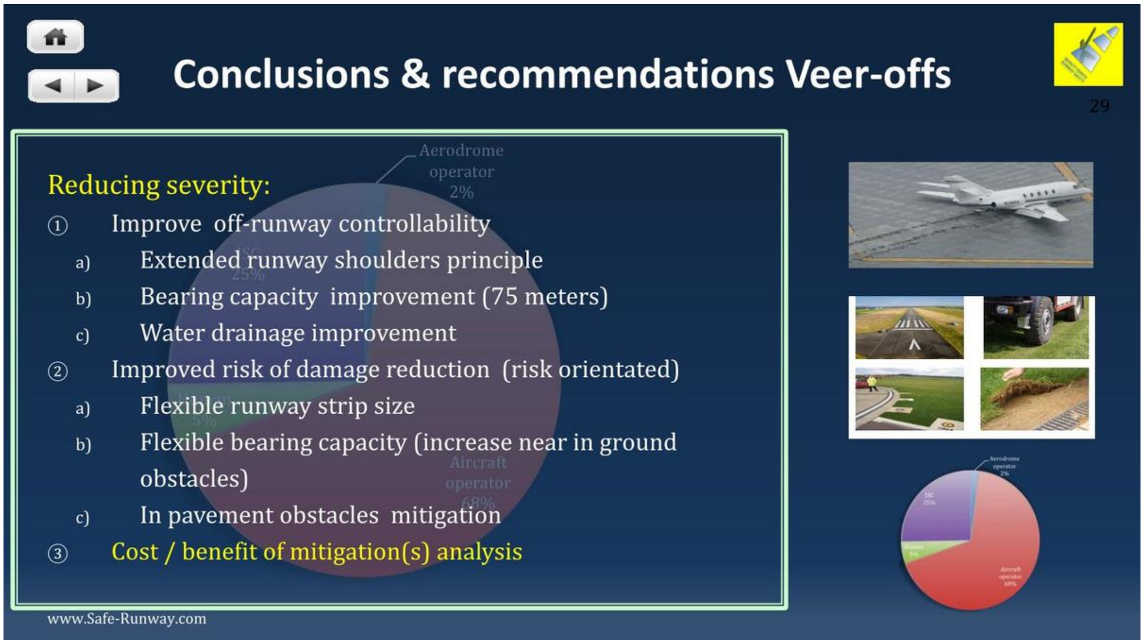
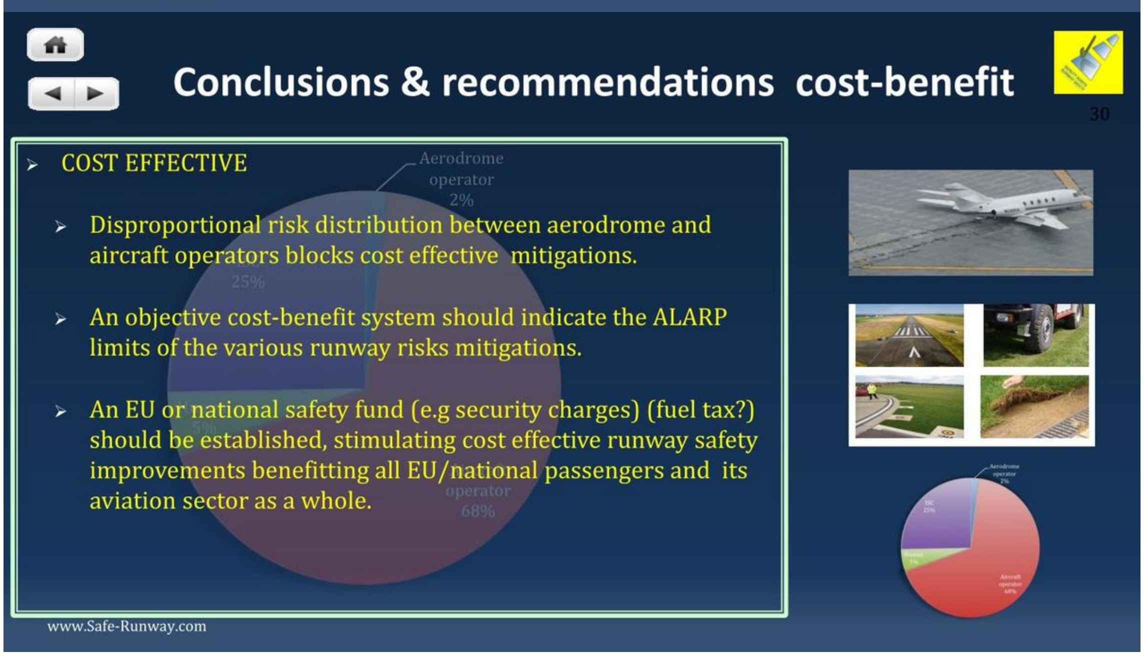
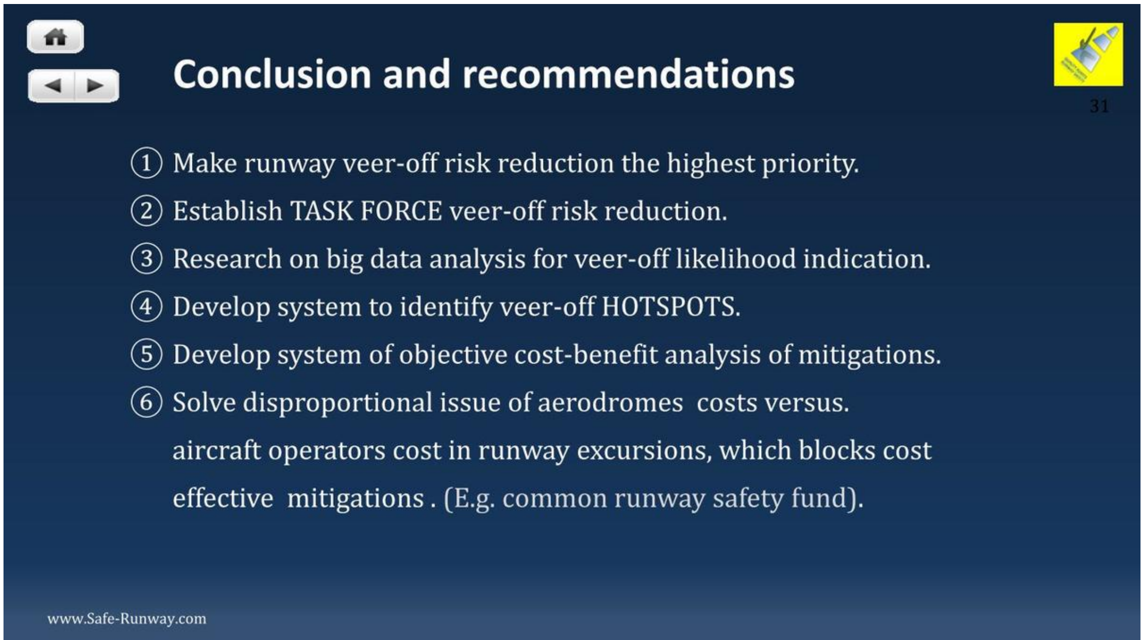




Future Sky Safety has received funding from the EU's Horizon 2020 Research and Innovation Programme, under Grant Agreement No. 640597.



Appendix B.6 “P3: Overview of the project and technical results P3: prevention of runway excursions” – Peter van der Geest, NLR

Future Sky Safety has received funding from the EU’s Horizon 2020 Research and Innovation Programme, under Grant Agreement No. 640597.


FUTURE SKY
SAFETY
European Commission
Overview of the project and technical results P3: prevention of runway excursions
Peter van der Geest, NLR
SAFETY | FUTURE SKY
7 November, 2018


FUTURE SKY
2017, B747-400 at Maastricht Airport
Veeroff during takeoff roll
SAUDIA CARGO

Landing overrun, Milan Bergamo , Aug 5th 2016

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Background

- ❑ European Action Plan Prevention of Runway Excursions provides recommendations to reduce runway excursions in Europe;
- ❑ Action Plan also identified areas were research is needed to further reduce runway excursion risk;
- ❑ Project P3 *Prevention of Runway Excursions* addresses some of these areas.

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Objectives P3

1. Improve methods for analysing aircraft ground control on slippery runways under crosswind;
2. Quantify impact of water/slush covered runways on braking performance for modern tires and anti-skid systems;
3. Develop new methods to identify veer-off risk using operational flight data;
4. Explore new concepts for prevention of excursions and reduction of consequences of runway excursions.

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1. Aircraft ground control on slippery Runways under crosswind

- ❑ Exploration of shortcomings in aircraft ground models;
- ❑ Tests with aircraft tyre on wet/flooded surfaces under yaw;
- ❑ Analysis of aircraft aerodynamics under high side slip angles;
- ❑ Comparison of desktop simulation models with full motion simulators experiments for different crosswind and runway conditions.

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Example: yawed tyre tests

Large test vehicle

Citation main gear tyre

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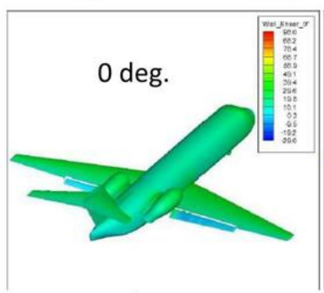
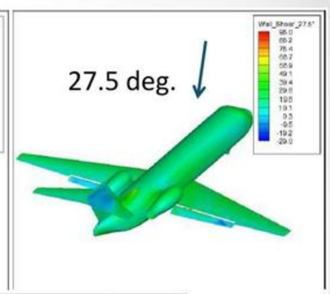
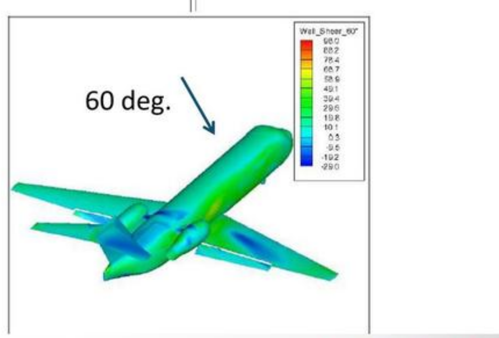
Aerodynamics under high side slip





- ❑ Important for crosswind landings;
- ❑ Mainly simulations;
- ❑ Limited analysis of experimental data.



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Future Sky Safety has received funding from the EU's Horizon 2020 Research and Innovation Programme, under Grant Agreement No. 640597.

2. Braking performance on flooded runways

- Inventory of current knowledge and test data;
- Flight tests conducted on flooded runway with a Citation and A400M aircraft;
- Exploration of improved models for braking performance on flooded runways.

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Tests with Citation and Airbus A400M

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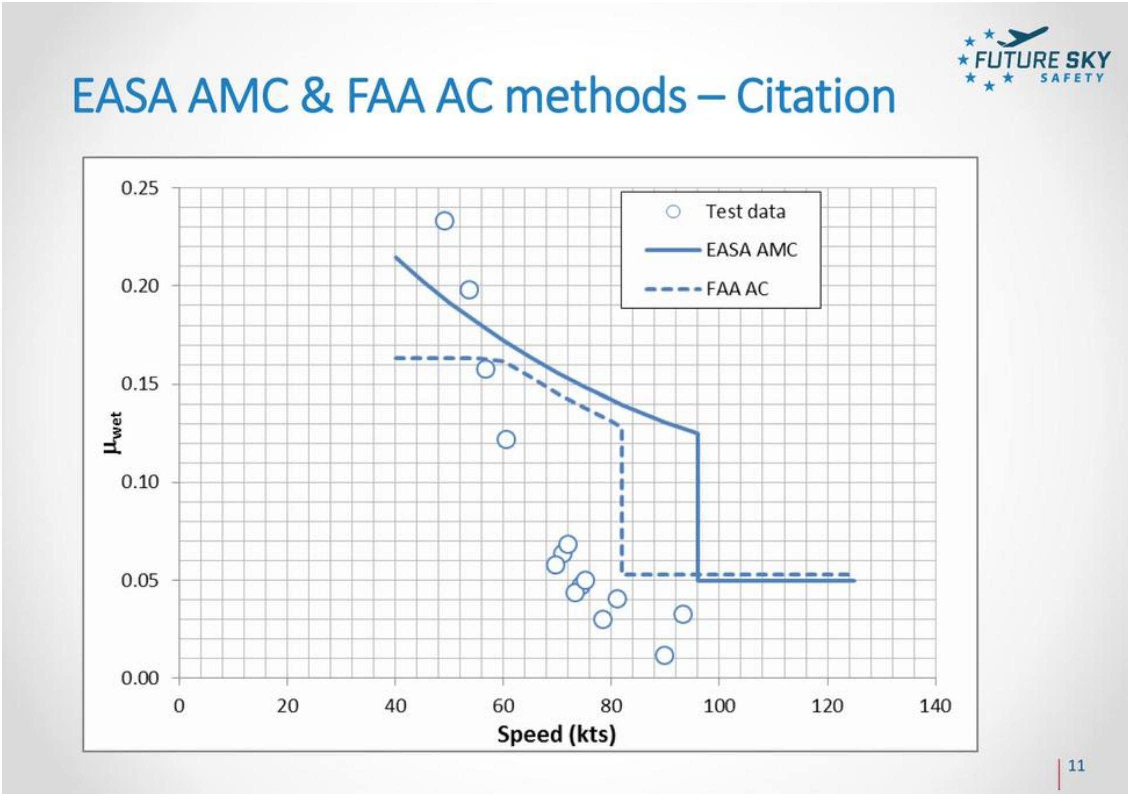
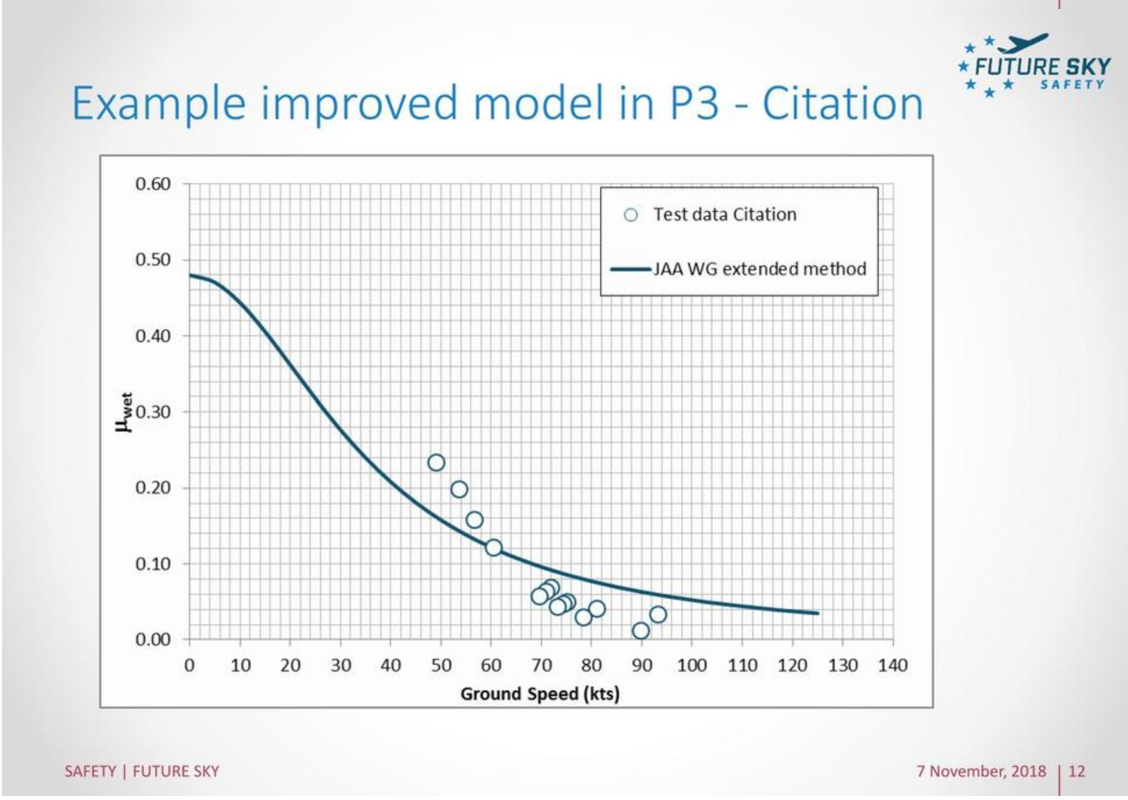

EASA AMC & FAA AC methods – Citation
Test data
EASA AMC
FAA AC
μ_{wet}
0.25
0.20
0.15
0.10
0.05
0.00
0
20
40
60
80
100
120
140
Speed (kts)
11


Example improved model in P3 - Citation
Test data Citation
JAA WG extended method
μ_{wet}
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
Ground Speed (kts)
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3. Methods to identify veer-off risk using operational flight data

- ❑ Analysis of historical veeroff accidents;
- ❑ Development of several algorithms to analyse flight data for runway veeroff risk factors;
- ❑ "Real" operator data used to test developed algorithms;
- ❑ Application of machine learning techniques.
- ❑ FDM workshop: Runway Veeroff Risk Monitoring Tools

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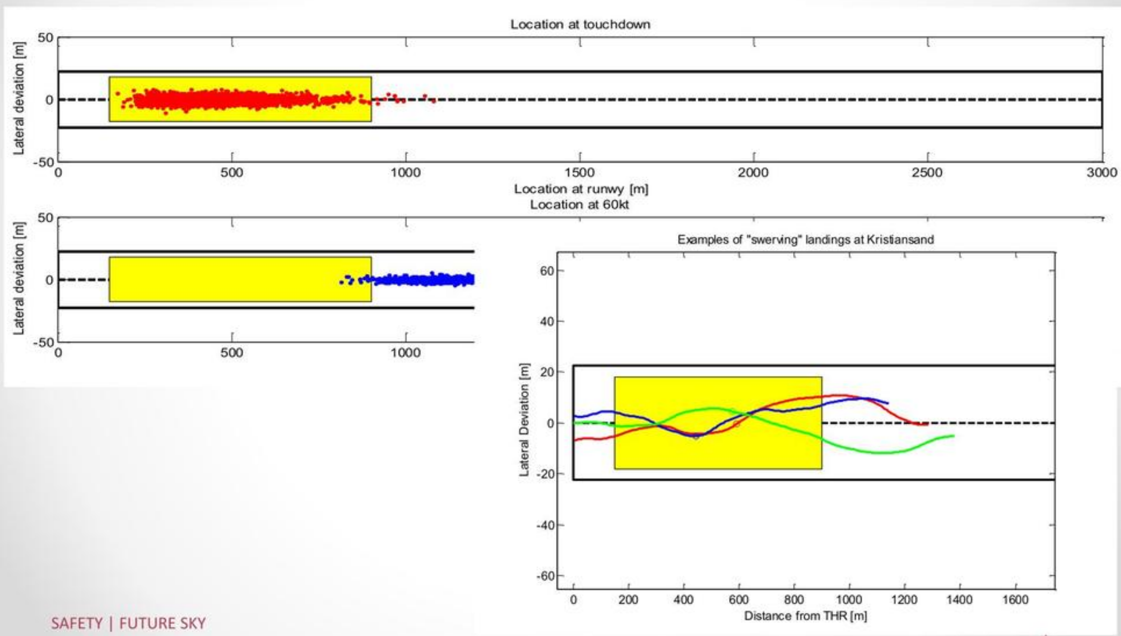
Example: Touchdown dispersion and ground trajectory



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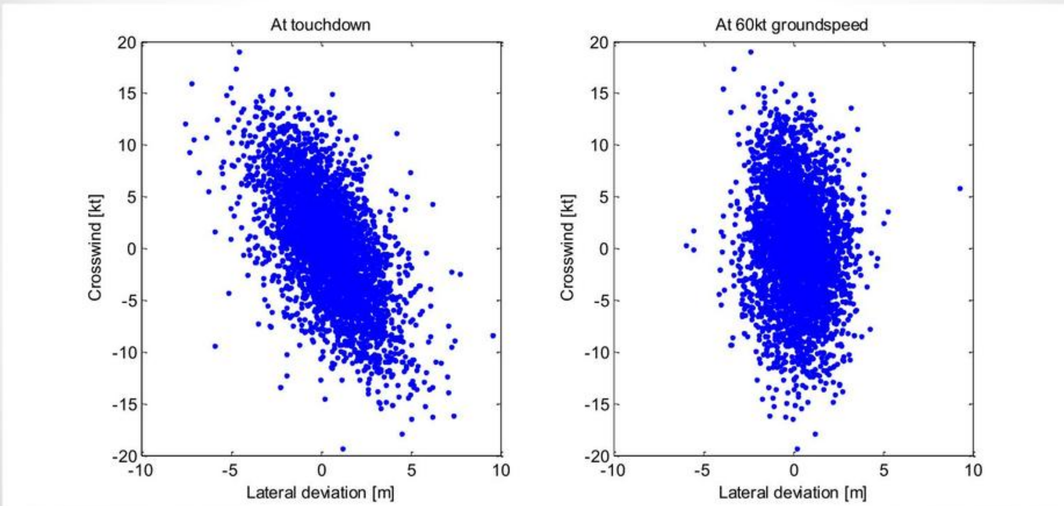
Example: Effect of crosswind on lateral deviation for regional jet



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4. New concepts for excursions risk reduction

- ❑ Inventory of current developments and new initiatives;
- ❑ Feasibility study and definition of R&D needed for implementation of new concepts;
- ❑ Assess impact of the new concepts on reducing excursions.

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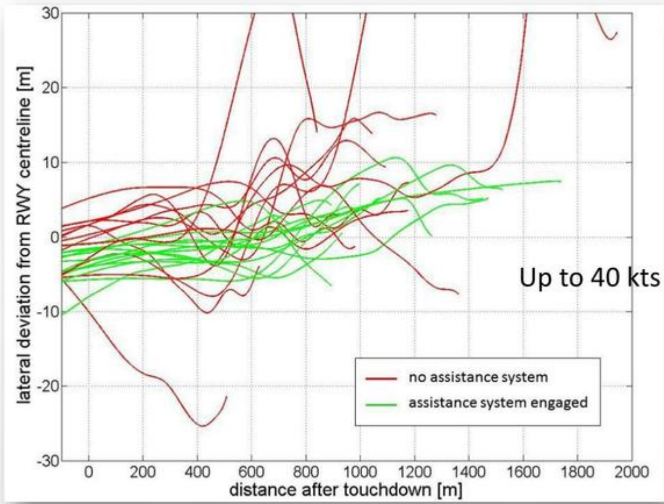
Example result: Crosswind Landing Assistance System" (CLAS)

Steerable main landing gear and CLAS implemented in A320-simulator



Up to 40 kts crosswind

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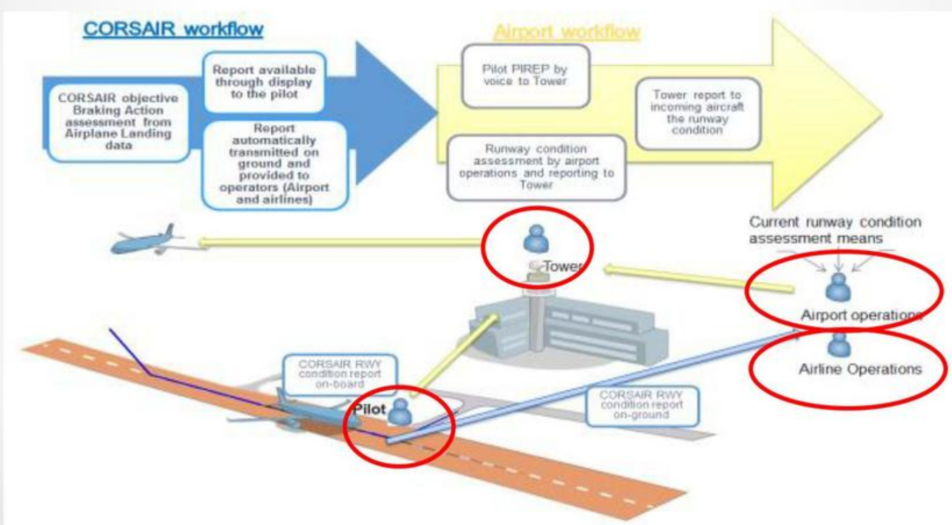
Onboard and aircraft based computation of Braking Action



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P3 in summary

- P3 addressed several elements that will help to reduce runway excursion risk;
- Several results can already be used.

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Questions?

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Appendix B.7 "P3: Contaminated Operations Analysis: Challenges and Opportunities for Large Transport Aircraft" – Sara Lagunas Caballero, Airbus

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Putting things into context

- The characterization of **braking friction** on **water-contaminated** runways is one of the main objectives of Future Sky Safety P3.
- The ulterior target is to provide evidence for updation current AMC 25.1591 curves, used as certification basis for contaminated conditions.
- As part of P3, two analogous test campaigns were carried out on Twenthe Airport (EHTW), in 2016 and 2017.
- Contamination was simulated on a specially constructed 100 m pond facility, filled with water ~ 15 mm depth.
- The following aircraft were used:
  - **2016 Campaign**: Cessna Citation (NLR)
  - **2017 Campaign**: A400M (Airbus D&S and NLR)

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How was it done for Cessna Citation?

- Cessna has a **single row** of tires on the MLG:
  - All tires see the same amount of contaminant.
  - All tires experience similar braking friction reduction.
- It is possible to derive the braking friction coefficient from **global aircraft loads.**

$$\mu_{braking\ a/c} = \mu_{braking\ wheel}$$

$$\mu_{braking} = \frac{F_{braking\ MLG}}{N_{MLG}}$$

  - N_{MLG} derived from normal loads balance.
  - $F_{braking\ MLG}$ derived from **test campaign philosophy:**

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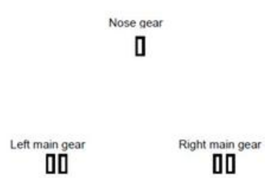
How was it done for Cessna Citation?



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$$\mu_{braking} = \frac{F_{braking\ MLG}}{N_{MLG}}$$

  - N_{MLG} derived from normal loads balance.
  - $F_{braking\ MLG}$ derived from **test campaign philosophy:**

Braked runs: $m.a_{brk} = T - D - D_{conta} - F_{rolling} - F_{braking\ MLG}$
Un-braked runs: $m.a_{ubr} = T - D - D_{conta} - F_{rolling}$

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How was it done for Cessna Citation?

- Cessna has a **single row** of tires on the MLG:
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$$\mu_{brk} = \frac{F_{brk\ MLG}}{N_{MLG}}$$

- N_{MLG} derived from normal loads balance.
- $F_{braking\ MLG}$ derived from **test campaign philosophy:**

Nose gear

Left main gear

Right main gear

Braked runs: $m.a_{brk} = T - D - D_{conta} - F_{rolling} - F_{brk\ MLG}$
Un-braked runs: $m.a_{ubr} = T - D - D_{conta} - F_{rolling}$

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How was it done for Cessna Citation?

- Cessna has a **single row** of tires on the MLG:
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$$\mu_{braking\ a/c} = \mu_{braking\ wheel}$$

$$\mu_{braking} = \frac{F_{braking\ MLG}}{N_{MLG}}$$

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- $F_{braking\ MLG}$ derived from **test campaign philosophy:**

Nose gear

Left main gear

Right main gear

Braked runs: $m.a_{brk} = T - D - D_{conta} - F_{rolling} - F_{braking\ MLG}$
Un-braked runs: $m.a_{ubr} = T - D - D_{conta} - F_{rolling}$

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How was it done for Cessna Citation?

Nose gear

Left main gear

Right main gear

- Cessna has a **single row** of tires on the MLG:
  - All tires see the same amount of contaminant.
  - All tires experience similar braking friction reduction.

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$$\mu_{braking} = \frac{F_{braking\ MLG}}{N_{MLG}}$$

- N_{MLG} derived from normal loads balance.
- $F_{braking\ MLG}$ derived from **test campaign philosophy:**

- Braked runs: $m.a_{brk} = T - D - D_{conta} - F_{rolling} - F_{braking\ MLG}$
- Un-braked runs: $m.a_{ubr} = T - D - D_{conta} - F_{rolling}$

$$\boxed{F_{braking\ MLG} = m.a_{ubr} - m.a_{brk}}$$

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What about A400M?

Nose gear

Left main gear

Right main gear

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What about A400M?

Nose gear

Left main gear

Right main gear

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What about A400M?

Nose gear

Left main gear

Right main gear

Nose gear

Left main gear

Right main gear

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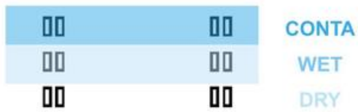
What about A400M?

- A400M has **three rows** of tires on the MLG:
  - Each row sees **a different amount** of contaminant.

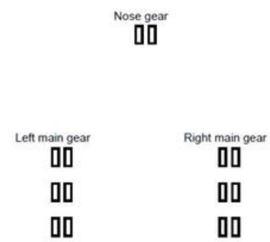


  - Each row experiences **a different** braking friction reduction.
- It is **NOT** possible to derive the braking friction coefficient from **global aircraft loads**

$$\mu_{brk\ a/c} \neq \mu_{brk\ wheel}$$

$$\mu_{brk\ wheel\ front} \neq \mu_{brk\ wheel\ mid} \neq \mu_{brk\ wheel\ aft}$$

- The interest is to obtain $\mu_{brk\ wheel\ front}$ (first row).



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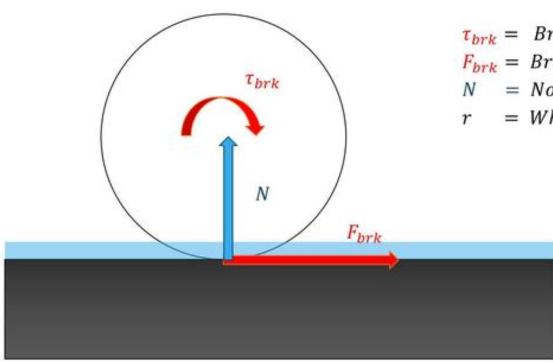
A400M: Challenge

- It is not useful to work with an horizontal loads balance **aircraft** level → **Need for a new methodology**
- **Proposal:** Work at **tire** level, applying **torque** balance around wheel axis.



τ_{brk} = *Braking Torque*
F_{brk} = *Braking Force*
N = *Normal Reaction*
r = *Wheel Radius*

$$\left.\begin{aligned} \tau_{brk} &= F_{brk}\cdot r \\ F_{brk} &= \mu_{brk}\cdot N \end{aligned}\right\} \quad \boxed{\mu_{brk} = \frac{\tau_{brk}}{r.N}}$$

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A400M: Challenge

- It is not useful to work with an horizontal loads balance **aircraft** level → **Need for a new methodology**
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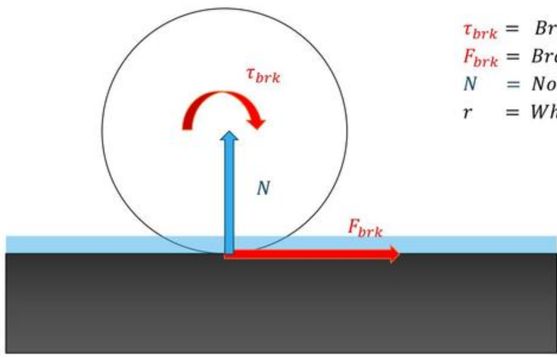

τ_{brk} = Braking Torque
F_{brk} = Braking Force
N = Normal Reaction
r = Wheel Radius

$$\left.\begin{aligned}\tau_{brk} &= F_{brk}\,.\,r\\ F_{brk} &= \mu_{brk}\,.\,N\end{aligned}\right\} \boxed{\mu_{brk} = \frac{\tau_{brk}}{r.N}}$$

Is this possible?

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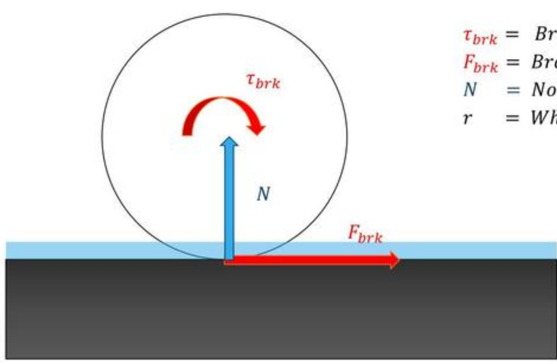
A400M: Challenge

- It is not useful to work with an horizontal loads balance **aircraft** level → **Need for a new methodology**
- **Proposal:** Work at **tire** level, applying **torque** balance around wheel axis.



τ_{brk} = Braking Torque
F_{brk} = Braking Force
N = Normal Reaction
r = Wheel Radius

$$\left.\begin{aligned}\tau_{brk} &= F_{brk}\,.\,r\\ F_{brk} &= \mu_{brk}\,.\,N\end{aligned}\right\} \boxed{\mu_{brk} = \frac{\tau_{brk}}{r.N}}$$

Is this possible?
YES

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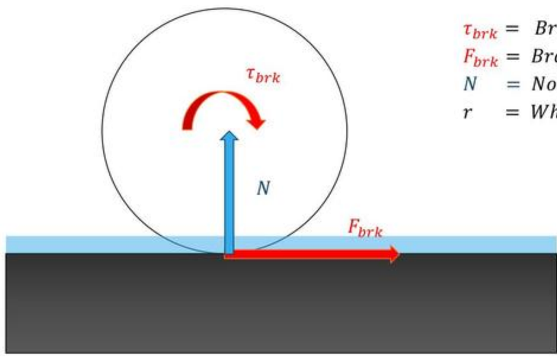
A400M: Opportunity 1 – Fully Instrumented Aircraft

- For the test campaign, a **fully instrumented** test aircraft was used.
- As a results, **individual measurements** of the required parameters were available for **all tires.**



$\tau_{brk} = Braking\ Torque$ → 128 Hz
$F_{brk} = Braking\ Force$ → 128 Hz
$N = Normal\ Reaction$ → 128 Hz
$r = Wheel\ Radius$

$$\left.\begin{array}{l}\tau_{brk} = F_{brk} \cdot r \\ F_{brk} = \mu_{brk} \cdot N\end{array}\right\} \boxed{\mu_{brk} = \frac{\tau_{brk}}{r \cdot N}}$$

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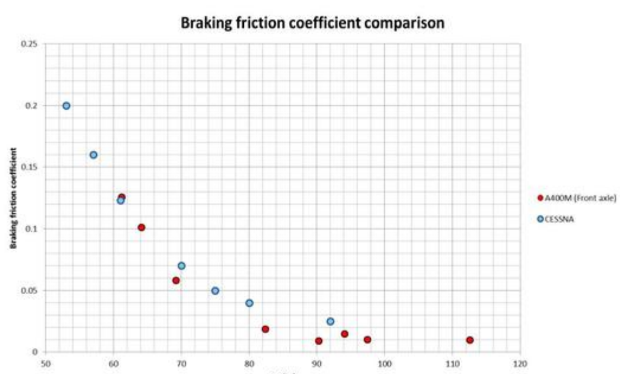
A400M: Opportunity 1 – Fully Instrumented Aircraft

- It has been possible to characterize $\mu_{brk} = f(GS)$ at **front wheel** level on highly contaminated (15 mm water) conditions.
  - Results show strong alignment with previous Cessna tests.
- Additionally, the combination of **"analysis by wheel"** methodology and **fully instrumented aircraft** has led to **further opportunities:**
  - Assessment of **inhomogeneities**.
  - Characterization of **aquaplaning speed**.
  - Characterization of **displacement drag**.



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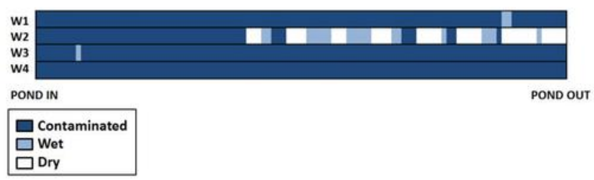
A400M: Opportunity 2 – Assessment of inhomogeneities

- Tests were performed on **artificially contaminated** conditions (pond where contaminant depth showed reasonable homogeneity).
- Nevertheless, **naturally contaminated** runways are, in general, inhomogeneous.



- Analysis by wheel (supported, of couse, by a fully instrumented aircraft) allow to tackle these (and other) inhomogeneities, and lead to a **more comprehensive outcome.**

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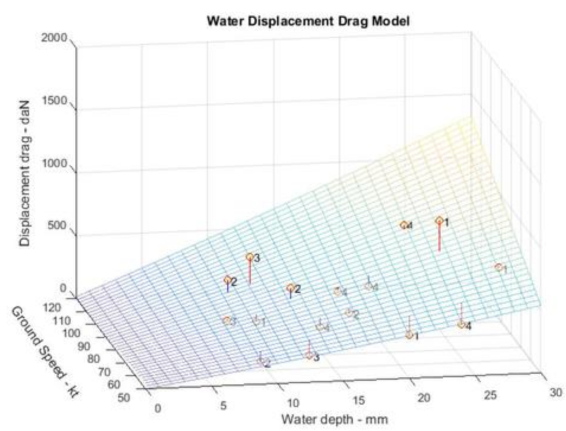
A400M: Opportunity 3 – Characterization of Displacement Drag

- Results from unbraked runs allowed to develop a **regression** model of Displacement Drag as a function of:
  - Ground Speed (GS).
  - Contaminant depth.
- The use of depth as a regression variable has been possible thanks to **individual wheel instrumentarion**.



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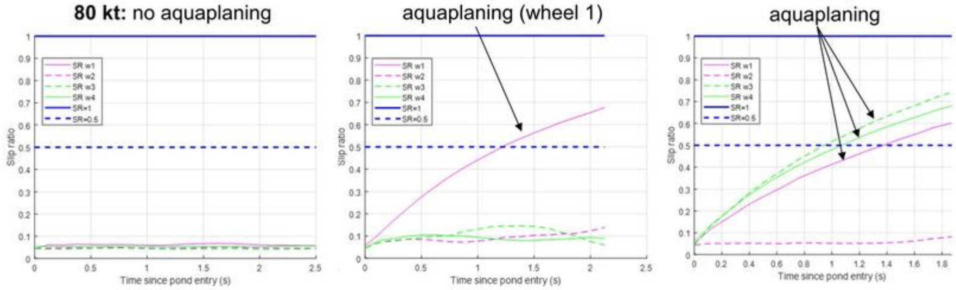
A400M: Opportunity 4 – Characterization of Aquaplaning

- Individual instrumentation on all wheels allowed to study the evolution of **aquaplaning,** as well as a more precise acotation of **aquaplaning speed**.
- The following graphs show the evolution of slip ratio $\left(1 - \frac{wheel\ speed}{GS}\right)$ with GS for A400M front wheels (w1 to w4)
  - Slip ratio > 0.5 indicates aquaplaning

80 kt: no aquaplaning

90 kt: incipient aquaplaning (wheel 1)

100 kt: fully developed aquaplaning



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So… what comes next?

Possible Areas of Future Work & Collaboration

- The results obtained in this test campaing are **indicative**, but by no means robust for a consistent change in the certification basis.
- A great stress has been placed on the assessment of braking friction. Nevertheless, a realistic assessment of retarding force should also include an appropriate characterization of **contaminant drag.**
- A strong need for **further testing** has been identifying, using:
  - Longer pond facilities (~ 500 m), which allow for more representative braking times.
  - **Naturally contaminated conditions:** essential for a realistic assessment.
- The use of a **fully instrumented** aircraft, equipped with a **multi-row** landing gear, is **crucial** for the success of **future** campaigns:
  - It allows for both wheel-level and aircraft-level assessment.
  - It permits results generalization for all undercarriage configurations.
  - It leads to more accurate estimations of displacement drag and aquaplaning speed.

Tuesday, November 6, 2018 20

AIRBUS DEFENCE & SPACE

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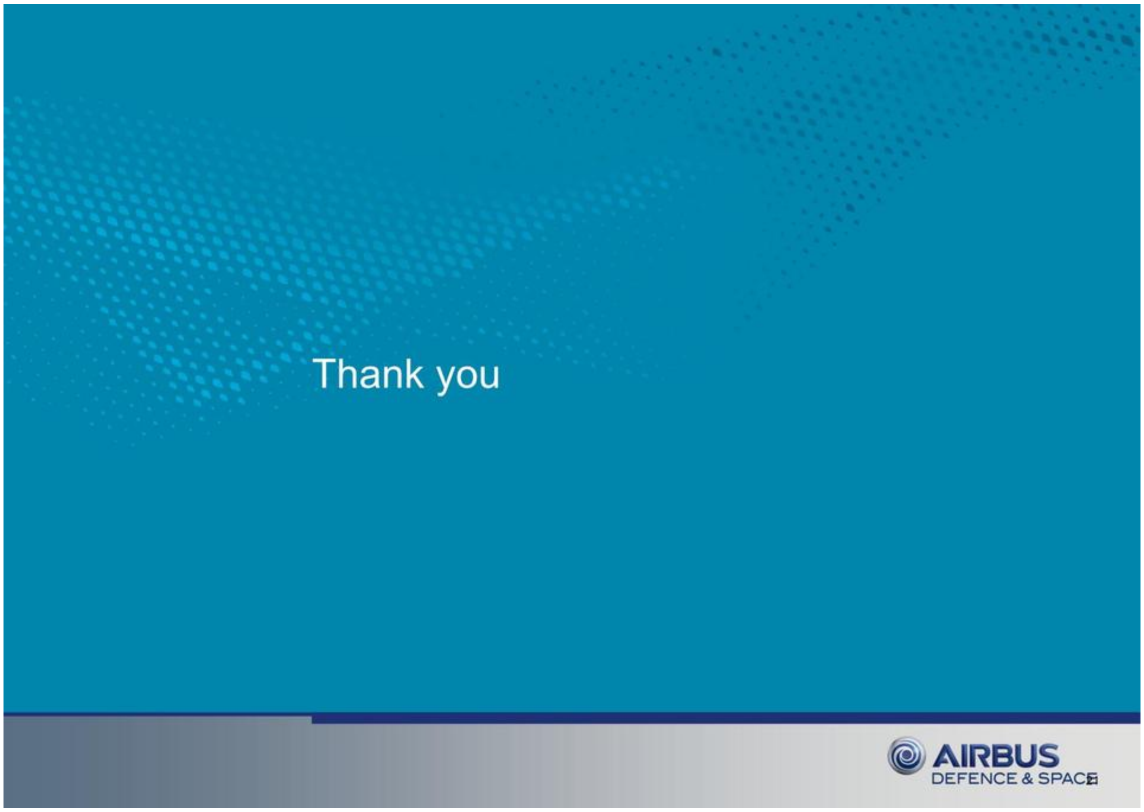
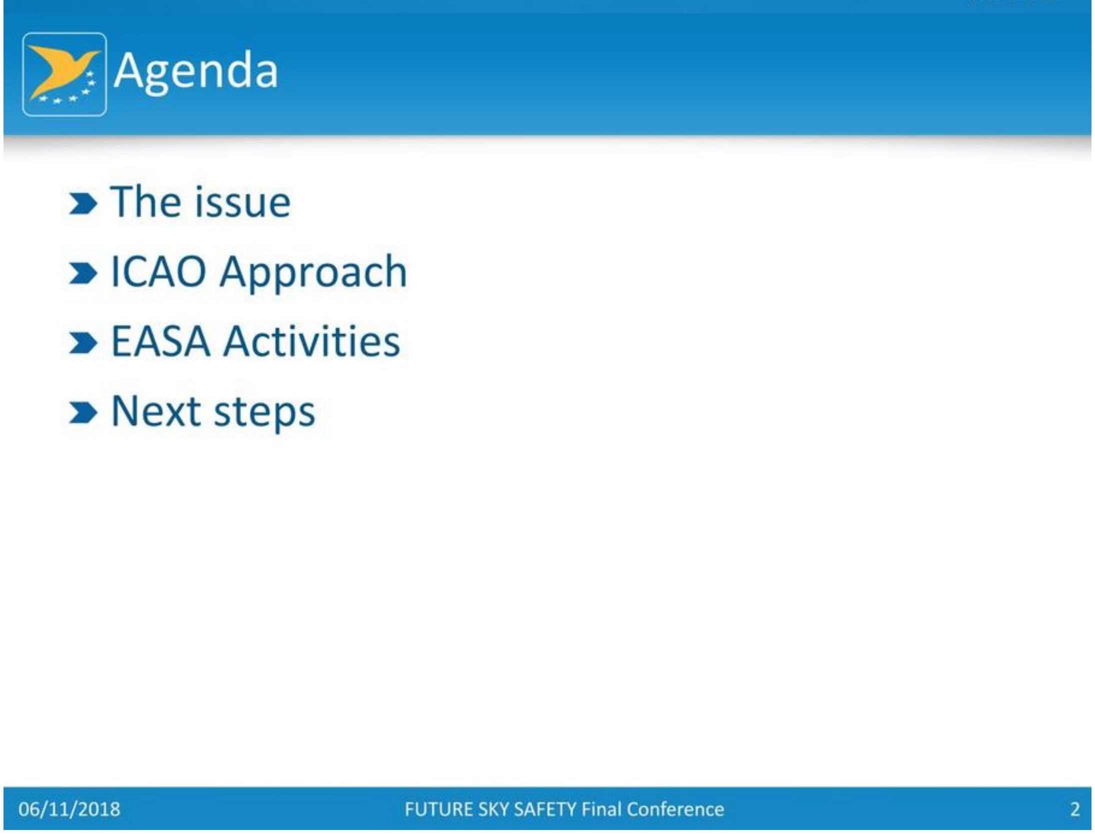


Appendix B.8 "P3: Managing the risk of runway excursionsh" – Vasileios Stefanioros, EASA

Future Sky Safety has received funding from the EU's Horizon 2020 Research and Innovation Programme, under Grant Agreement No. 640597.



Future Sky Safety has received funding from the EU’s Horizon 2020 Research and Innovation Programme, under Grant Agreement No. 640597.

The issue

- Southwest Airlines Flight 1248, 8/12/2005
- NTSB recommendation to FAA
  - *"Develop and issue formal guidance regarding standards and guidelines for the development, delivery and interpretation of runway surface condition reports (A-07-62)"*
- FAA initiated the Take-off and Landing Performance Assessment Advisory and Rulemaking Committee (TALPA ARC)

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The issue

- Information on RWY surface condition
  - Subjective and based on individual
  - No standardized method of reporting
  - No actual relation with aeroplane performance data
  - Measurements of friction on contaminated runways by CFME unreliable

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ICAO Approach

- ICAO Friction Task Force (FTF) took over TALPA ARC recommendations and developed the Global Reporting Format (GRF)
  - Amendment 13-B to ICAO Annex 14
  - Amendment 1 to ICAO Doc 9981 "PANS-Aerodromes"
  - Amendments to ICAO Annexes 3, 4, 6, 9, 10, 11, 15, PANS-ATM, PANS-OPS, PANS-ABC
- GRF will be applicable on 5 November 2020

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ICAO Approach

Table II-1-5. Runway condition assessment matrix (RCAM)

Runway condition assessment matrix (RCAM)			
Assessment criteria		Downgrade assessment criteria	
Runway condition code	Runway surface description	Aeroplane deceleration or directional control observation	Pilot report of runway braking action
6	• DRY	—	—
5	• FROST • WET (The runway surface is covered by any visible dampness or water up to and including 3 mm depth) *Up to and including 3 mm depth:* • SLUSH • DRY SNOW • WET SNOW	Braking deceleration is normal for the wheel braking effort applied AND directional control is normal.	GOOD
4	*−15ºC and Lower outside air temperature:* • COMPACTED SNOW	Braking deceleration OR directional control is between Good and Medium.	GOOD TO MEDIUM
3	• WET ("slippery wet" runway) • DRY SNOW or WET SNOW (any depth) ON TOP OF COMPACTED SNOW *More than 3 mm depth:* • DRY SNOW • WET SNOW *Higher than −15ºC outside air temperature*[1]*:* • COMPACTED SNOW	Braking deceleration is noticeably reduced for the wheel braking effort applied OR directional control is noticeably reduced.	MEDIUM
2	*More than 3 mm depth of water or slush:* • STANDING WATER • SLUSH	Braking deceleration OR directional control is between Medium and Poor.	MEDIUM TO POOR
1	• ICE [2]	Braking deceleration is significantly reduced for the wheel braking effort applied OR directional control is significantly reduced.	POOR
0	• WET ICE [2] • WATER ON TOP OF COMPACTED SNOW [2] • DRY SNOW or WET SNOW ON TOP OF ICE [2]	Braking deceleration is minimal to non-existent for the wheel braking effort applied OR directional control is uncertain.	LESS THAN POOR

- RCAM
  - Basis for assessment and reporting
  - Used by both runway assessors and flight crews
  - Provides a 'common language'

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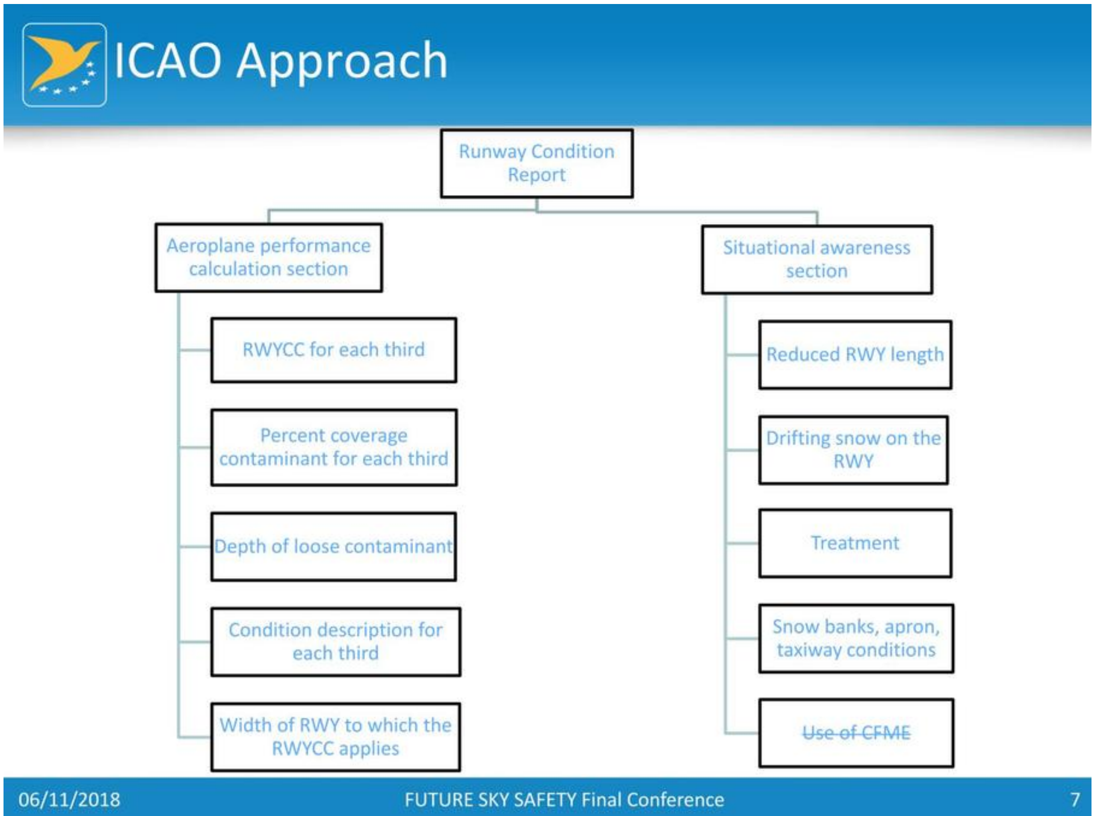
ICAO Approach
Runway Condition Report
Aeroplane performance calculation section
RWYCC for each third
Percent coverage contaminant for each third
Depth of loose contaminant
Condition description for each third
Width of RWY to which the RWYCC applies
Situational awareness section
Reduced RWY length
Drifting snow on the RWY
Treatment
Snow banks, apron, taxiway conditions
~~Use of CFME~~
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EASA Activities
EASA
THE EUROPEAN PLAN for AVIATION SAFETY (EPAS)
2018-2022
European Plan for Aviation Safety EPAS 2018–2022
Safety
5.3.2 Runway safety
Issue/rationale
This section deals both with Runway Excursions and Runway Collisions and is a strategic priority.
According to the definition provided by ICAO, an RE is a veer or overrun off the runway surface. RE events can happen during take-off or landing.. They account for 13% of the fatal accidents in CAT aeroplane operations involving airline/cargo operations in the past decade. This includes materialised runway excursions, both high and low speed and occurrences where the flight crew had difficulties maintaining the directional control of the aircraft or of the braking action during landing, where the landing occurred long, fast, off-centred or hard, or where the aircraft had technical problems with the landing gear (not locked, not extended or collapsed) during landing.
An Runway Incursions refers to the incorrect presence of an aircraft, vehicle or person on an active runway or in its areas of protection. Their accident outcome, runway collisions have been the outcome in 1% of fatal accidents in the past decade. Despite the low percentage, the risk of the reported occurrence demonstrated to be very real..
What we want to achieve
Continuously assess and improve risk controls to mitigate the risk of REs and RIs.
How we monitor improvement
Continuous monitoring of safety issues identified in the ATM and Aerodrome risk portfolio (currently under development)
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8

EASA Activities

Rulemaking

Rulemaking

RMT.0296 Review of aeroplane performance requirements for operations

- Develop regulatory material to provide improved clarity, technical accuracy, flexibility or a combination of these benefits for the EU operational requirements on aeroplane performance in air operations with the aim of reducing the number of accidents and serious incidents where aeroplane performance is a causal factor; and
- Contribute to the harmonisation of the FAA and EU operational requirements on aeroplane performance in CAT operations.

Owner	Affected stakeholders
EASA FS.2	Aeroplane operators, manufacturers, Competent authorities

PIA	Proc	3rdC	ToR	NPA	Opinion	Commission IR	Decision
A-	ST	-	09/06/2015	30/09/2016	2018 Q2	2019 Q4	2019 Q4

RMT.0570 Reduction of runway excursions

The objective of this task is to increase the level of safety by reducing the number of REs through mandating existing technologies on aeroplane that allow to measure remaining runway left and thus support pilot-decision-making.

Due to the nature of the comments received on NPA 2013-09, EASA has decided to publish a new NPA on the reduction of REs. The proposal of the new NPA will put more emphasis on safety objectives against the risk of REs, while providing more flexibility in terms of design solutions. The means to achieve these objectives will be provided in a technical standard developed jointly by industry and NAAs with the support of an international standardisation body (EUROCAE).

Owner	Affected stakeholders
EASA CT.7	Operators, manufacturers, applicants for TC/STC

PIA	Proc	3rdC	ToR	NPA	Opinion	Commission IR	Decision
A-	ST	-	09/10/2012	10/05/2013	2018 Q4	2018 Q4	2018 Q4
				2018 Q1	n/a	n/a	2020 Q1

RMT.0703 Runway safety

European Action Plans for the Prevention of Runway Incursions (EAPPRI) and Excursions (EAPPRE) contain several recommendations to Competent Authorities, Aerodrome Operators and EASA in order to mitigate the risks.

In the aerodromes' domain, EASA had included in Regulation (EU) No 139/2014[10] and in the relevant AMC/GM and CS many of these recommendations, however there are some of them that have not been addressed.

Owner	Affected stakeholders
EASA FS.4.3	National Aviation Authorities, aerodrome operators

PIA	Proc	3rdC	ToR	NPA	Opinion	Commission IR	Decision
A1 to 2.5	ST	-	14/09/2017	2018 Q1	2019 Q1	2020 Q1	2020 Q1

RMT.0704 Runway surface condition assessment and reporting

Revision and update of Regulation (EU) No 139/2014 and of the related AMC and GM in order to include the changes in Annex 14 and PANS Aerodromes.

Owner	Affected stakeholders
EASA FS.4.3	Aerodrome operators, aircraft operators, GA, ANSPs, National Aviation Authorities

PIA	Proc	3rdC	ToR	NPA	Opinion	Commission IR	Decision
A2.5	ST	-	13/09/2017	2018 Q3	2019 Q1	2020 Q2	2020 Q2

RMT.0722 Provision of aeronautical data by the aerodrome operator

Owner	Affected stakeholders
EASA FS.4.3	

PIA	Proc	3rdC	ToR	NPA	Opinion	Commission IR	Decision
A2	ST	-	2018 Q3	2019 Q3	2020 Q2	2021 Q2	2021 Q2

EASA Activities

Safety promotion

Safety Promotion

MST.007 Include runway excursions in national SSPs

REs should be addressed by the MS on their SSPs in close cooperation with the aircraft operators, air traffic control, airport operators and pilot representatives. This will include as a minimum agreeing a set of actions and measuring their effectiveness. MS should implement actions suggested by the European Action Plan for the Prevention of Runway Excursions (EAPPRE) and monitor effectiveness.

Owner	Activity sector	Deliverable	Date
MS	CAT, HF	SSP established	Continuous

MST.014 Include runway incursions in national SSPs

RIs should be addressed by the MS on their SSPs. This will include as a minimum agreeing a set of actions and measuring their effectiveness. MS should implement actions suggested by the European Action Plan for the Prevention of Runway Incursions (EAPPRI).

Owner	Activity sector	Deliverable	Date
MS	CAT/GA, HF	SSP established	Continuous

EASA Activities

- Horizontal approach
  - Objective
    - Support pilot's decision making
  - How
    - Improve accuracy and timeliness of runway surface condition – RMT.0704
    - In-flight assessment of landing performance at the time of arrival in line with ICAO – RMT.0296
    - Technology – installation of runway overrun awareness and alerting system (ROAAS) – RMT.0570

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EASA Activities

- Weak link
  - Accuracy of assessing runway surface conditions
- How we want to solve the issue
  - Standardized method of assessment based on ICAO
  - Specific training requirements for runway assessors
  - Improve accuracy of the assessment using technology
    - EUROCAE WG-109 'Runway weather information systems'

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EASA Activities

- Utilization of CFME on contaminated runways
  - Two studies performed by the Agency
    - RuFAB – Runway friction characteristics measurement and aircraft braking
    - Use of CFME on dry and contaminated surfaces
  - Theoretical models in-place
  - Need for field trials to validate

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Next steps

- RMT.0296
  - Publication of Opinion in Q1/2019
- RMT.0704
  - Publication of NPA in November 2018
  - Publication of Opinion in Q2/2019
- RMT.0570
  - NPA published October 2018
  - Publication of Opinion in Q1/2019

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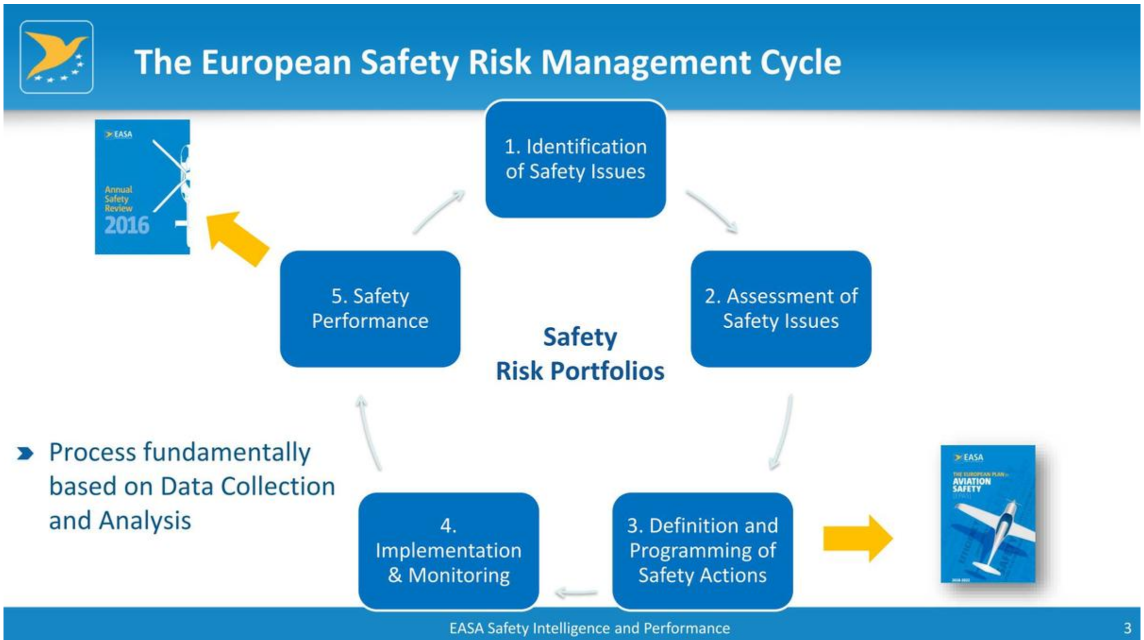
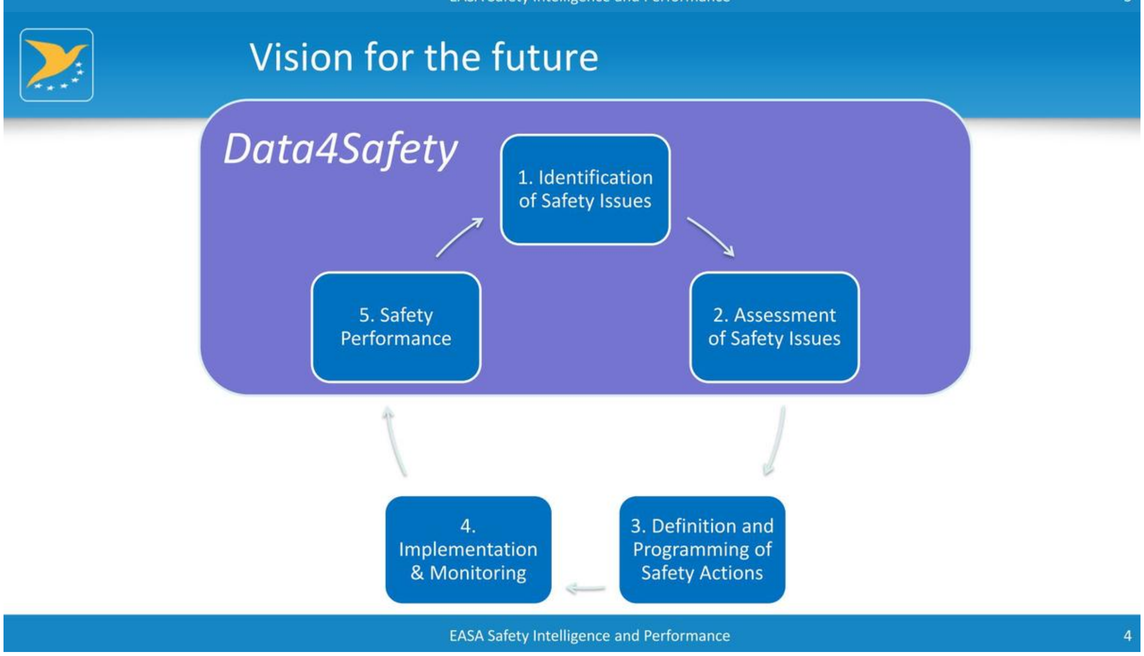
Appendix B.9 "P4: The Data4Safety Programme" – Erick Ferrandez, EASA

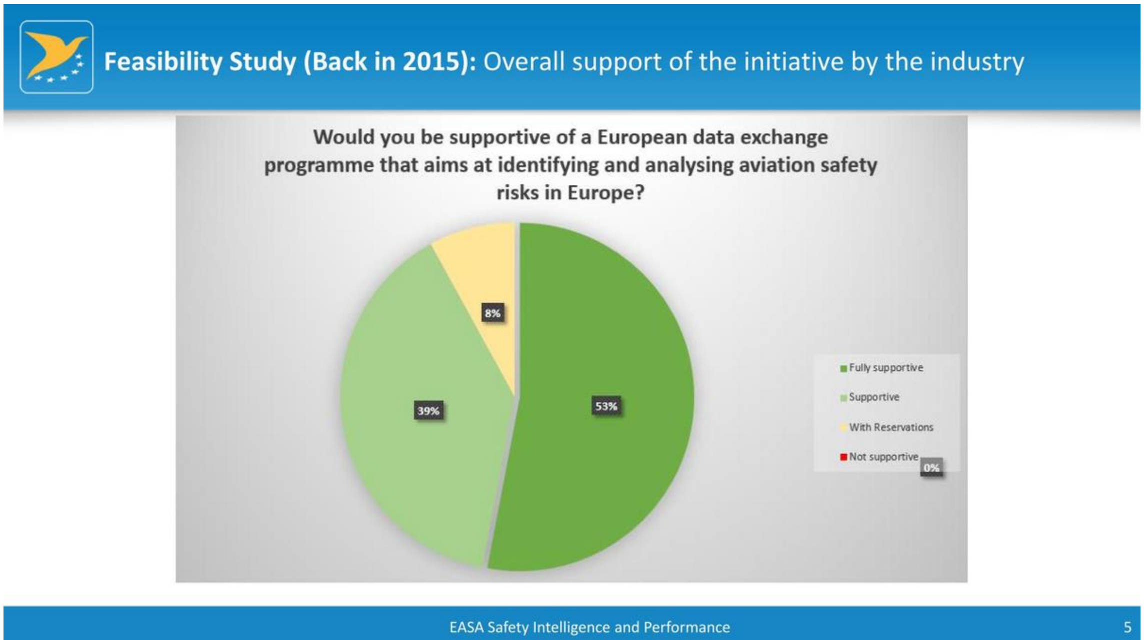
Future Sky Safety has received funding from the EU's Horizon 2020 Research and Innovation Programme, under Grant Agreement No. 640597.

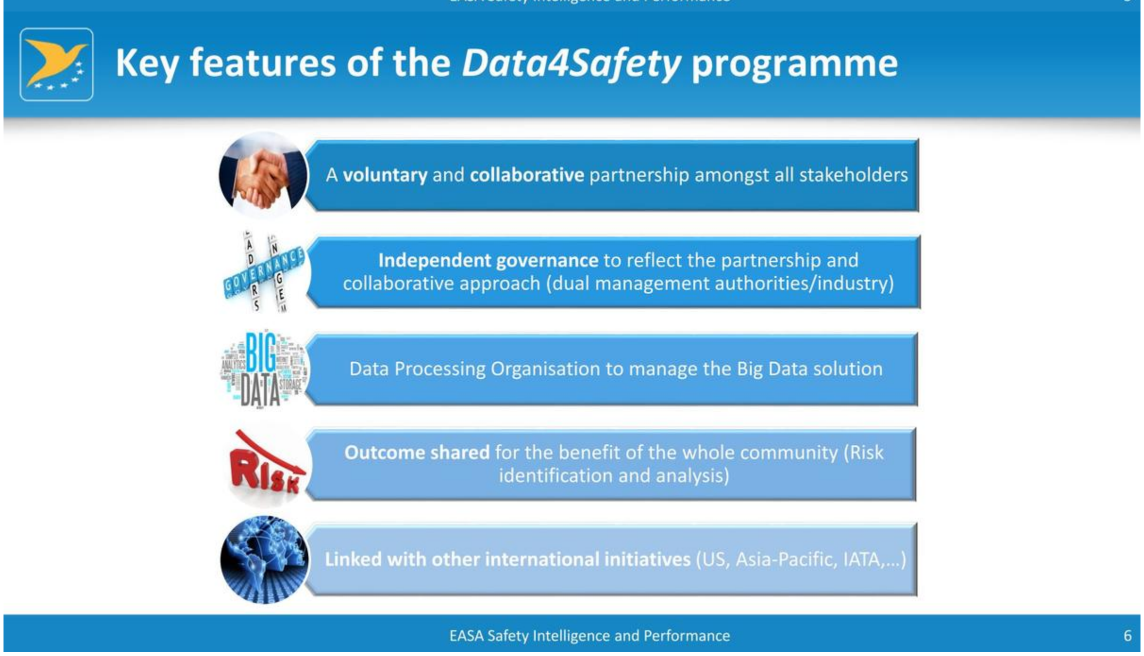

EASA
European Aviation Safety Agency
The *Data4Safety* Programme
Future Sky Safety Conference
Brussels, 6 Nov 2018
Your safety is our mission.
An agency of the European Union


The European Safety Risk Management Cycle
Collaborative work with experts from Industry and States
Identify safety priorities
Connect safety intelligence with actions
EASA Safety Intelligence and Performance
2


The European Safety Risk Management Cycle
1. Identification of Safety Issues
2. Assessment of Safety Issues
3. Definition and Programming of Safety Actions
4. Implementation & Monitoring
5. Safety Performance
Safety Risk Portfolios
Process fundamentally based on Data Collection and Analysis
EASA
Annual Safety Review
2016
EASA
AVIATION SAFETY
EASA Safety Intelligence and Performance
3


Vision for the future
Data4Safety
1. Identification of Safety Issues
2. Assessment of Safety Issues
3. Definition and Programming of Safety Actions
4. Implementation & Monitoring
5. Safety Performance
EASA Safety Intelligence and Performance
4


Feasibility Study (Back in 2015): Overall support of the initiative by the industry
Would you be supportive of a European data exchange programme that aims at identifying and analysing aviation safety risks in Europe?
8%
39%
53%
0%
Fully supportive
Supportive
With Reservations
Not supportive
EASA Safety Intelligence and Performance
5


Key features of the Data4Safety programme
A voluntary and collaborative partnership amongst all stakeholders
Independent governance to reflect the partnership and collaborative approach (dual management authorities/industry)
Data Processing Organisation to manage the Big Data solution
Outcome shared for the benefit of the whole community (Risk identification and analysis)
Linked with other international initiatives (US, Asia-Pacific, IATA,…)
EASA Safety Intelligence and Performance
6

Who will be in?

EASA Safety Intelligence and Performance 7

Proof of Concept Phase

- The initial Feasibility Study concluded on the necessity to have a proof of concept phase before going to the potential full deployment.
- The proof of concept will be done with a limited number of stakeholders and will enable to confirm the expected benefits while testing the technical and governance models.

EASA Safety Intelligence and Performance 8

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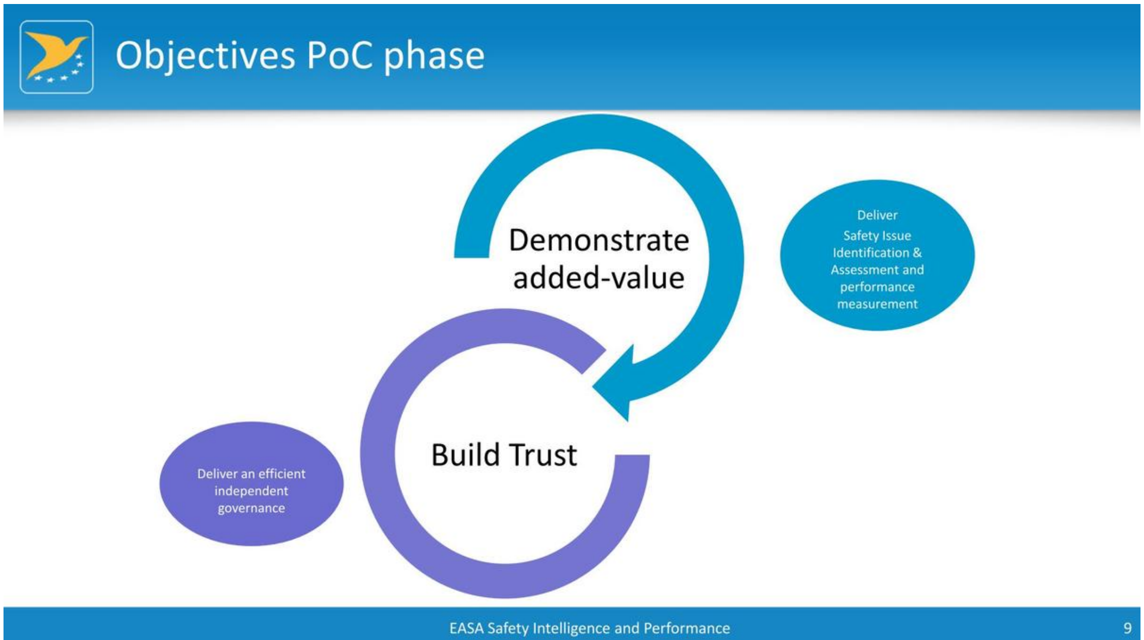
Objectives PoC phase
Demonstrate added-value
Deliver Safety Issue Identification & Assessment and performance measurement
Build Trust
Deliver an efficient independent governance
EASA Safety Intelligence and Performance
9


D4S Founding Members
D4S
AIRBUS
BOEING
BRITISH AIRWAYS
AESA
AGENCIA ESTATAL DE SEGURIDAD AEREA
EASA
easyJet
ECA
European Cockpit Association
dgac
IBERIA
Lufthansa
RYANAIR
IAA
Civil Aviation Authority
AESA, Airbus, Boeing, British Airways, DGAC France, EASA, easyJet, ECA (European Cockpit Association), IAA (Irish Aviation Authority), Iberia, Lufthansa, Ryanair, UK CAA
EASA Safety Intelligence and Performance
10

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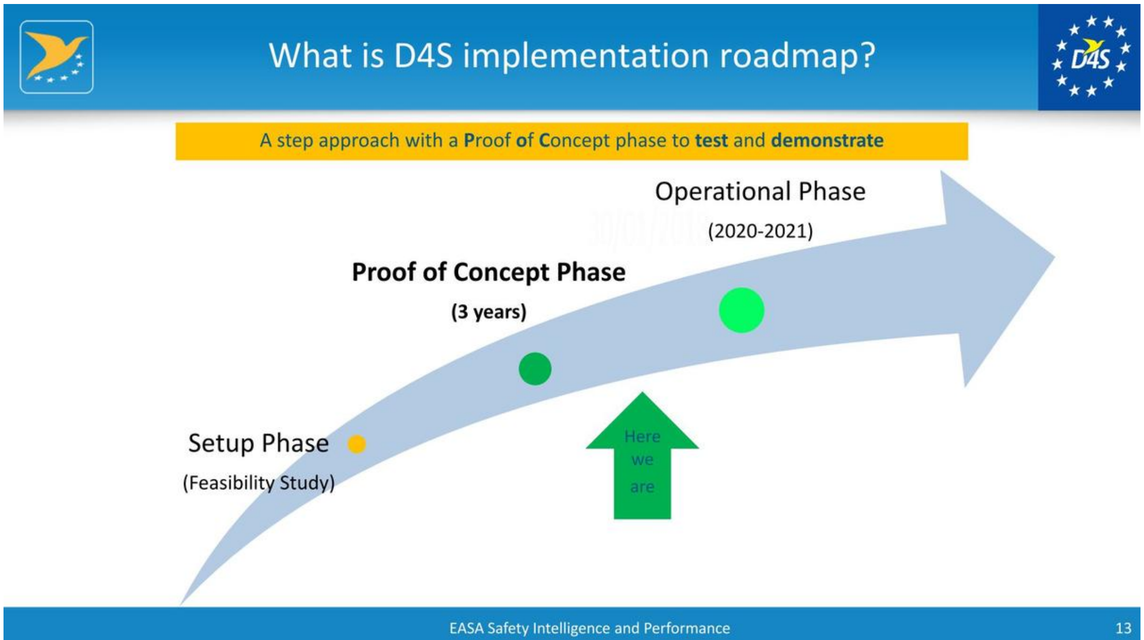
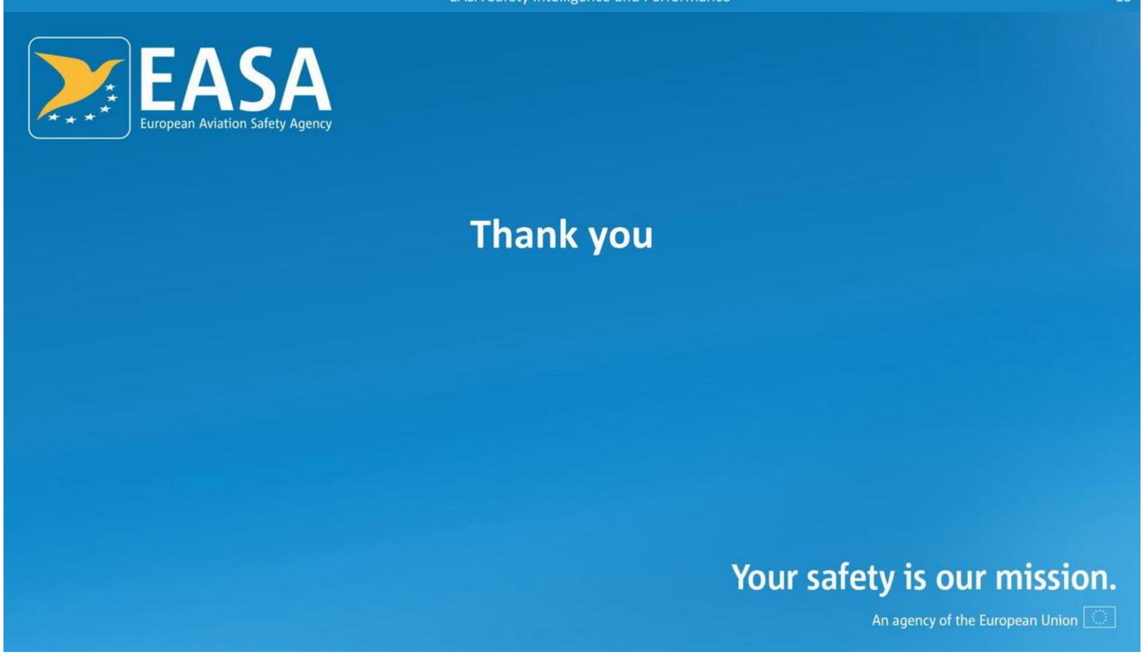




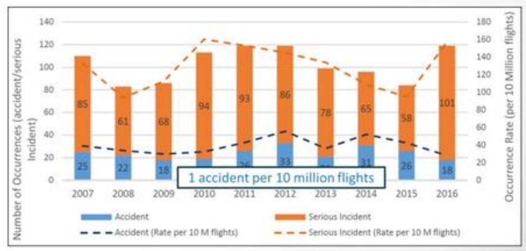
Appendix B.10 "P4: Total System Risk Assessment" – Wilfred Rouwhorst, NLR


European Commission
FUTURE SKY SAFETY
P4 – Total System Risk Assessment
Wilfred Rouwhorst (NLR) and project partners
SAFETY | FUTURE SKY
7 November, 2018


FUTURE SKY SAFETY
P4 - partners
1. Stichting Nationaal Lucht- en Ruimtevaartlaboratorium (NLR)
2. Office National d'Études et de Recherches Aérospatiales (ONERA)
3. Centro para a Excelência e Inovação na Indústria Automóvel (CEiiA)
4. Centro Italiano Ricerche Aerospaziali (CIRA)
5. Instituto Nacional de Técnica Aeroespacial (INTA)
6. European Organisation for the Safety of Air Navigation (EUROCONTROL)
7. Civil Aviation Authority (CAA UK)
8. NAVBLEU (NavBlue)
9. Airbus SAS (AI-SAS)
10. Airbus Operations SAS (AI-F)
11. Thales AVS France SAS (TAV)
12. Thales LAS France SAS (TR6)
13. Technische Universität München (TUM)
14. Deutsche Lufthansa Aktiengesellschaft (DLH)
15. Koninklijke Luchtvaartmaatschappij (KLM)
SAFETY | FUTURE SKY
7 November, 2018 | 2

Objectives

- Develop **a prototype Risk Observatory (RO)** as an enabling tool for safety management
- Develop a **Risk Assessment Framework** that **integrates Risk Assessment Models** specifically developed to represent a certain domain



SAFETY | FUTURE SKY

7 November, 2018 | 3

WP4.1

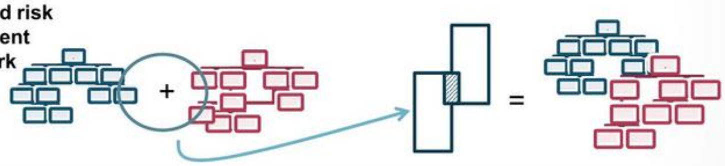
Risk observatory requirements

WP4.2

Risk assessment within domains

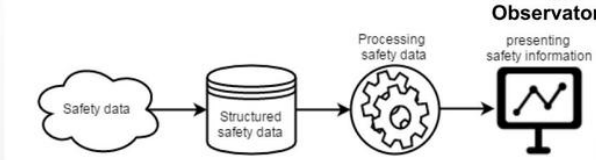
WP4.3

Integrated risk assessment framework



Prototype Risk Observatory

WP4.4



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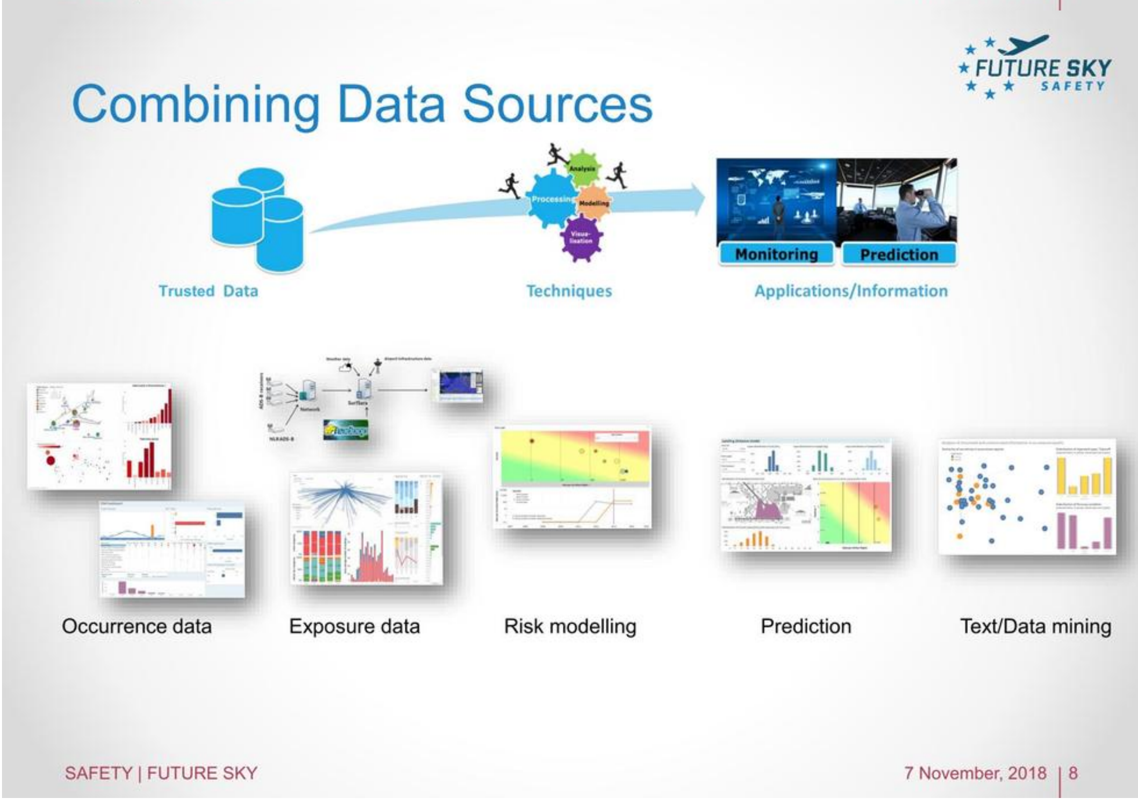
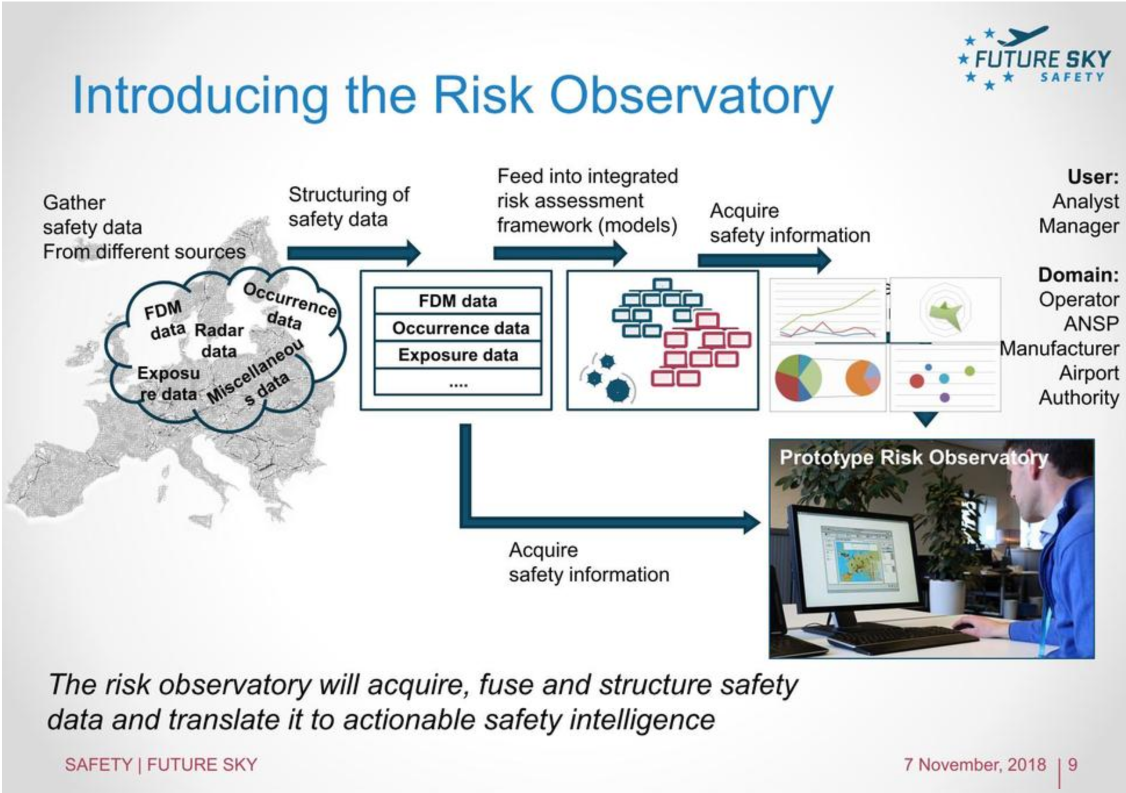
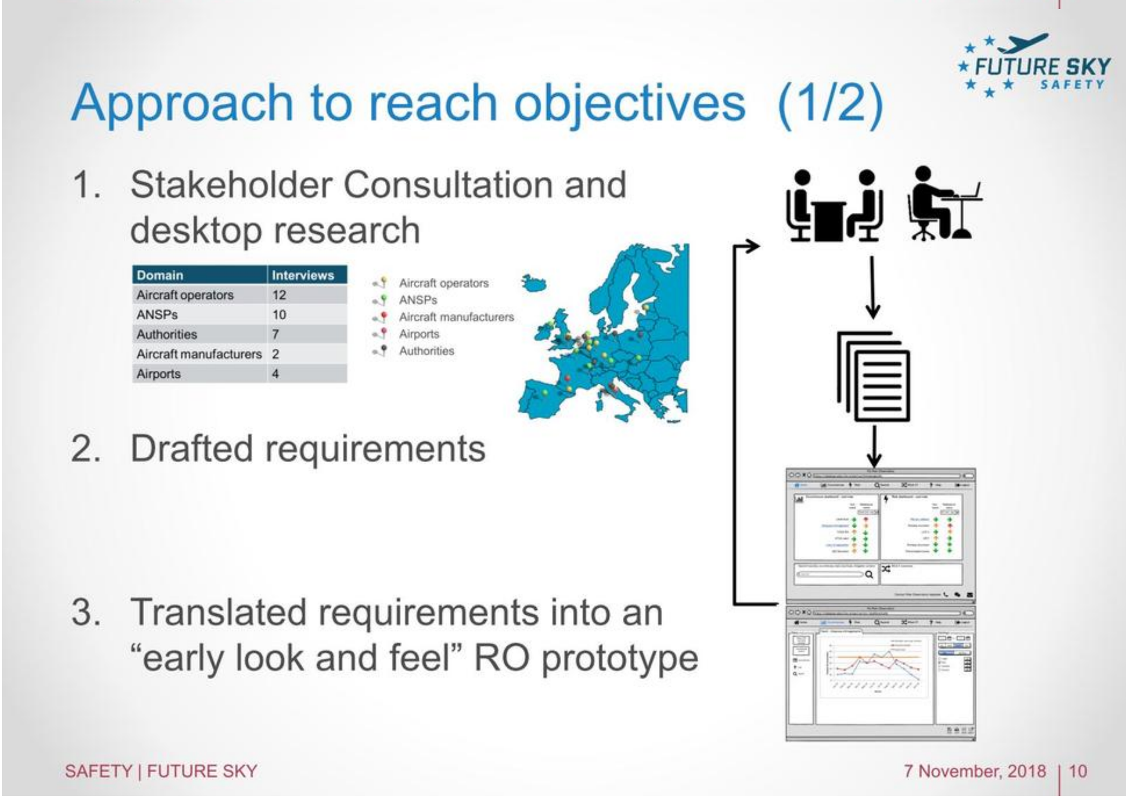


Future Sky Safety has received funding from the EU's Horizon 2020 Research and Innovation Programme, under Grant Agreement No. 640597.





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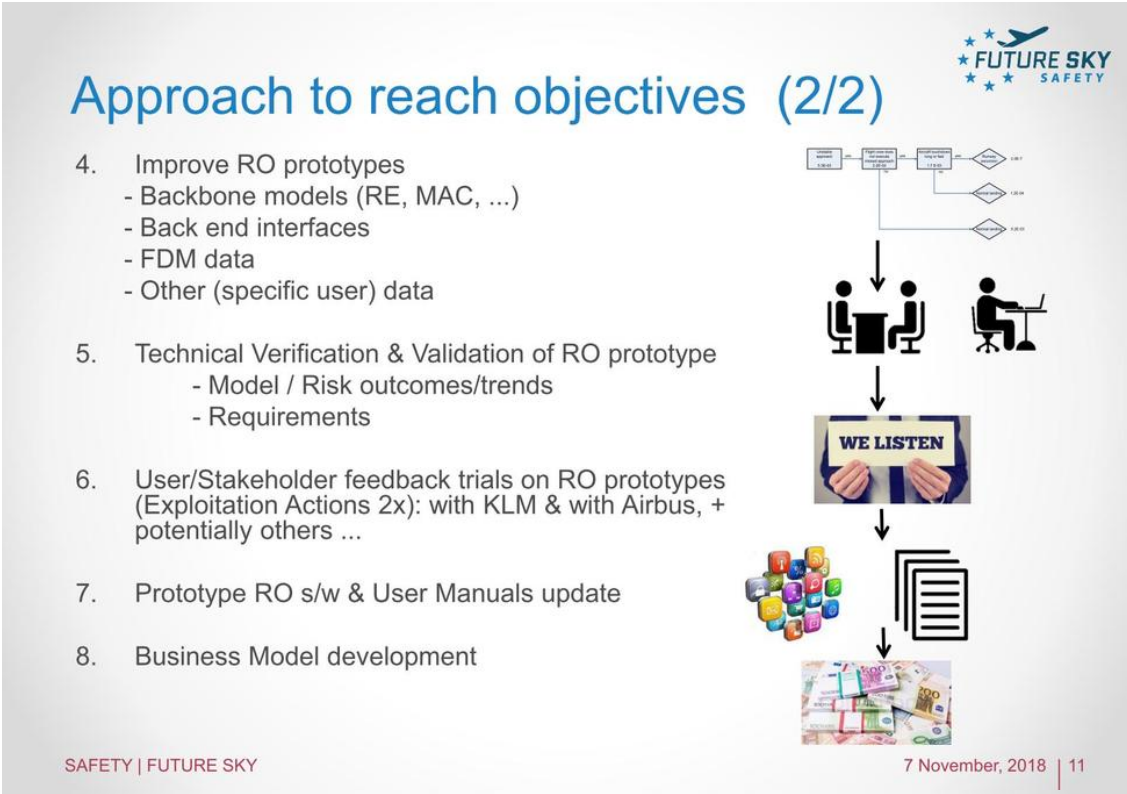
FUTURE SKY SAFETY
Approach to reach objectives (2/2)
4. Improve RO prototypes
- Backbone models (RE, MAC, ...)
- Back end interfaces
- FDM data
- Other (specific user) data
5. Technical Verification & Validation of RO prototype
- Model / Risk outcomes/trends
- Requirements
6. User/Stakeholder feedback trials on RO prototypes (Exploitation Actions 2x): with KLM & with Airbus, + potentially others ...
7. Prototype RO s/w & User Manuals update
8. Business Model development
WE LISTEN
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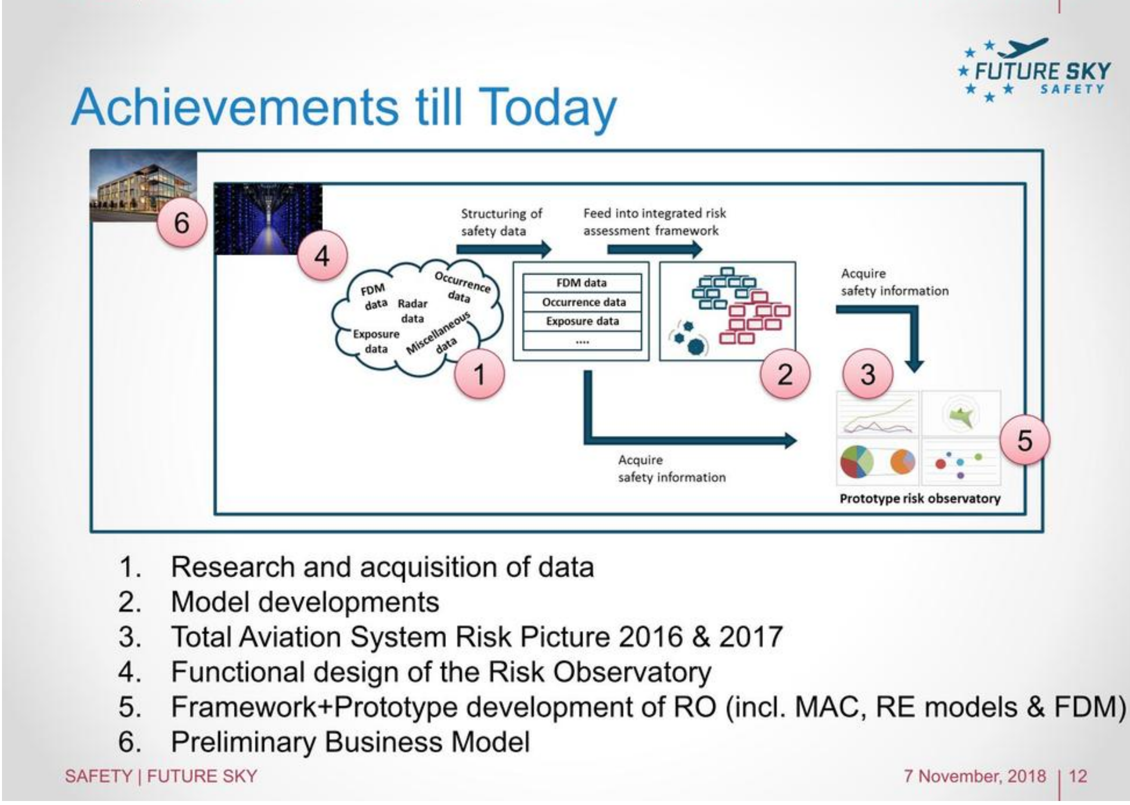
7 November, 2018 | 11


FUTURE SKY SAFETY
Achievements till Today
Structuring of safety data
Feed into integrated risk assessment framework
FDM data
Radar data
Occurrence data
Exposure data
Miscellaneous data
FDM data
Occurrence data
Exposure data
....
Acquire safety information
Acquire safety information
Prototype risk observatory
1
2
3
4
5
6
1. Research and acquisition of data
2. Model developments
3. Total Aviation System Risk Picture 2016 & 2017
4. Functional design of the Risk Observatory
5. Framework+Prototype development of RO (incl. MAC, RE models & FDM)
6. Preliminary Business Model
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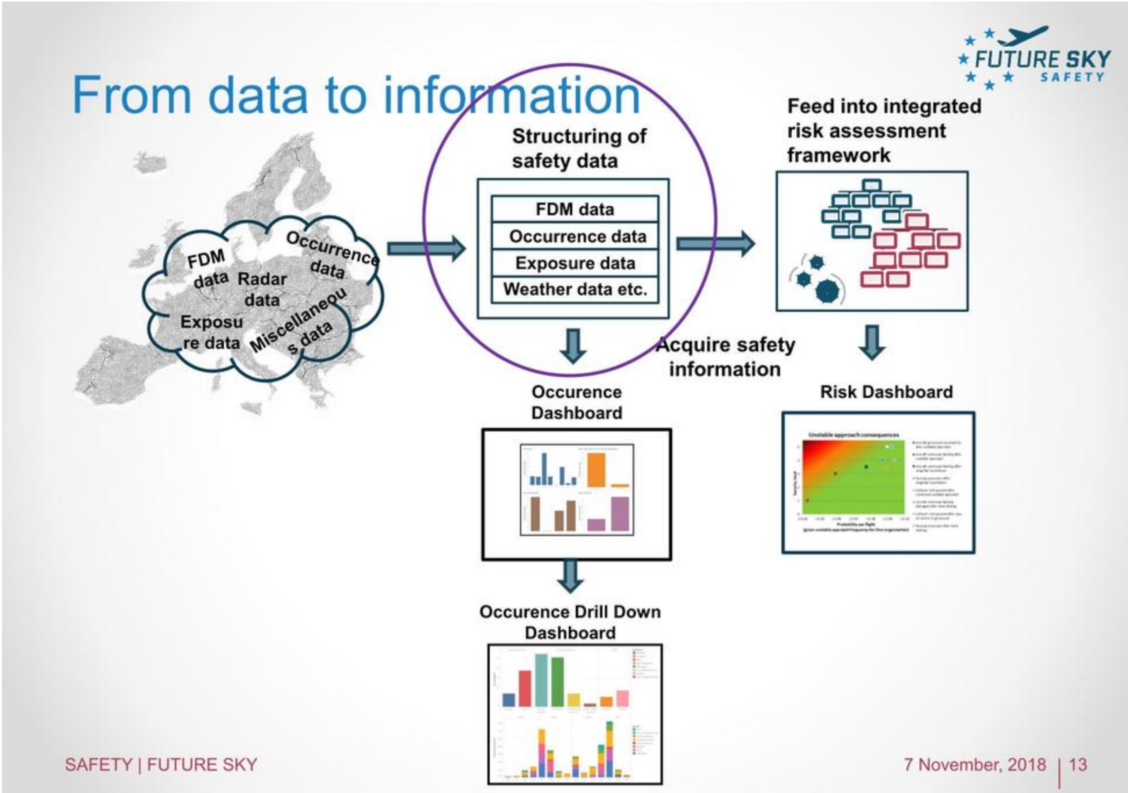
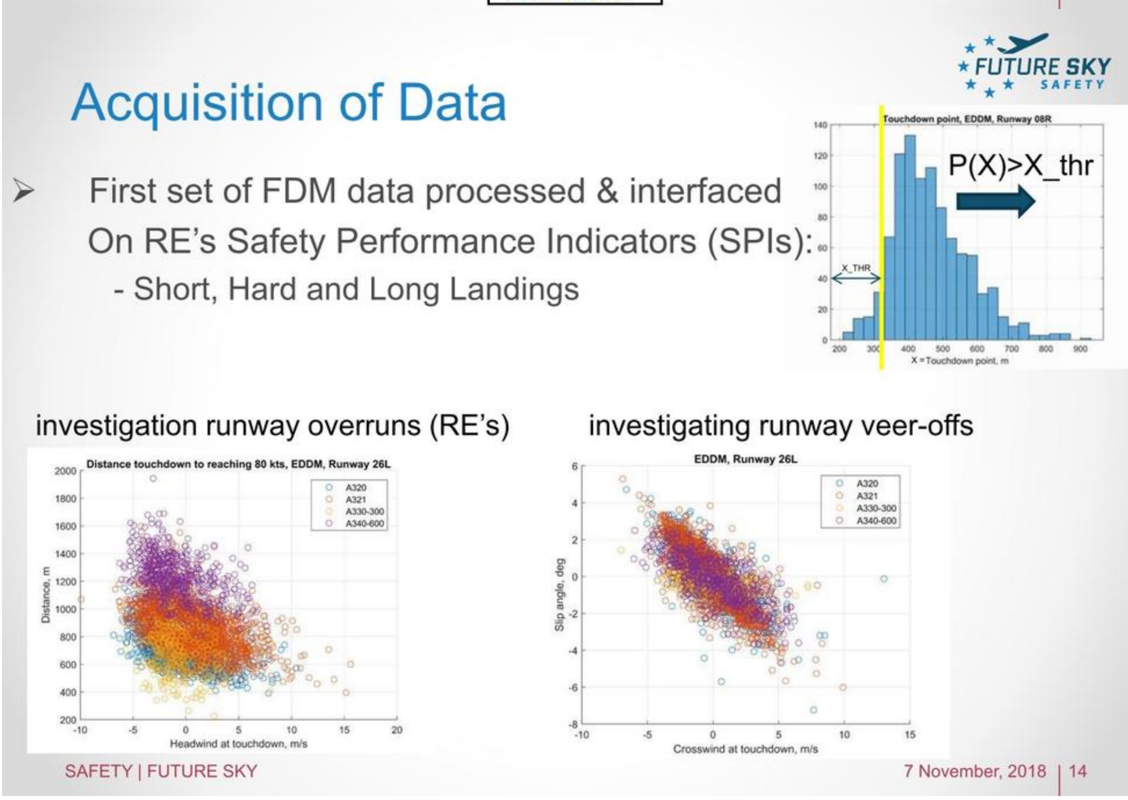
7 November, 2018 | 12





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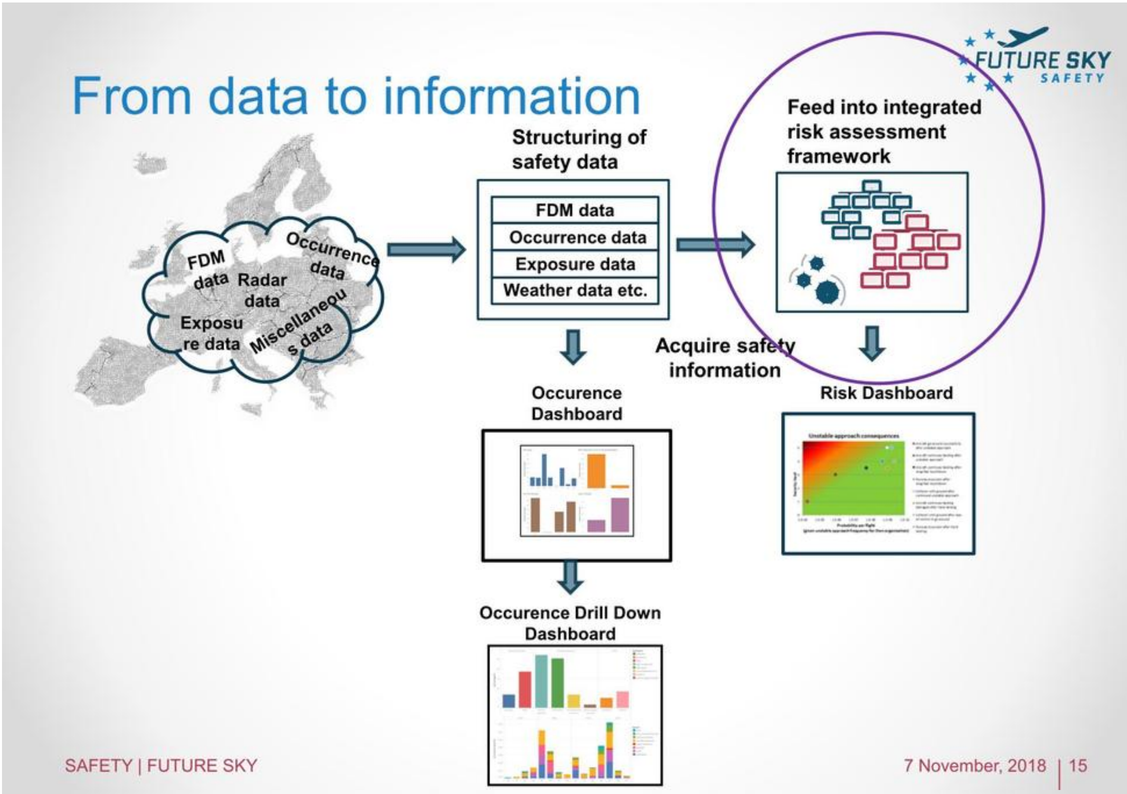

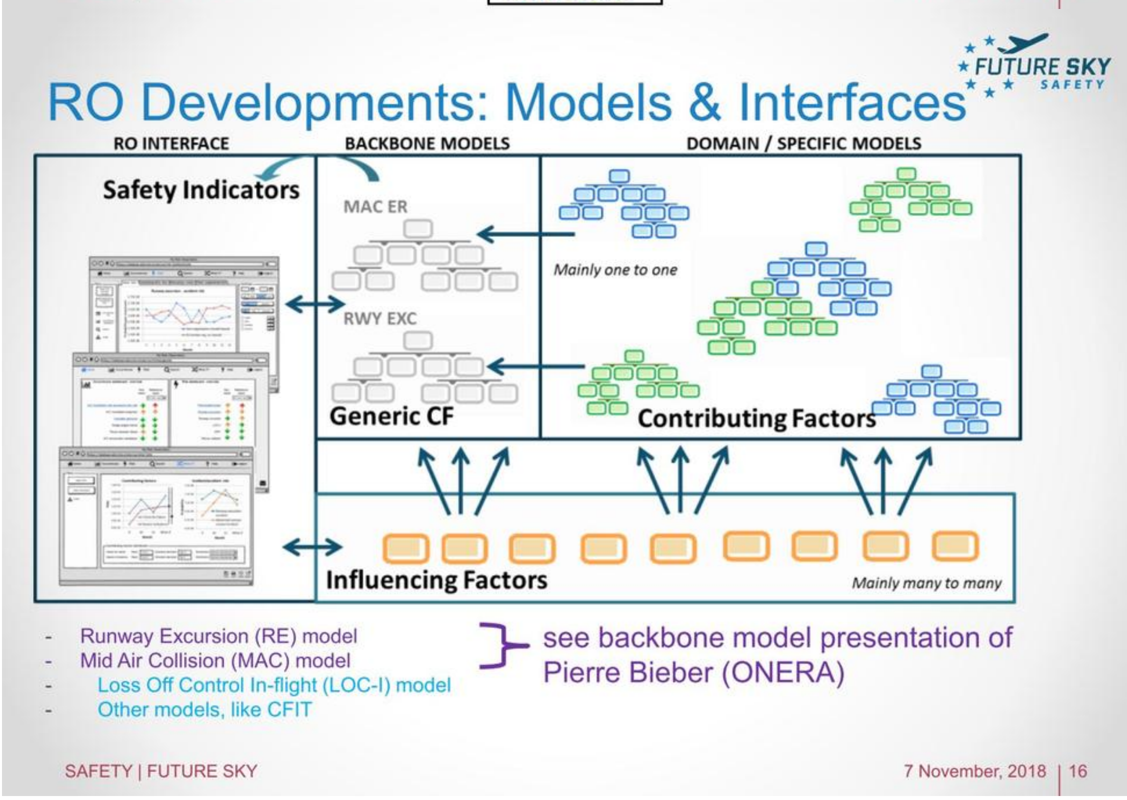

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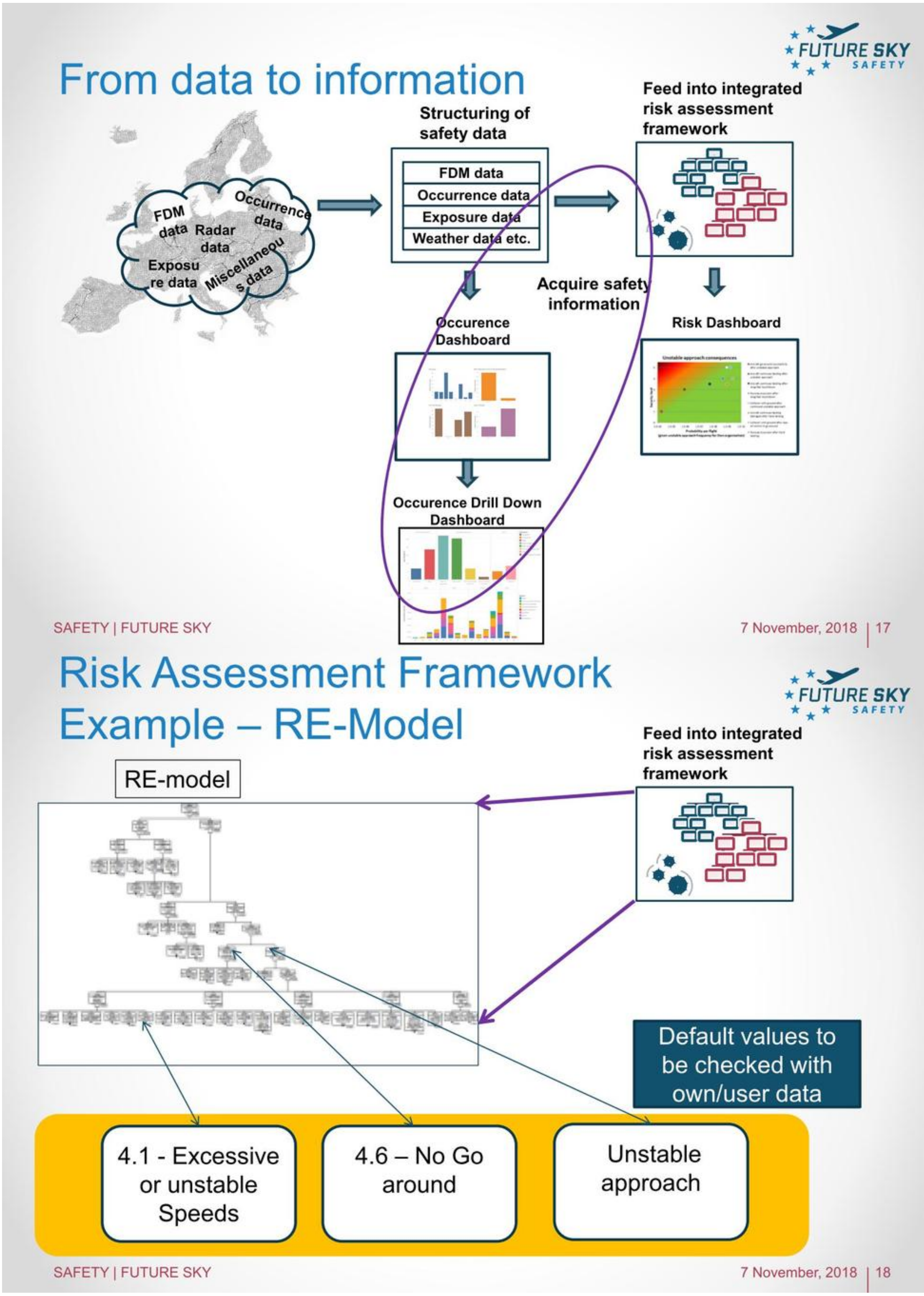

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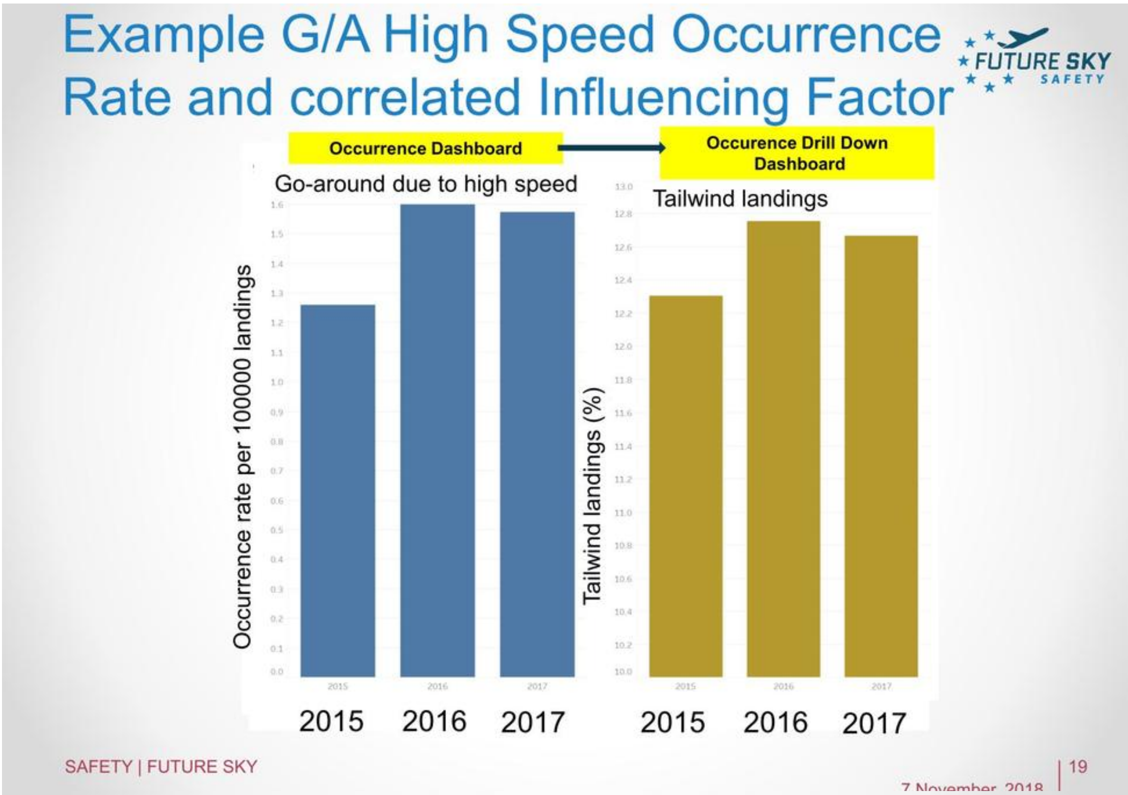

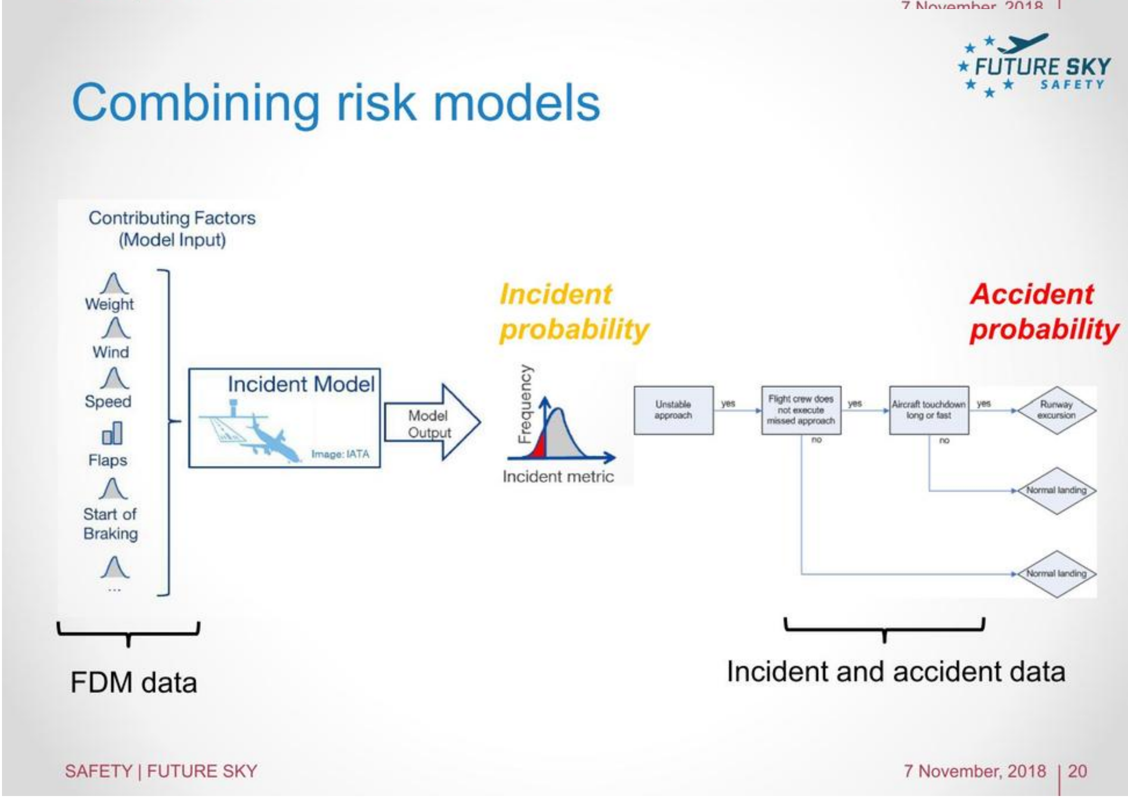

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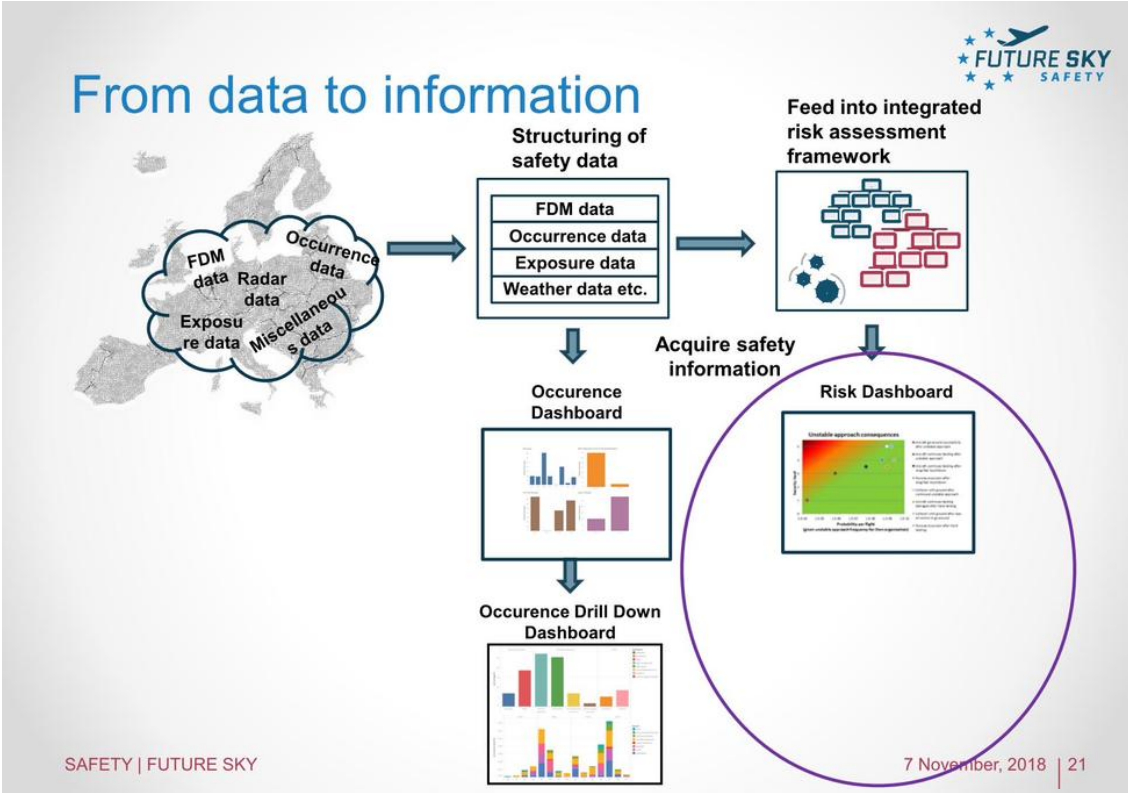

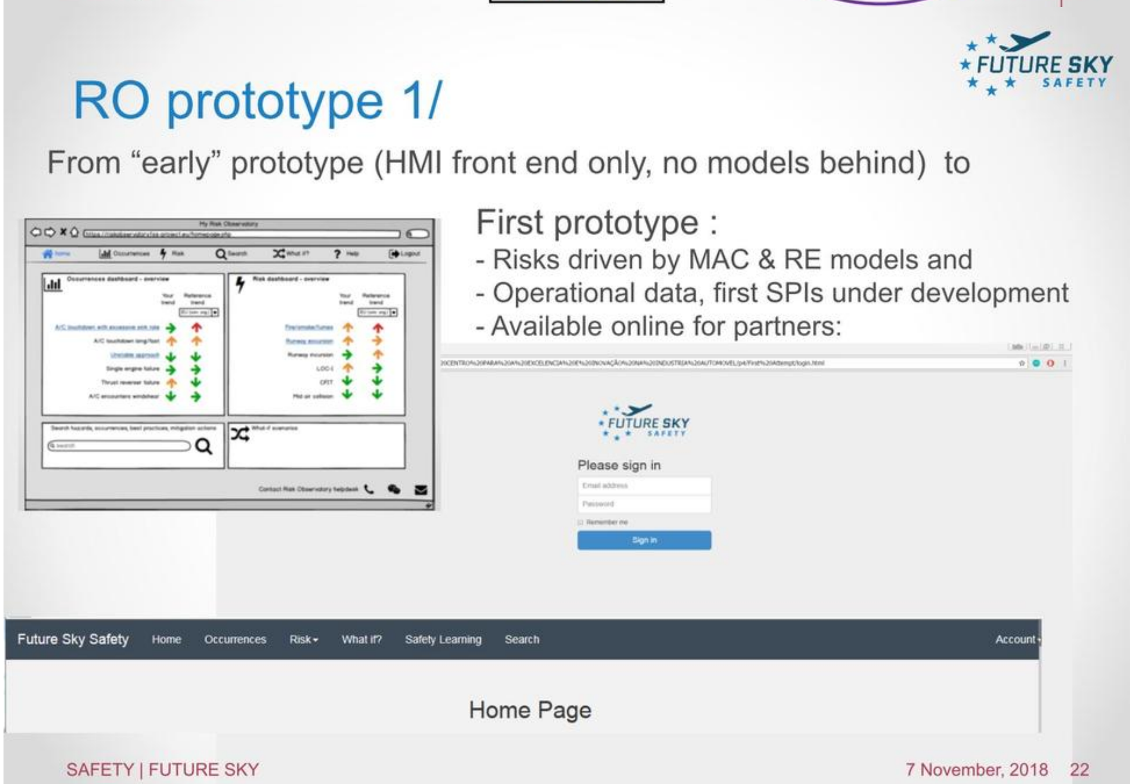

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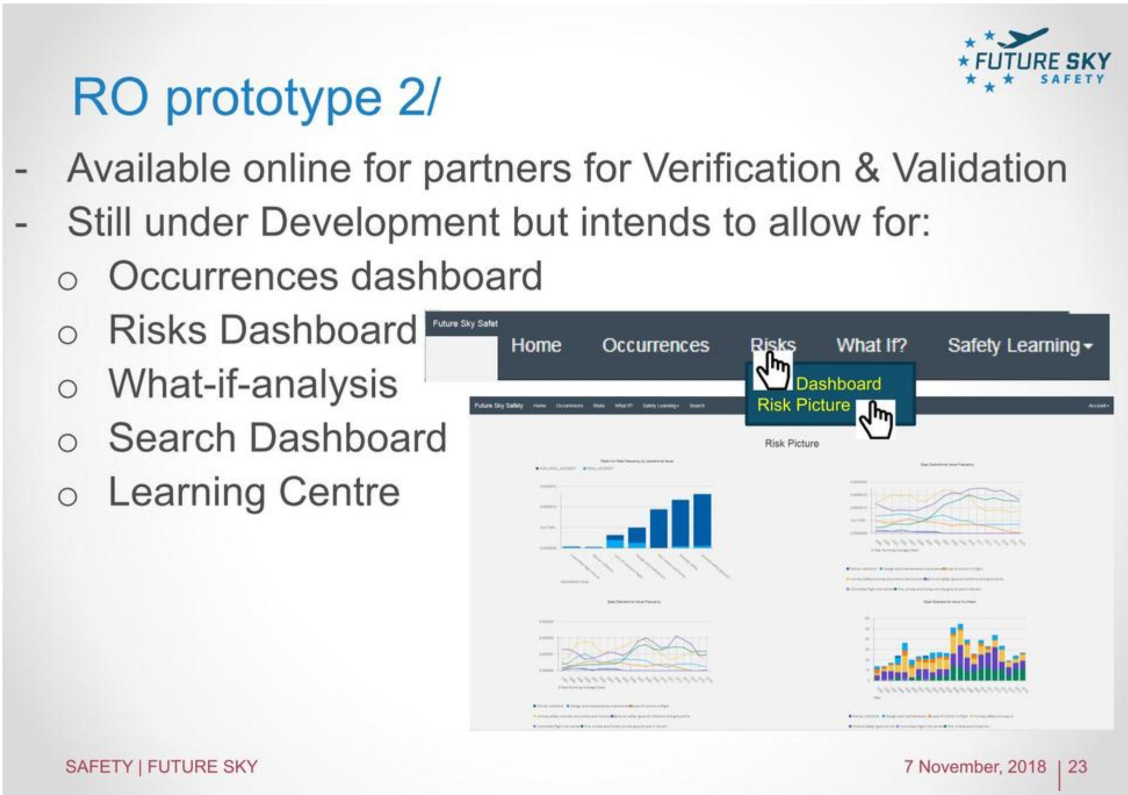
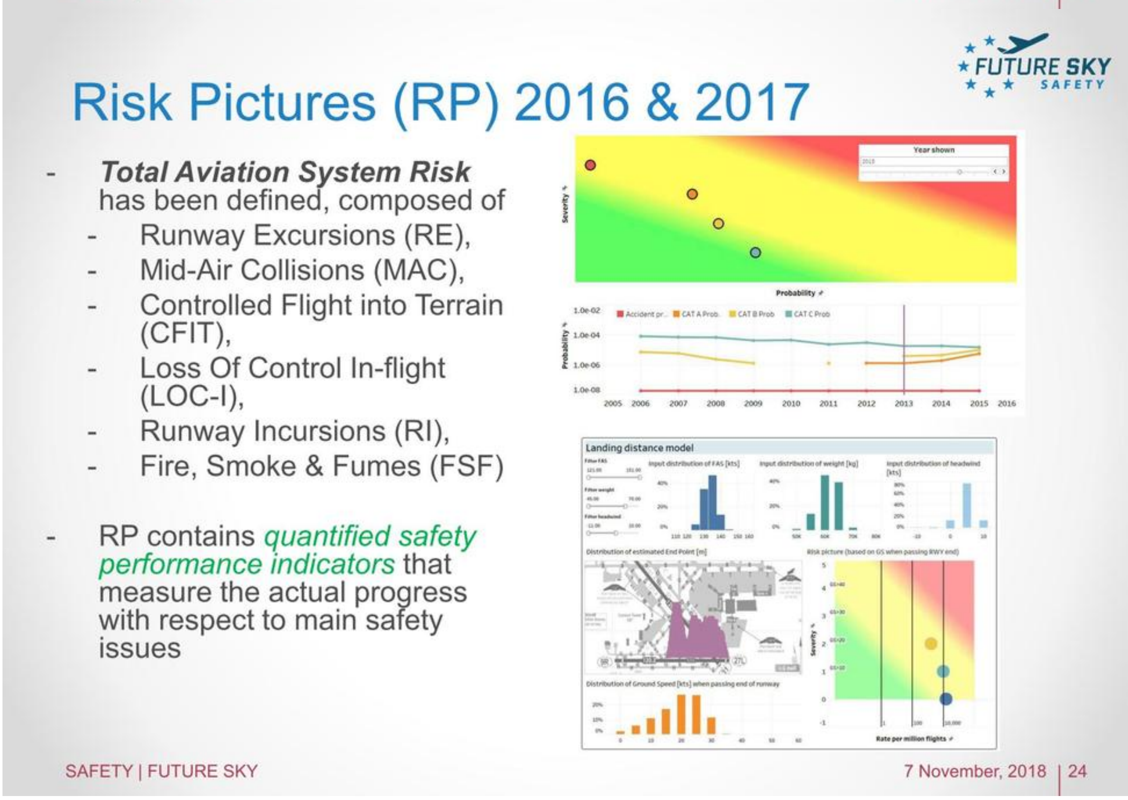

RO prototype 2/
- Available online for partners for Verification & Validation
- Still under Development but intends to allow for:
o Occurrences dashboard
o Risks Dashboard
o What-if-analysis
o Search Dashboard
o Learning Centre
Future Sky Safet
Home
Occurrences
Risks
What If?
Safety Learning
Dashboard
Risk Picture
SAFETY | FUTURE SKY
7 November, 2018 | 23


Risk Pictures (RP) 2016 & 2017
- Total Aviation System Risk has been defined, composed of
- Runway Excursions (RE),
- Mid-Air Collisions (MAC),
- Controlled Flight into Terrain (CFIT),
- Loss Of Control In-flight (LOC-I),
- Runway Incursions (RI),
- Fire, Smoke & Fumes (FSF)
- RP contains quantified safety performance indicators that measure the actual progress with respect to main safety issues
Year shown
Severity
Probability
Landing distance model
SAFETY | FUTURE SKY
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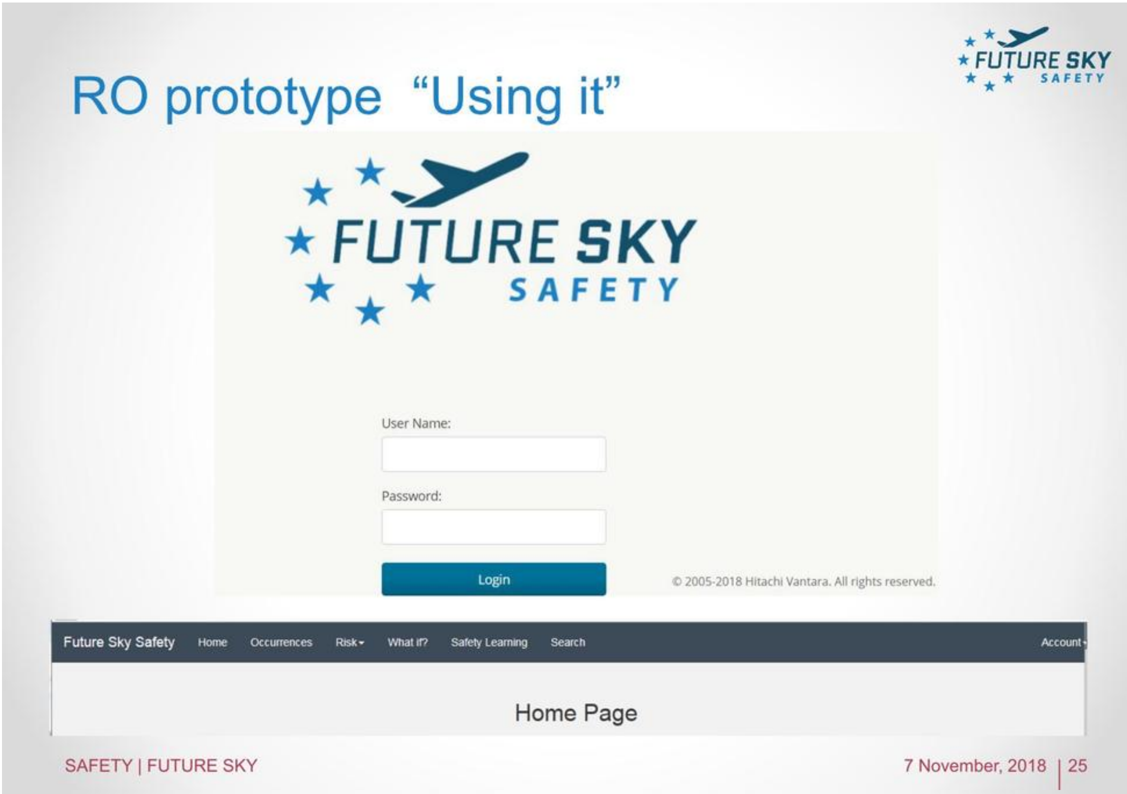

Future Sky Safety has received funding from the EU's Horizon 2020 Research and Innovation Programme, under Grant Agreement No. 640597.


FUTURE SKY SAFETY
Future Sky Safety
Home
Occurrences
Risk
What If?
Safety Learning
Search
Account
Longitudinal Runway Excursion Risk
Options
Date
From 2018-01-01
To 2018-09-19
Show/Hide
Baseline
Contributing factors
Non-decelerated incorrect touchdown
Non-rejected incorrect touchdown
Incorrect touchdown
Non-corrected unstable approach
Unstable approach
Incorrect Touchdown
Period
Non-corrected Unstable Approach
SAFETY | FUTURE SKY
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Longitudinal Runway Excursion Risk
Options
Date
From 2018-01-01
To 2018-09-19
Show/Hide
Baseline
Contributing factors
Non-decelerated incorrect touchdown
Non-rejected incorrect touchdown
Incorrect touchdown
Non-corrected unstable approach
Unstable approach
Period
Unstable approach
Period
SAFETY | FUTURE SKY
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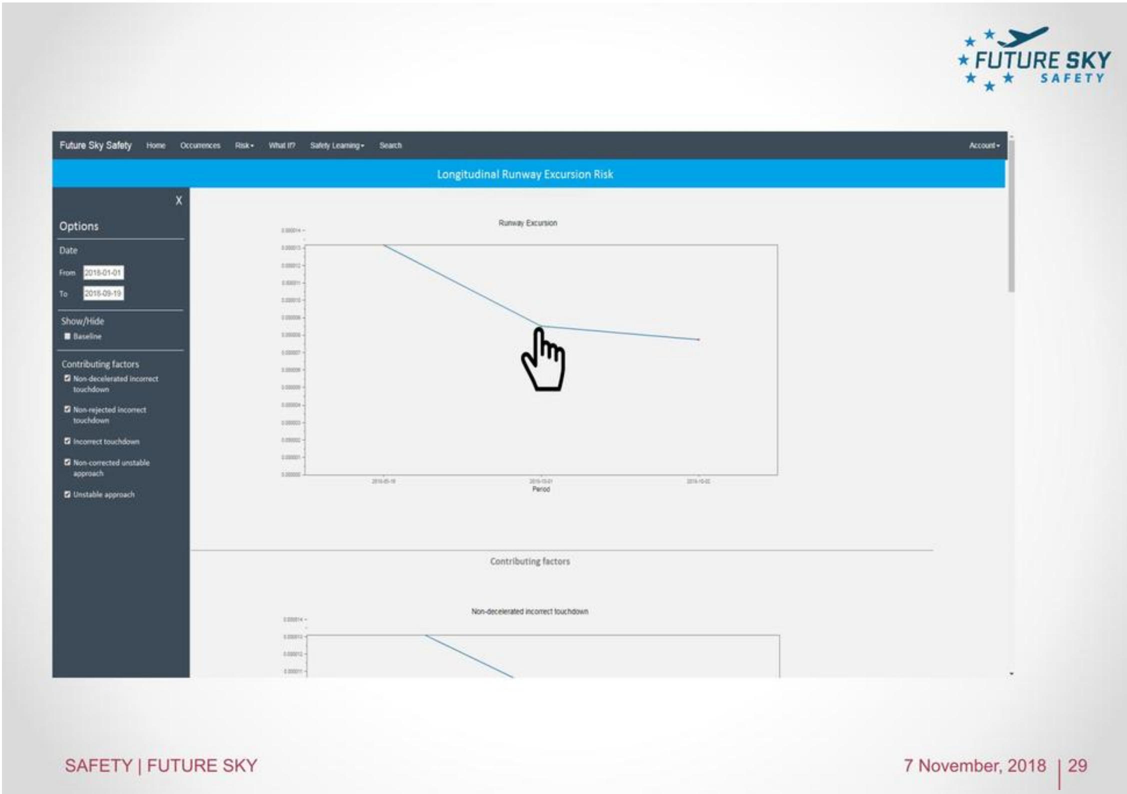
Future Sky Safety
Home
Occurrences
Risk
What If?
Safety Learning
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Longitudinal Runway Excursion Risk
X
Options
Date
From 2018-01-01
To 2018-09-19
Show/Hide
Baseline
Contributing factors
Non-decelerated incorrect touchdown
Non-rejected incorrect touchdown
Incorrect touchdown
Non-corrected unstable approach
Unstable approach
Runway Excursion
Period
Contributing factors
Non-decelerated incorrect touchdown
SAFETY | FUTURE SKY
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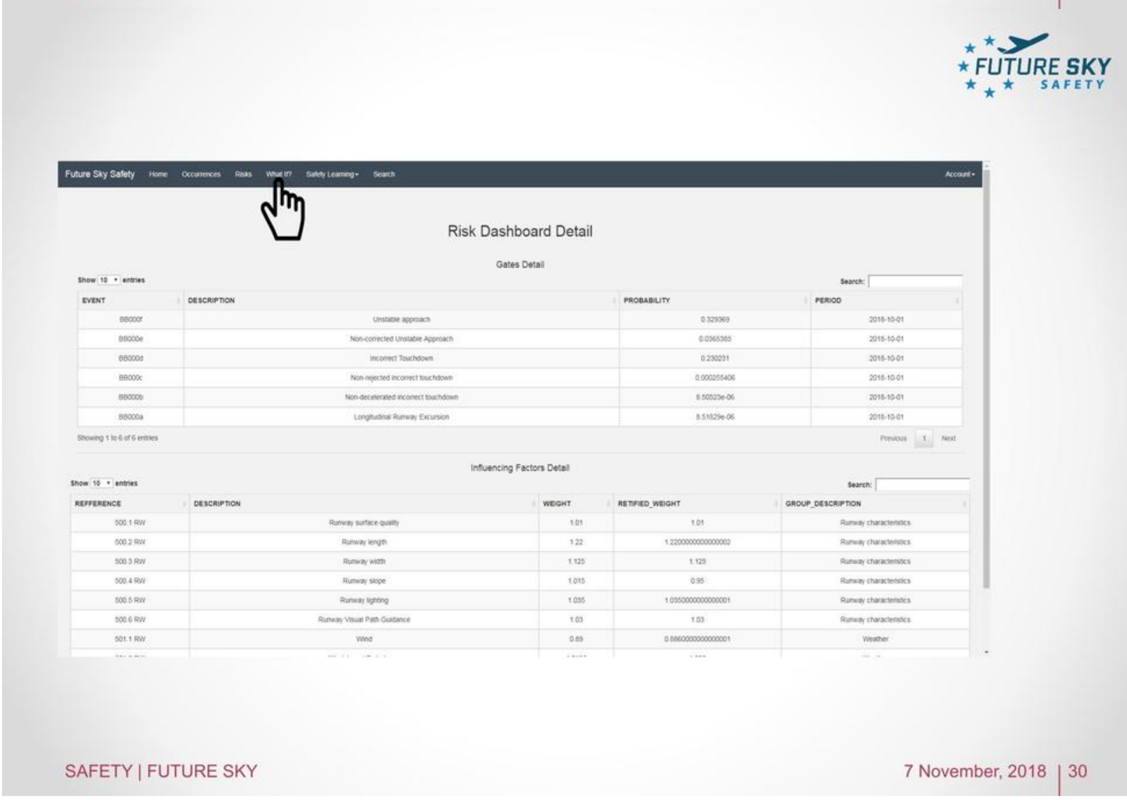
Future Sky Safety
Home
Occurrences
Risks
What If?
Safety Learning
Search
Account
Risk Dashboard Detail
Gates Detail
Show 10 entries
Search:
EVENT | DESCRIPTION | PROBABILITY | PERIOD
BB000f | Unstable approach | 0.329369 | 2018-10-01
BB000e | Non-corrected Unstable Approach | 0.0365385 | 2018-10-01
BB000d | Incorrect Touchdown | 0.230231 | 2018-10-01
BB000c | Non-rejected incorrect touchdown | 0.000255406 | 2018-10-01
BB000b | Non-decelerated incorrect touchdown | 8.50523e-06 | 2018-10-01
BB000a | Longitudinal Runway Excursion | 8.51829e-06 | 2018-10-01
Showing 1 to 6 of 6 entries
Previous 1 Next
Influencing Factors Detail
Show 10 entries
Search:
REFFERENCE | DESCRIPTION | WEIGHT | RETIFIED_WEIGHT | GROUP_DESCRIPTION
500.1 RW | Runway surface quality | 1.01 | 1.01 | Runway characteristics
500.2 RW | Runway length | 1.22 | 1.2200000000000002 | Runway characteristics
500.3 RW | Runway width | 1.125 | 1.125 | Runway characteristics
500.4 RW | Runway slope | 1.015 | 0.95 | Runway characteristics
500.5 RW | Runway lighting | 1.035 | 1.0350000000000001 | Runway characteristics
500.6 RW | Runway Visual Path Guidance | 1.03 | 1.03 | Runway characteristics
501.1 RW | Wind | 0.89 | 0.8860000000000001 | Weather
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Contributing factors
Set Contributing Factors
Influencing factors
Set Influencing Factors
Show/Hide
Baseline
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Non-rejected incorrect touchdown
Incorrect touchdown
Non-corrected unstable approach
Unstable approach
Runway Excursion
Period
What if?
Contributing factors
Non-decelerated incorrect touchdown
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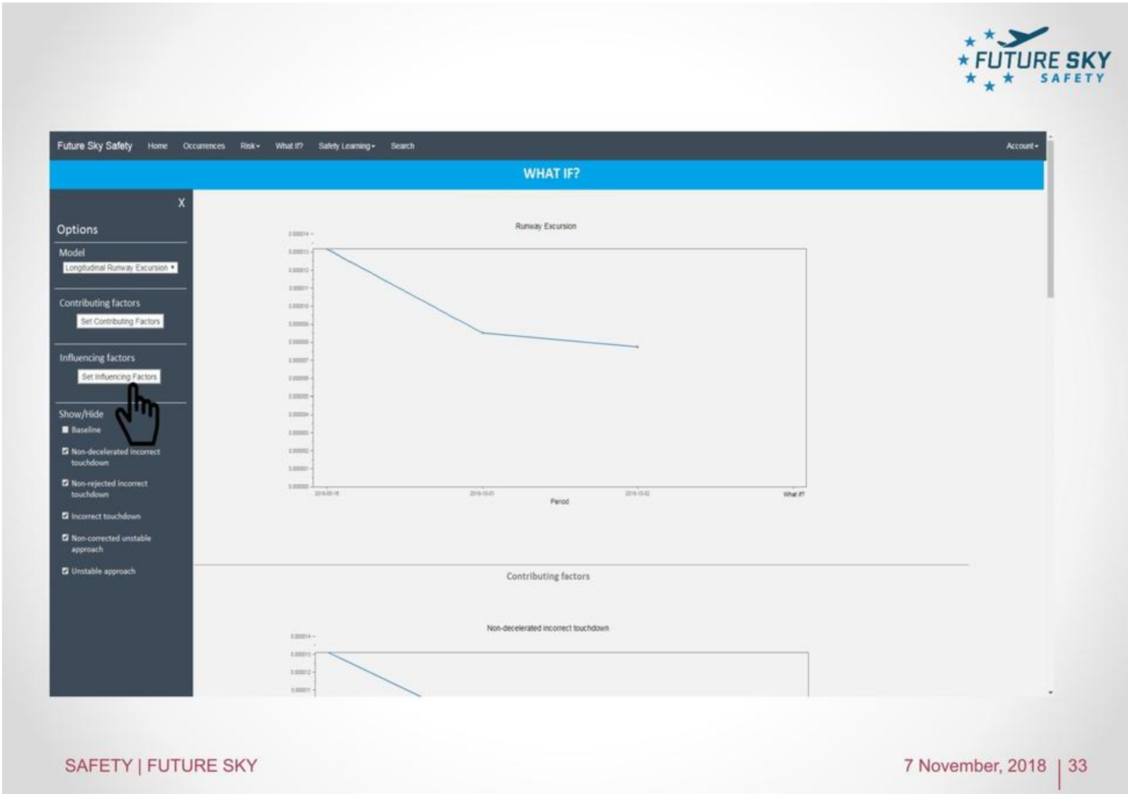
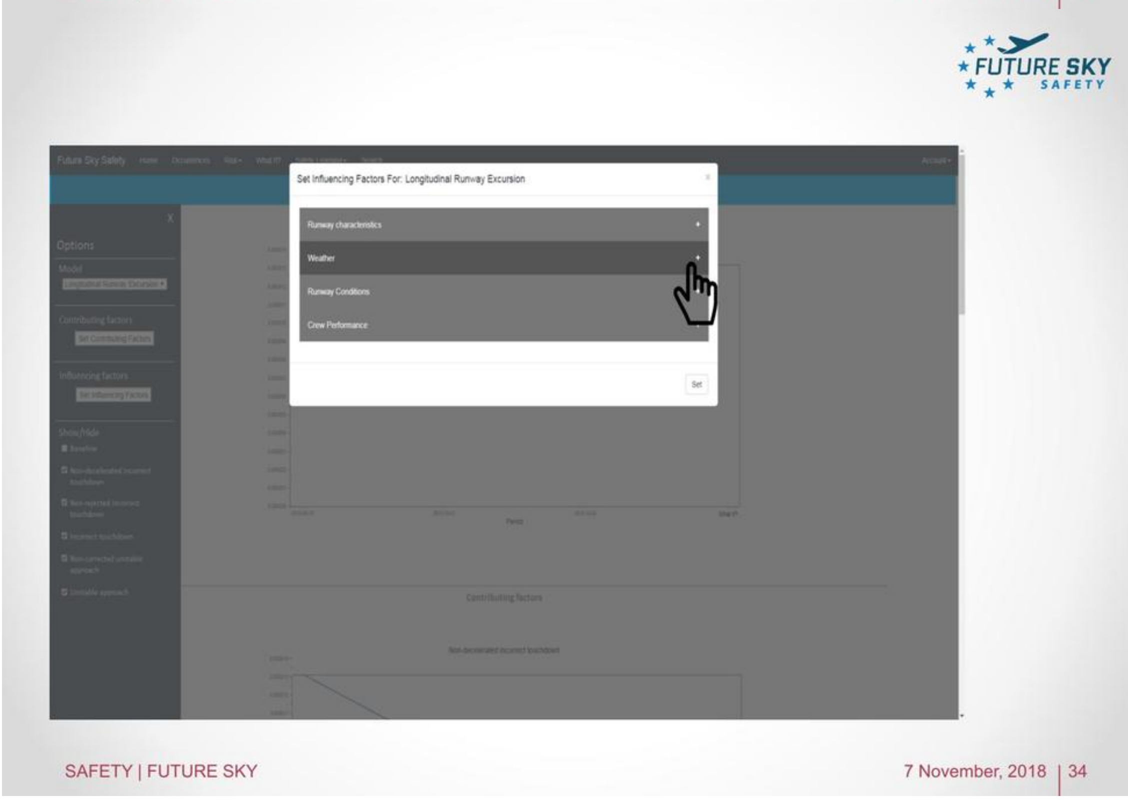
WHAT IF?
Options
Model
Longitudinal Runway Excursion
Mid Air Collision - v5
Mid Air Collision - v5.2
Influencing factors
Set Influencing Factors
Show/Hide
Baseline
Non-decelerated incorrect touchdown
Non-rejected incorrect touchdown
Incorrect touchdown
Non-corrected unstable approach
Unstable approach
Runway Excursion
Period
What if?
Contributing factors
Non-decelerated incorrect touchdown
SAFETY | FUTURE SKY
7 November, 2018
32





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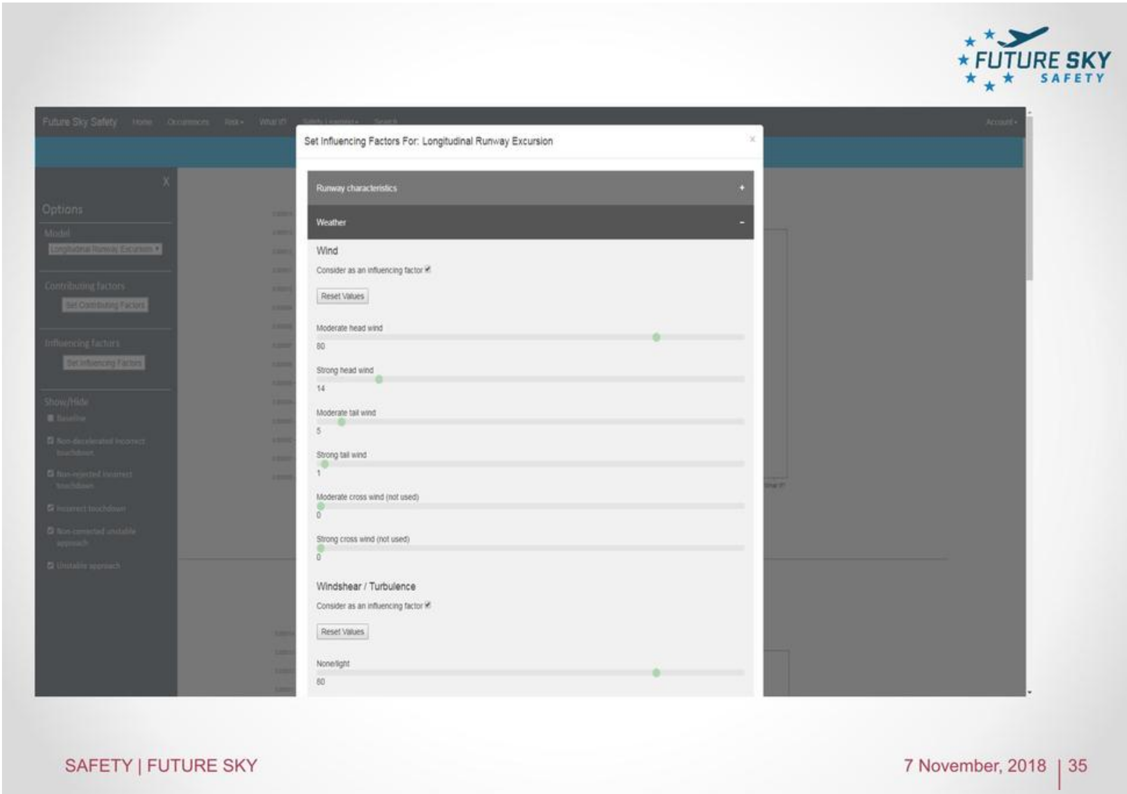
FUTURE SKY SAFETY
Set Influencing Factors For: Longitudinal Runway Excursion
Runway characteristics
Weather
Wind
Consider as an influencing factor
Reset Values
Moderate head wind
80
Strong head wind
14
Moderate tail wind
5
Strong tail wind
1
Moderate cross wind (not used)
0
Strong cross wind (not used)
0
Windshear / Turbulence
Consider as an influencing factor
Reset Values
None/light
80
SAFETY | FUTURE SKY
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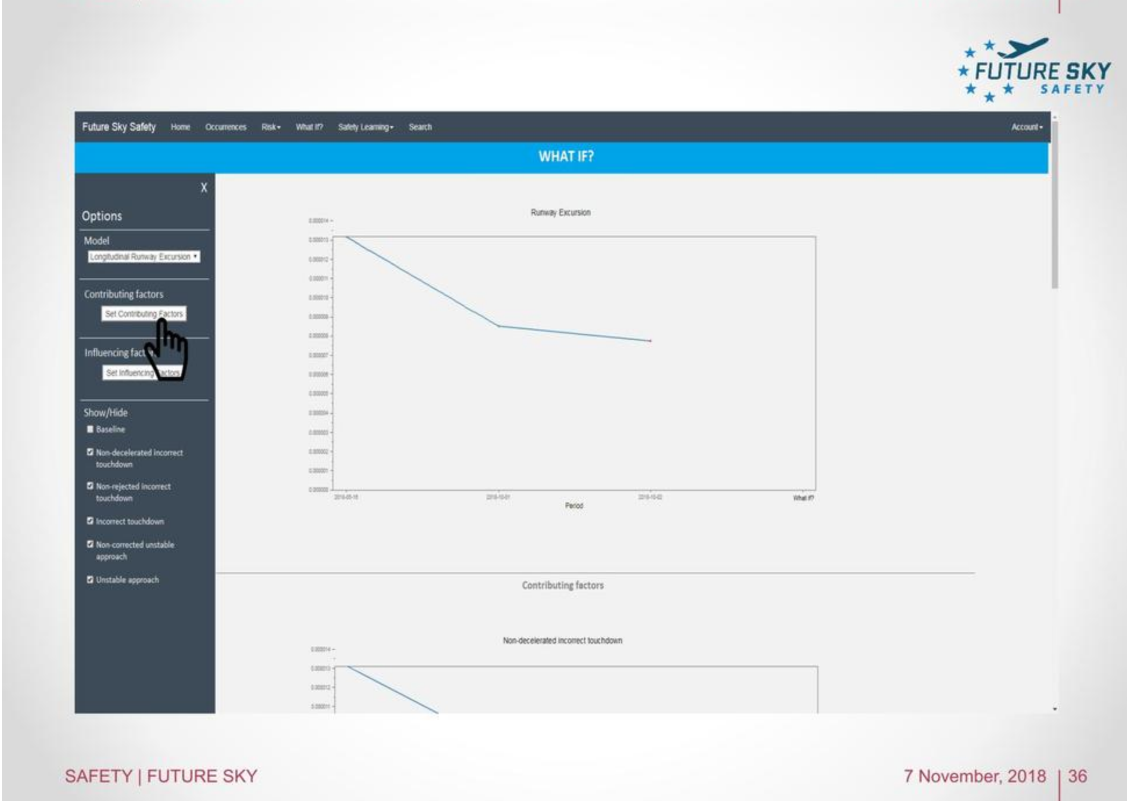
FUTURE SKY SAFETY
Future Sky Safety
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Safety Learning
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Account
WHAT IF?
Options
Model
Longitudinal Runway Excursion
Contributing factors
Set Contributing Factors
Show/Hide
Baseline
Non-decelerated incorrect touchdown
Non-rejected incorrect touchdown
Incorrect touchdown
Non-corrected unstable approach
Unstable approach
Runway Excursion
Period
What if?
Contributing factors
Non-decelerated incorrect touchdown
SAFETY | FUTURE SKY
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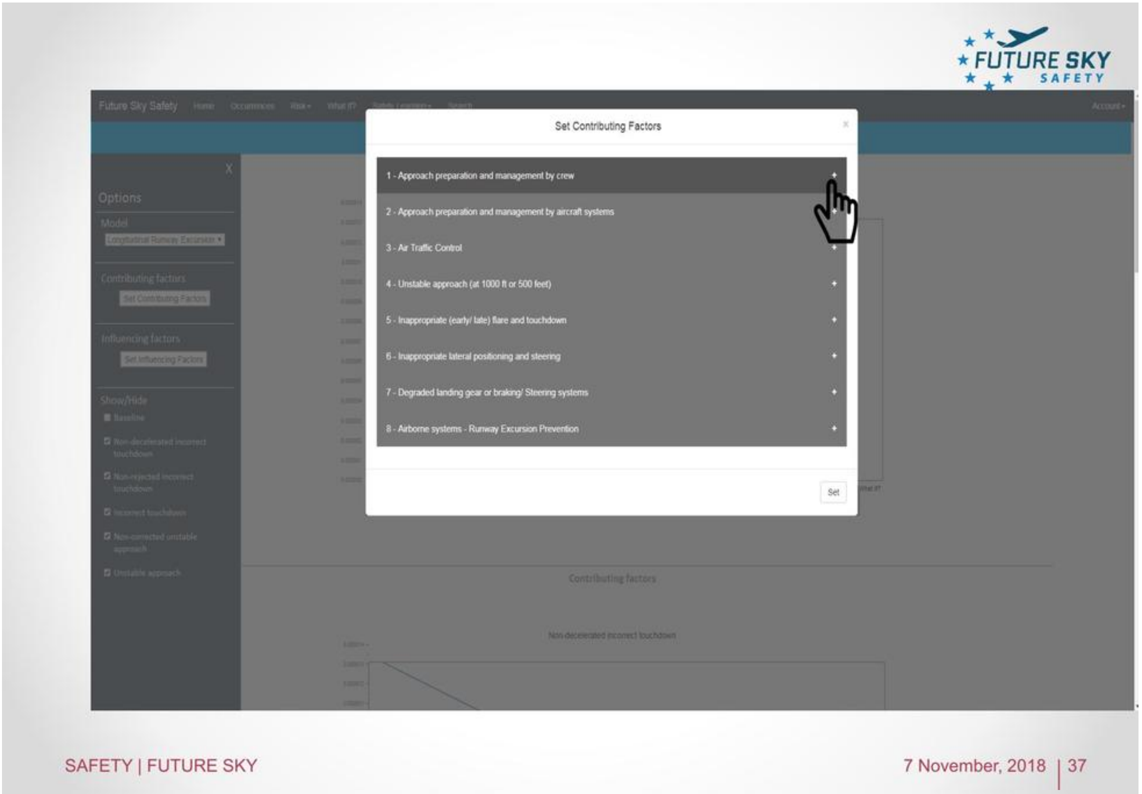
FUTURE SKY SAFETY
Set Contributing Factors
1 - Approach preparation and management by crew
2 - Approach preparation and management by aircraft systems
3 - Air Traffic Control
4 - Unstable approach (at 1000 ft or 500 feet)
5 - Inappropriate (early/ late) flare and touchdown
6 - Inappropriate lateral positioning and steering
7 - Degraded landing gear or braking/ Steering systems
8 - Airborne systems - Runway Excursion Prevention
Set
SAFETY | FUTURE SKY
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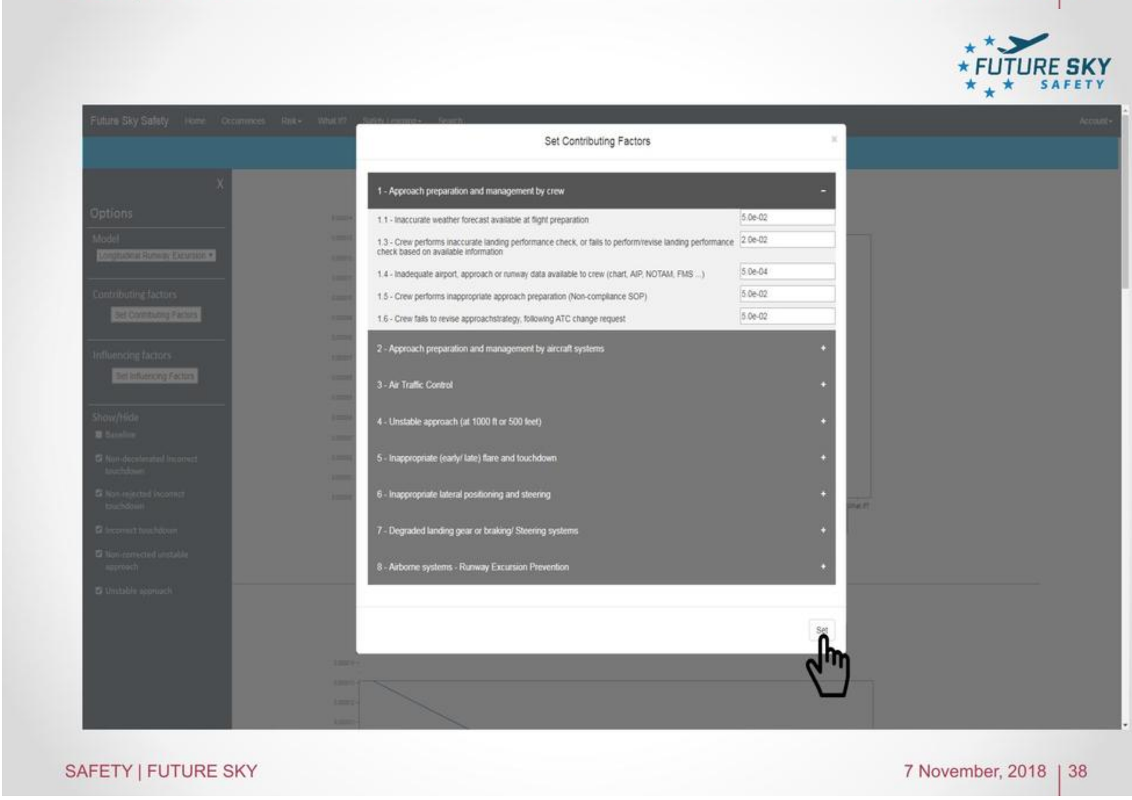
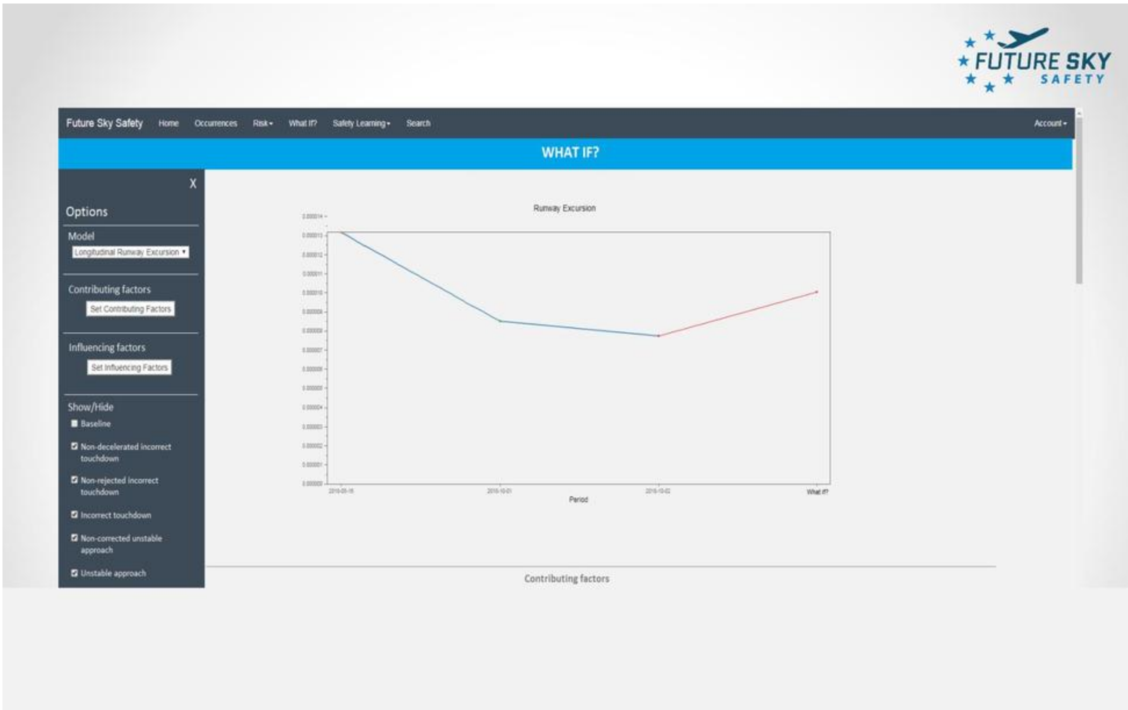

FUTURE SKY SAFETY
Set Contributing Factors
1 - Approach preparation and management by crew
1.1 - Inaccurate weather forecast available at flight preparation
5.0e-02
1.3 - Crew performs inaccurate landing performance check, or fails to perform/revise landing performance check based on available information
2.0e-02
1.4 - Inadequate airport, approach or runway data available to crew (chart, AIP, NOTAM, FMS ...)
5.0e-04
1.5 - Crew performs inappropriate approach preparation (Non-compliance SOP)
5.0e-02
1.6 - Crew fails to revise approachstrategy, following ATC change request
5.0e-02
2 - Approach preparation and management by aircraft systems
3 - Air Traffic Control
4 - Unstable approach (at 1000 ft or 500 feet)
5 - Inappropriate (early/ late) flare and touchdown
6 - Inappropriate lateral positioning and steering
7 - Degraded landing gear or braking/ Steering systems
8 - Airborne systems - Runway Excursion Prevention
Set
SAFETY | FUTURE SKY
7 November, 2018 | 38


Future Sky Safety
Home
Occurrences
Risk
What If?
Safety Learning
Search
Account
WHAT IF?
Options
Model
Longitudinal Runway Excursion
Contributing factors
Set Contributing Factors
Influencing factors
Set Influencing Factors
Show/Hide
Baseline
Non-decelerated incorrect touchdown
Non-rejected incorrect touchdown
Incorrect touchdown
Non-corrected unstable approach
Unstable approach
Runway Excursion
Period
What if?
Contributing factors
SAFETY | FUTURE SKY
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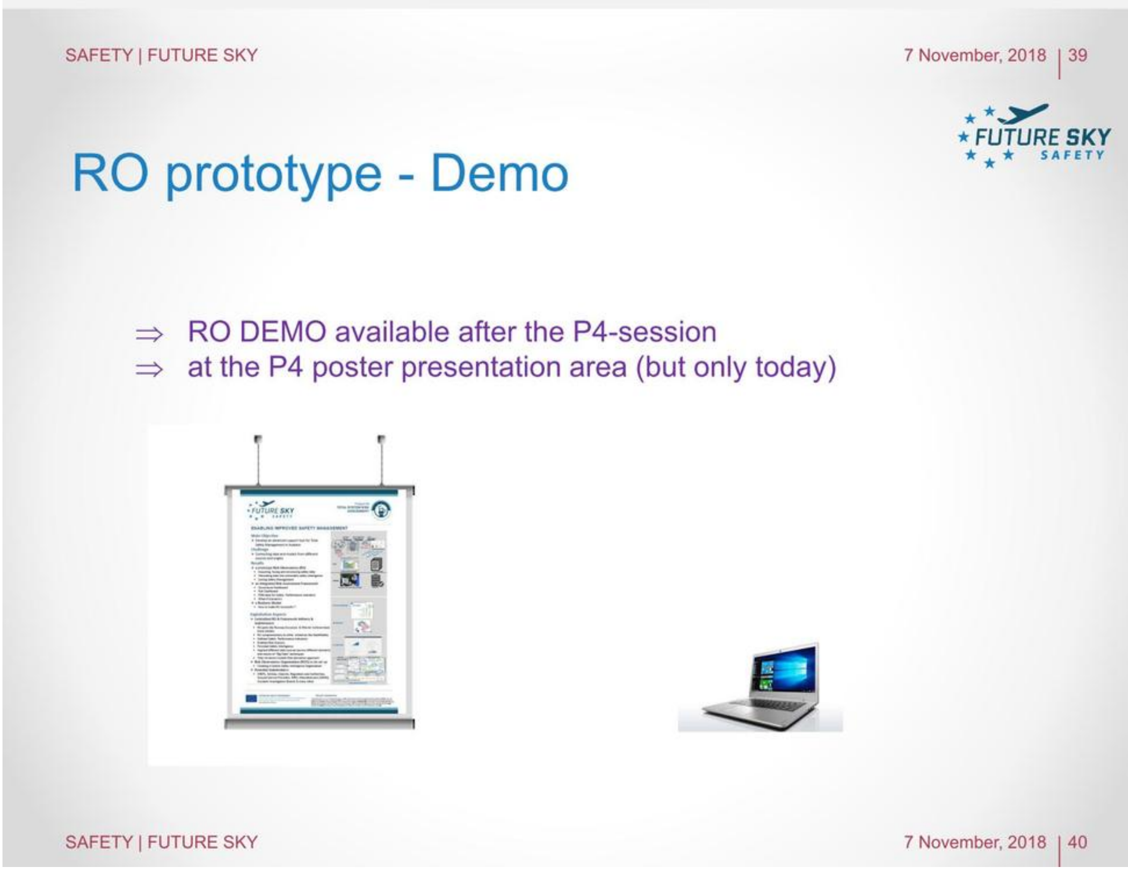
RO prototype - Demo
⇒ RO DEMO available after the P4-session
⇒ at the P4 poster presentation area (but only today)
SAFETY | FUTURE SKY
7 November, 2018 | 40

Preliminary Business Model

- RO intends to be
  - Complementary to other initiatives (e.g. Data4Safety)
  - Eventually run by an independent organisation within the European aviation safety system
  - Structured to be a centre of excellence for aviation safety data analysis
  - With analysis capabilities significantly greater than available within aviation organisations
  - Of sufficient size to conduct the required tasks and staffed with highly qualified, experienced analysts in order to be able to provide better information than currently available
- Work on business model continues in 2019

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RO Next steps

- RO prototype available & online accessible
- RO+integrated risk assessment framework Verification & Validation
- First RO s/w version prototype + user interface description - ready before year ends
- The Exploitation Action is expected to consist of:
  - Trial of prototype at KLM and at Airbus (in 2019)
  - Check other Stakeholder interest
  - Update prototype according to outcomes
- Total Aviation System Risk Picture 2018
  - Showing use cases of prototype RO
- Final RO s/w version ready before project ends
- Complete Business Model

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Summary: Why RO?

- Support tool need: acquire safety data and translate it into actionable safety information
- Tailorable for each Stakeholder individually
- Strengthening the ability to monitor safety performance
- Contribute to reaching < 1 accident per 10 million commercial aircraft flights:
  - More safety information available to organisations
  - Support business cases for mitigating overarching risks
  - Focus resources on highest risks
  - Tackle concerns at interfaces

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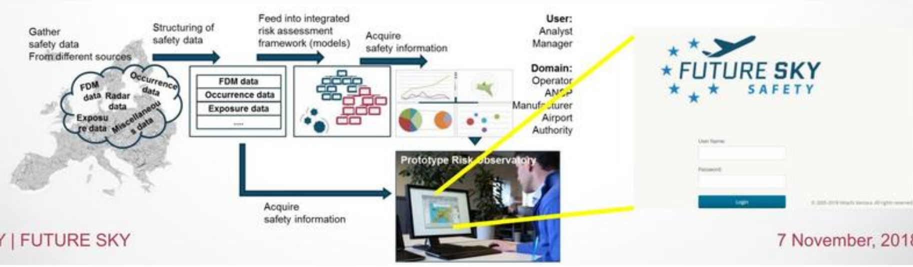
Concluding Remarks
P4 - Total System Risk Assessment

- To deliver a prototype RO, a Proof of Concept, incl. an integrated risk assessment framework, with RE and MAC backbones models.
- Providing a full (Aviation) risk picture
- Showing the contribution to risk from several domains
- Supporting the safety impact assessment of changes within several domains
- Finding best ways to visualize data: the quickest route from safety data to safety information
- Implementation, maintenance and operational use in a real environment are beyond the timeframe of P4



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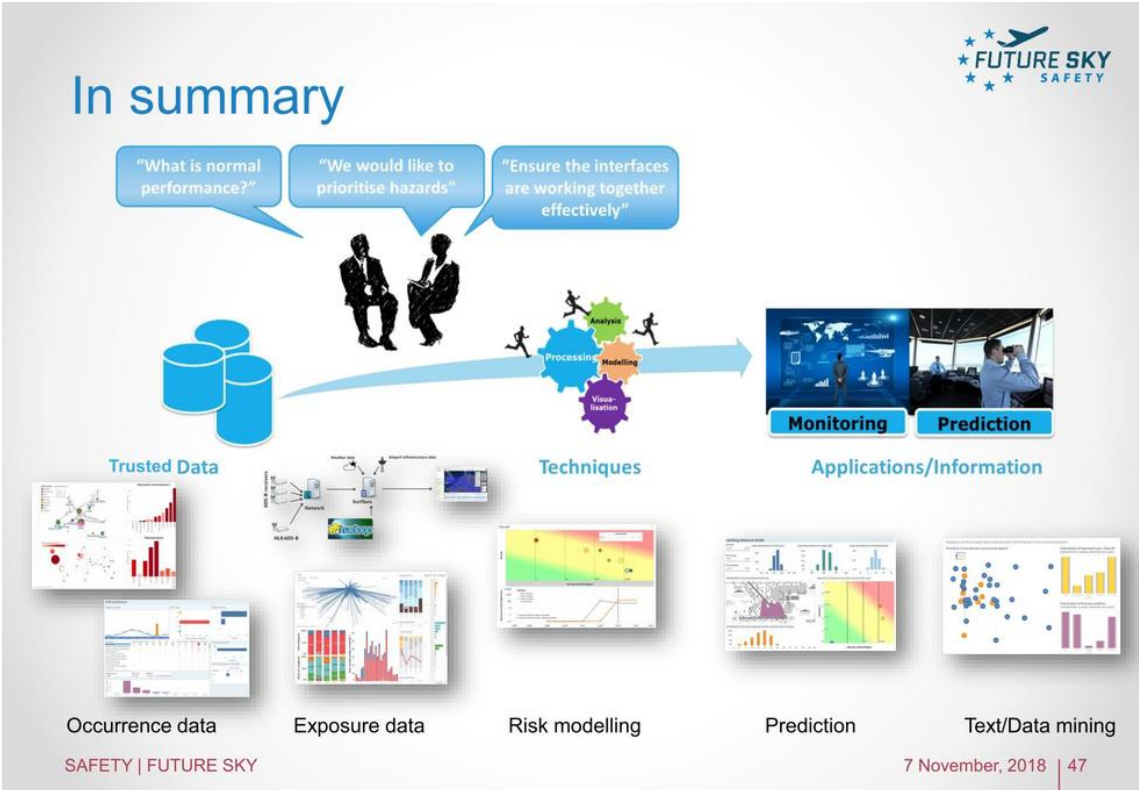


Appendix B.11 "P4: Backbone models supporting a total safety assessment inside the air transport system" – Pierre Bieber, ONERA

BACKBONE MODELS

SUPPORTING A TOTAL SAFETY ASSESSMENT INSIDE THE AIR TRANSPORT SYSTEM

SAFETY | FUTURE SKY

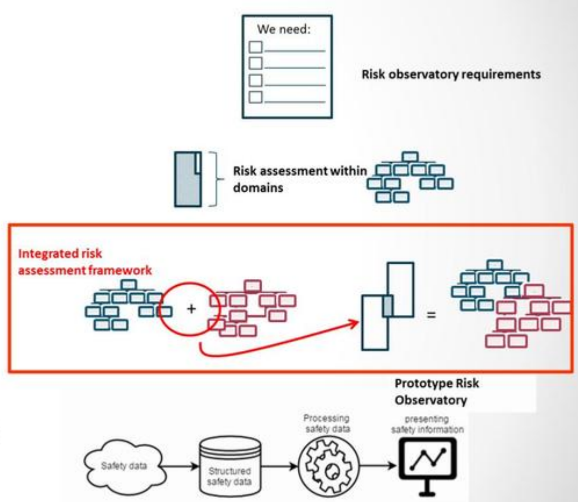
Goals

→ Propose means

→ to integrate risk models developed within various domains

→ to perform What-if computation

→ to implement the risk models in the Risk Observatory



SAFETY | FUTURE SKY | 2

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Total Aviation System Risk Models

- Two-step Modelling Approach
  - 1^{st} step : Backbone model derived from IRP (Eurocontrol) and CATS (NLR) models
  - 2^{nd} step : Risk models developed within domains : ANSP detailed risk model (Eurocontrol), ATM Ground equipment model (Thales), Airborne system models (Thales, Airbus)
- Two risks were selected to validate the modelling approach
  - Runway Excursions (RE), Mid-Air Collisions (MAC),
- Other risks were reviewed, No blocking points were identified
  - Controlled Flight into Terrain (CFIT), Loss of Control in Flight (LOCF), Runway Incursions (RI)
  - *Fire, Smoke & Fumes (FSF)*

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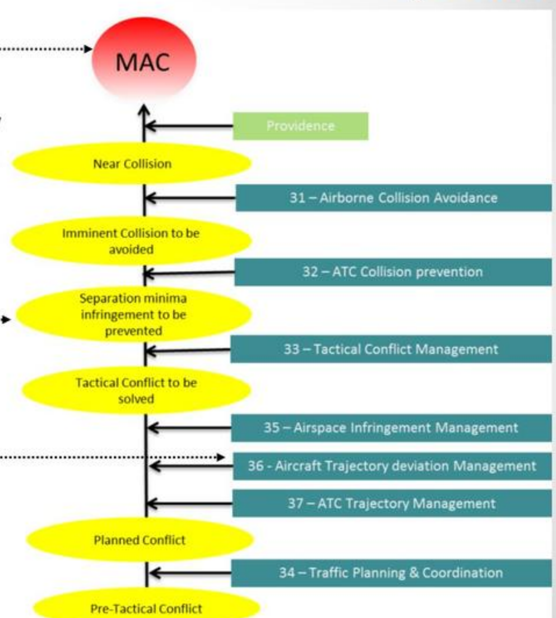
Backbone model – 1/4

Backbone model - Principle

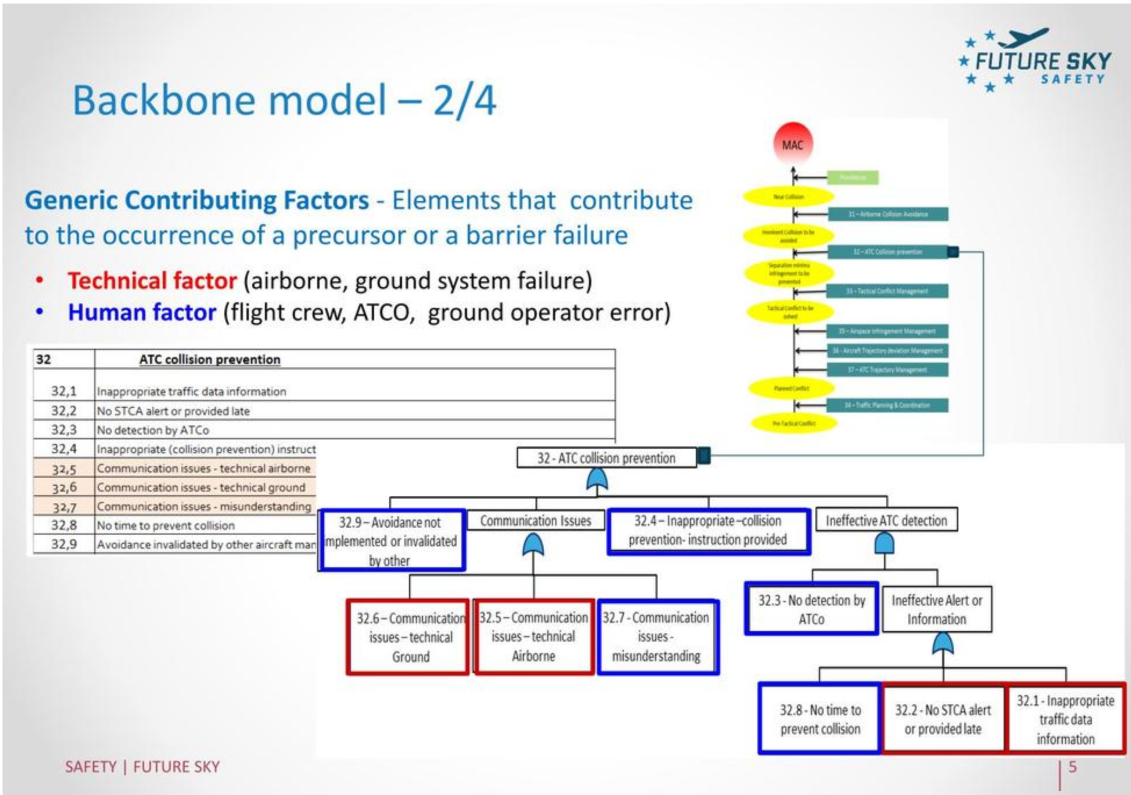
The backbone model manages in a consistent way **contributors** and **influencing factors** leading to a **Global risk**

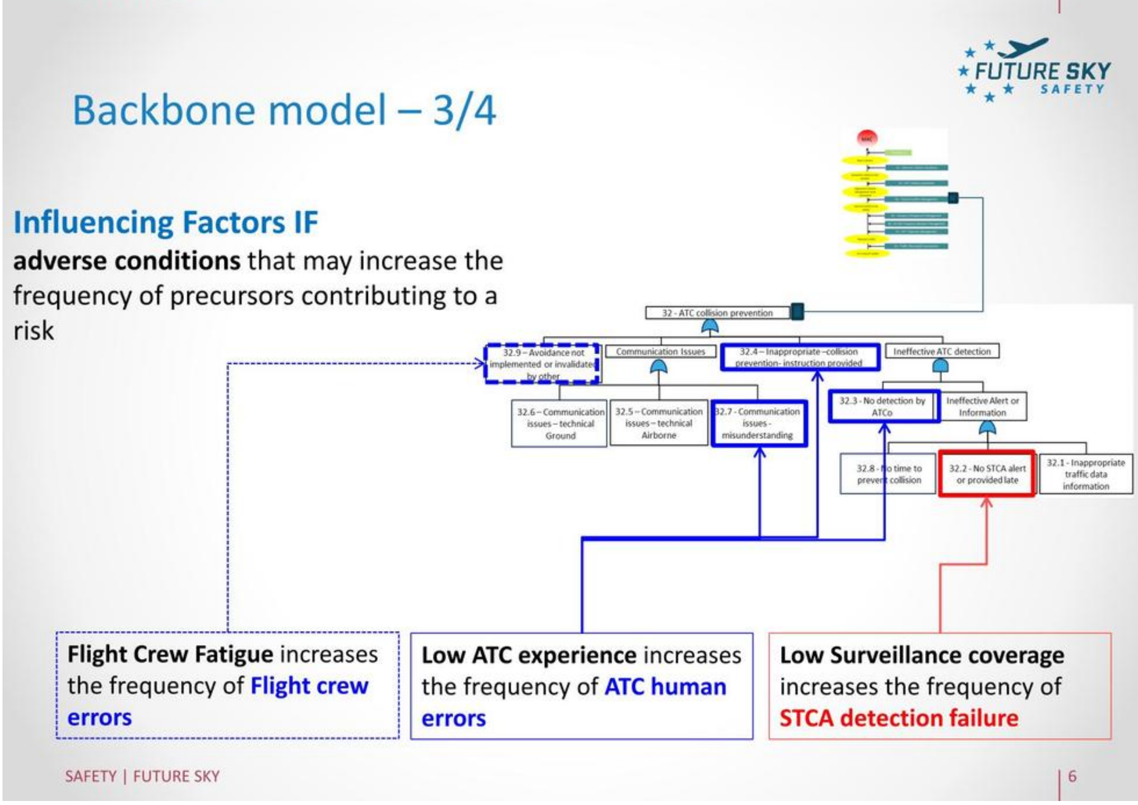
Precursors Hazardous situations

Barriers Means to **prevent error** and **failure propagation**



SAFETY | FUTURE SKY | 4





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Backbone model – 4/4

- **Influencing Factors** are defined by **Attributes, Weight** and **Occurrence Rate**
  - Attributes and weights are generic
  - Occurrence rates are specific to an organization (e.g. Airline, ANSP, …)

ATC Experience level

Attribute	Weight	Rate
High	1	5%
Medium	1.2	90%
Low	2	5%

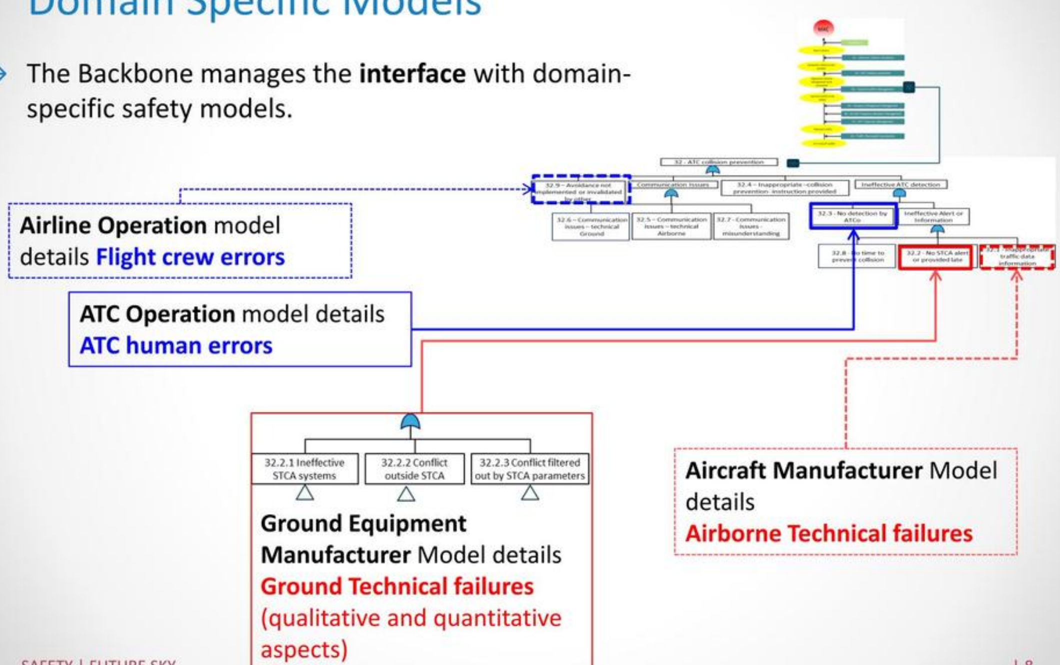
Rectified weight = $\text{Sum}_{i:\text{attributes}}(\text{Rate}_i * \text{Weight}_i)$

- Rectified weight for "ATC Experience level"= 1.23
  - Probabilities of influenced contributors are multiplied by the Rectified weight

SAFETY | FUTURE SKY 7

Domain Specific Models

→ The Backbone manages the **interface** with domain-specific safety models.



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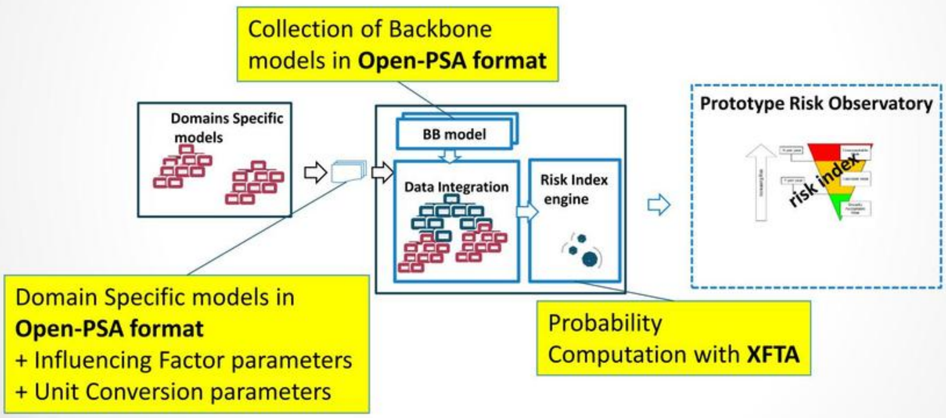
Implementation in the Risk Observatory

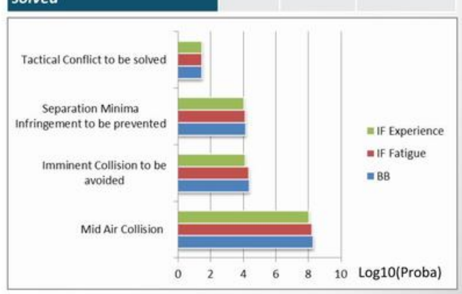


SAFETY | FUTURE SKY 9

What-if Computations – 1/2

- Compute the probability of safety indicators (MAC, Imminent collision, …) with variations of the Backbone model
  - Backbone standalone provides the baseline figures
  - Study the Impact of Influencing Factors :
    - Select active IFs
      - Crew Fatigue, ATC Experience Level
    - Change occurrence rates of IFs
    - Compute the probability of safety indicators and compare with baseline figures

Precursor	BB	IF Fatigue	IF Experience
Mid Air Collision	5,0E-9	6,2E-9	9,2E-9
Imminent Collision to be avoided	4,2E-5	4,5E-5	7,7E-5
Separation Minima Infringement to be prevented	6,9E-5	7,2E-5	9,1E-5
Tactical Conflict to be solved	3,3E-2	3,3E-2	3,4E-2



SAFETY | FUTURE SKY 10

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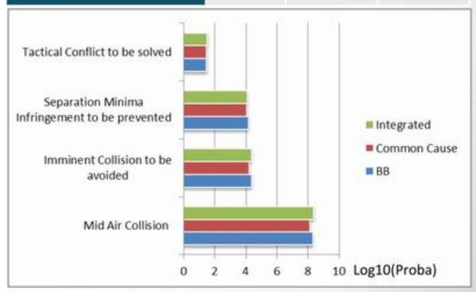
What-if Computations – 2/2

- Compare the probability computed with variations of the Backbone model
  - Study the Impact of Domain Specific models
    - Integrate Backbone + Domain specific risk models
      - ATM Ground equipment, Airborne equipment
      - Airline Contributing Factor Probabilities
    - Compare probability of safety indicators with baseline figures
  - Study the Impact of Common Causes
    - Add Common Causes Groups to the Risk models
      - Airborne Communication Failures
    - Compare probability of safety indicators with baseline figures

Precursor	BB	Common Cause	Integrated
Mid Air Collision	5,0E-9	7.5e-9	4.3e-9
Imminent Collision to be avoided	4,2E-5	6.0e-5	4.4e-5
Separation Minima Infringement to be prevented	6,9E-5	8.8e-5	8.2e-5
Tactical Conflict to be solved	3,3E-2	3,4E-2	3.0e-2



SAFETY | FUTURE SKY 11

Conclusion

Lessons Learnt

The Backbone Model helps to compute safety indicators using domain specific contributors

... this requires some Modelling Effort

- Define Generic Contributors for a given risk
- Link Generic and Domain Specific Contributors
- Use Conversion rules for quantification (various units : per flight, per flight-hour, per operational-hour, ….)

Way forward

Use collected data to quantify Generic and Domain Specific Contributors

Reuse existing Backbone models to study new concepts of operations (for instance RPAS insertion in Traffic)

Propose Backbone models for other Risks

SAFETY | FUTURE SKY 12

Appendix B.12 "P5: Raising our game in organisational safety management" – Barry Kirwan, Eurocontrol

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P5 Resolving the organisational accident
3
SAFETY INTELLIGENCE AT THE TOP
Ensuring that Executive Board and senior managers lead safety
MINDFULNESS
Fast and effective transmission of safety info at the operational layer
SAFETY CULTURE BEYOND ATM
Extending ATM's successful safety culture approach to the rest of aviation
AGILE RESPONSE TO CRISES
Ensuring we are prepared for pan-European crises affecting the Network
ADVANCED SAFETY MANAGEMENT SYSTEM
Integrating the above into current SMS frameworks
INTELLIGENCE
MINDFULNESS
SAFETY CULTURE
AGILE RESPONSE
ADVANCED SMS


FUTURE SKY SAFETY
Safety Intelligence
SAFETY INTELLIGENCE
SAFETY MINDFULNESS
People
EXECUTIVES
People
MIDDLE MANAGEMENT
People
STAFF
SAFETY | FUTURE SKY
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How middle managers can take account of safety:
A Safety Blueprint
Two hours for safety…
After interviewing 48 middle managers from 10 aviation organisations, a 'training' package has been developed to enable middle managers to reflect on how they take account of safety in their daily activities, and to see how other organisations do so.


8
The Middle Manager
Mindset
Personal experience & approach to safety
Managing
Managing information, making decisions, influencing others
Working Environment
Organisational focus on safety, support from bosses & peers, procedures/processes
External Environment
Cost pressures, stakeholder relations and expectations, regulatory climate

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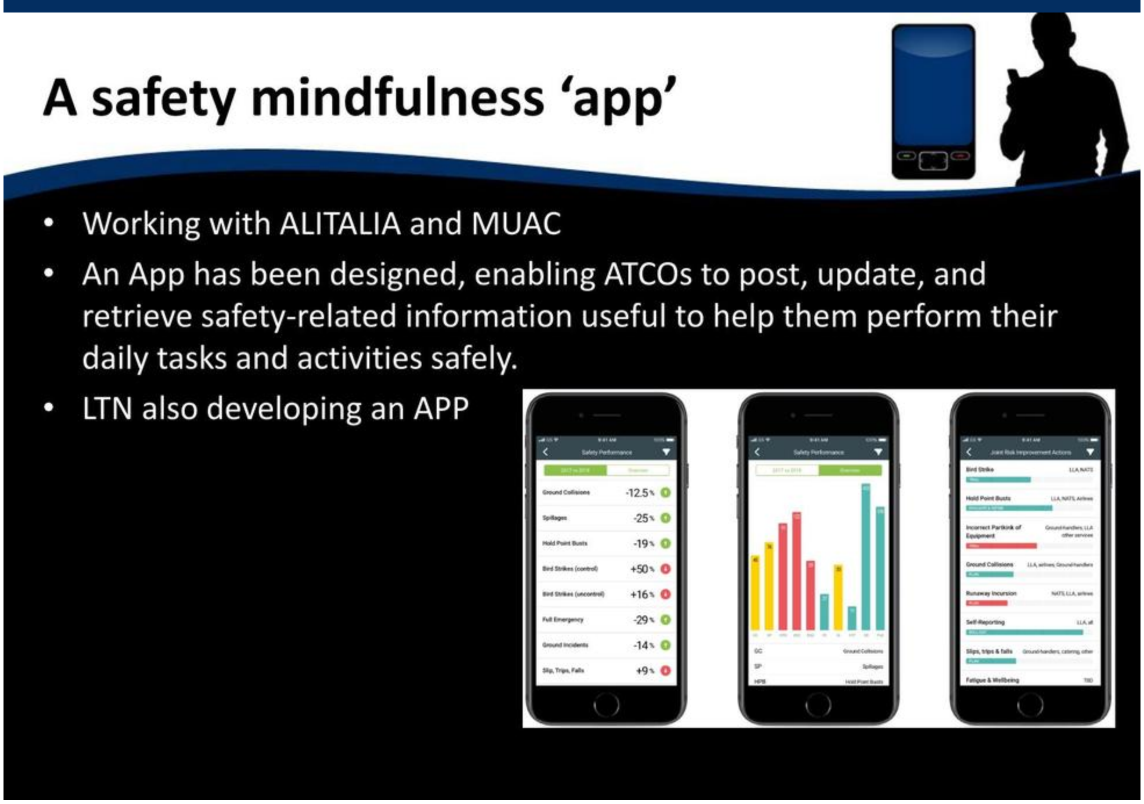


Future Sky Safety has received funding from the EU's Horizon 2020 Research and Innovation Programme, under Grant Agreement No. 640597.

Future Sky Safety has received funding from the EU's Horizon 2020 Research and Innovation Programme, under Grant Agreement No. 640597.

Survey of European Commercial Pilots

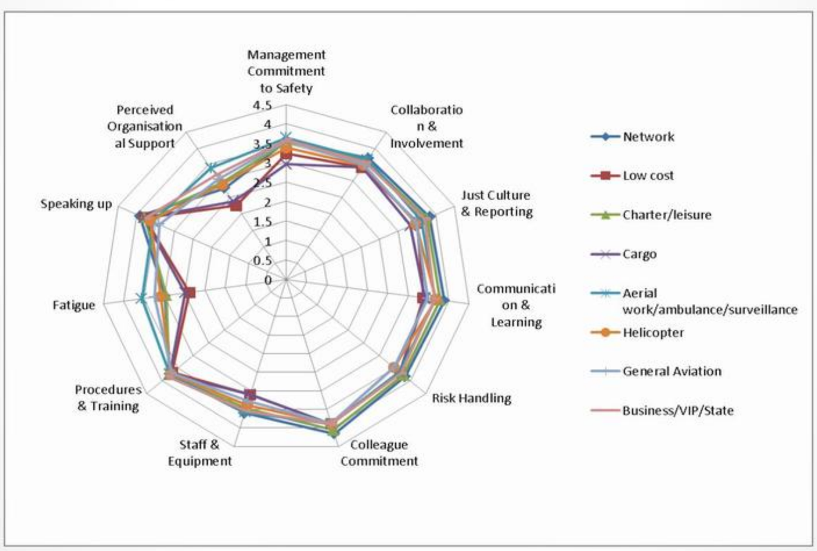
7200 Pilots

17 Countries

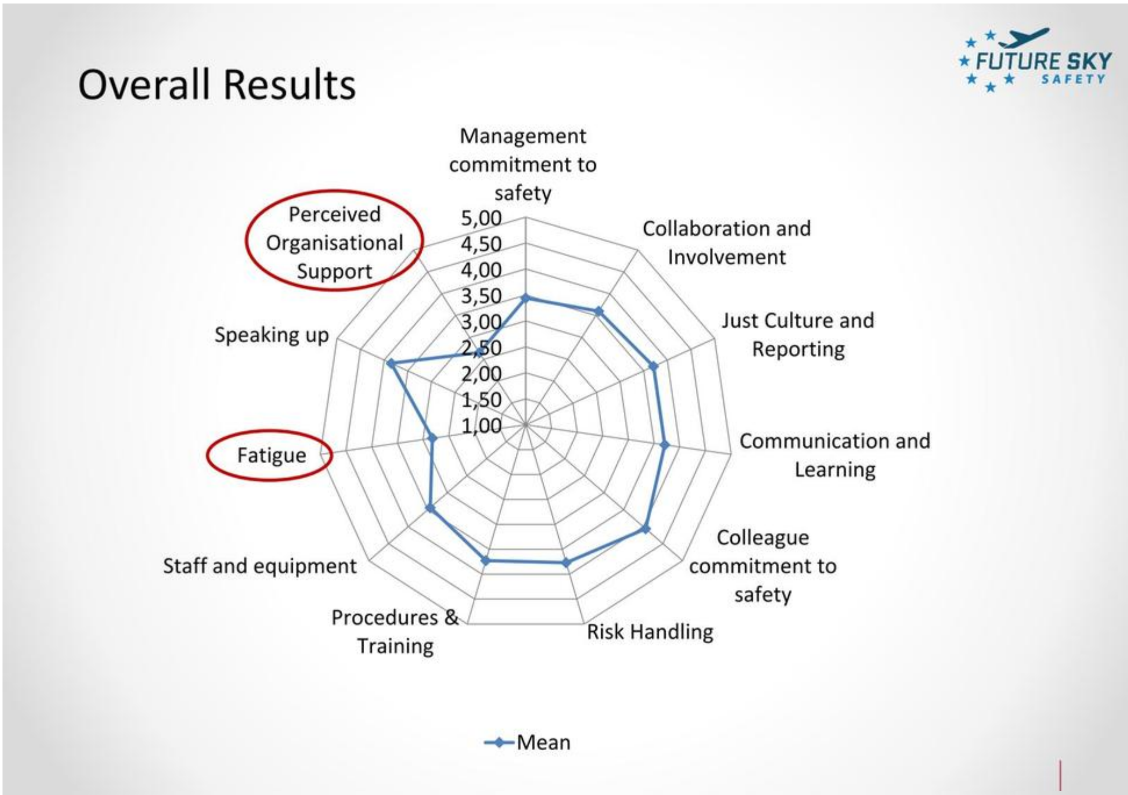
33 Companies

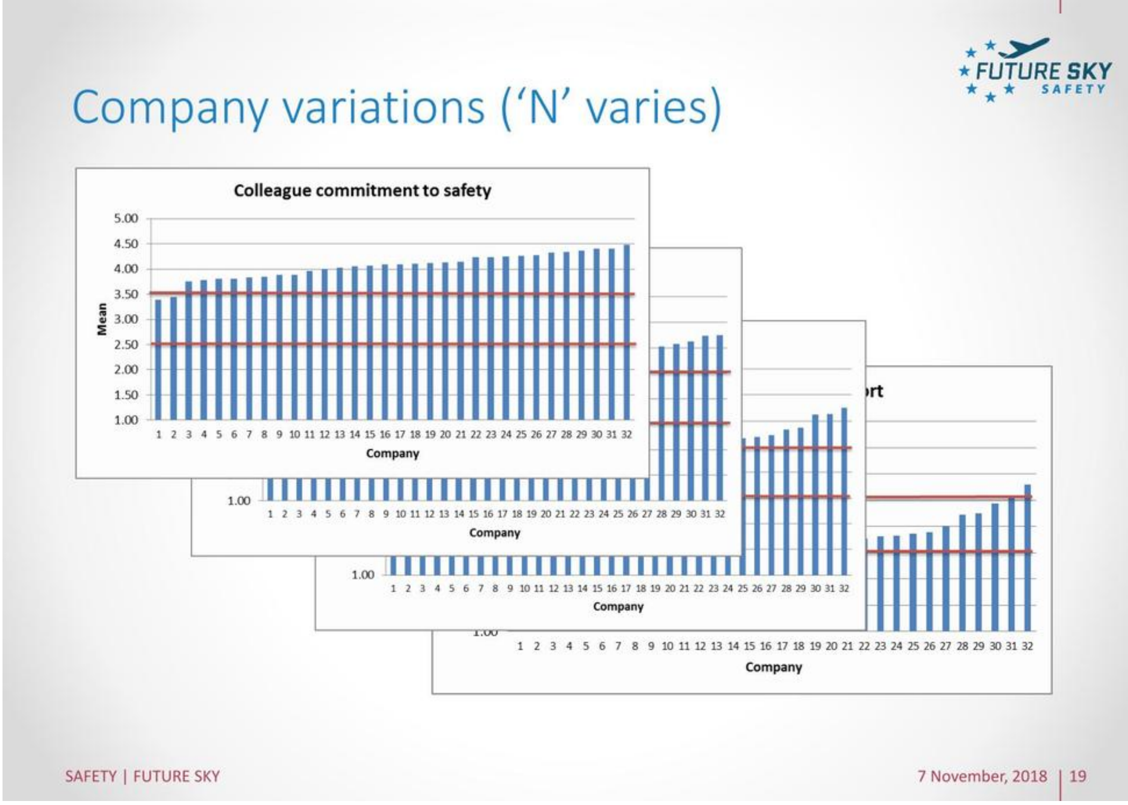
Network, Low-cost, Charter, Cargo, Business Jets, S&R, Helicopter, GA

By company type



Future Sky Safety has received funding from the EU's Horizon 2020 Research and Innovation Programme, under Grant Agreement No. 640597.


Overall Results
Management commitment to safety
Collaboration and Involvement
Just Culture and Reporting
Communication and Learning
Colleague commitment to safety
Risk Handling
Procedures & Training
Staff and equipment
Fatigue
Speaking up
Perceived Organisational Support
5,00
4,50
4,00
3,50
3,00
2,50
2,00
1,50
1,00
Mean


Company variations ('N' varies)
Colleague commitment to safety
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
Mean
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
Company
SAFETY | FUTURE SKY
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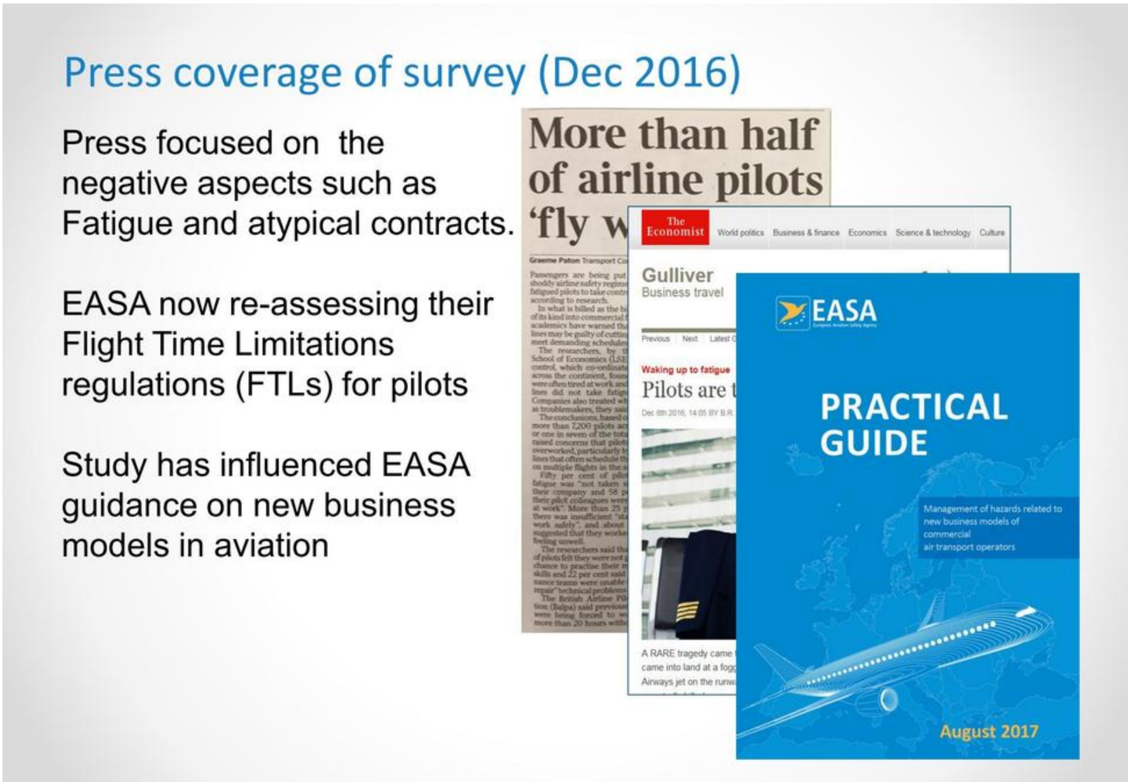

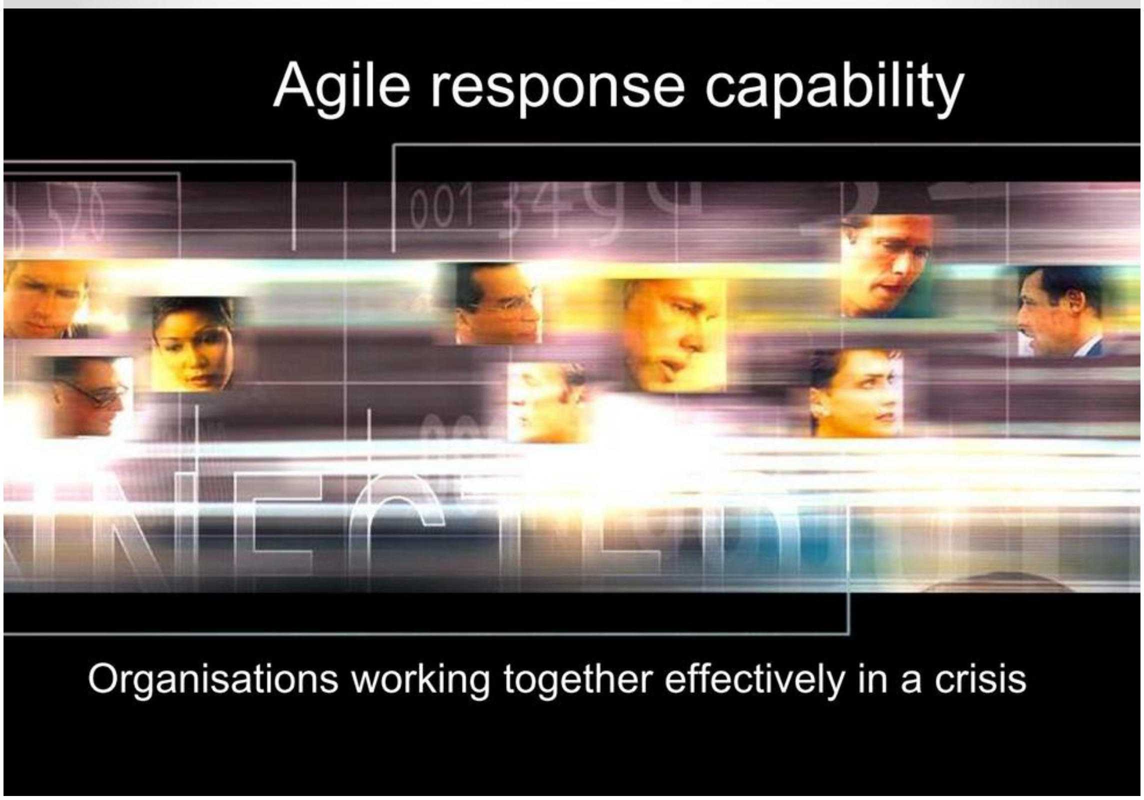

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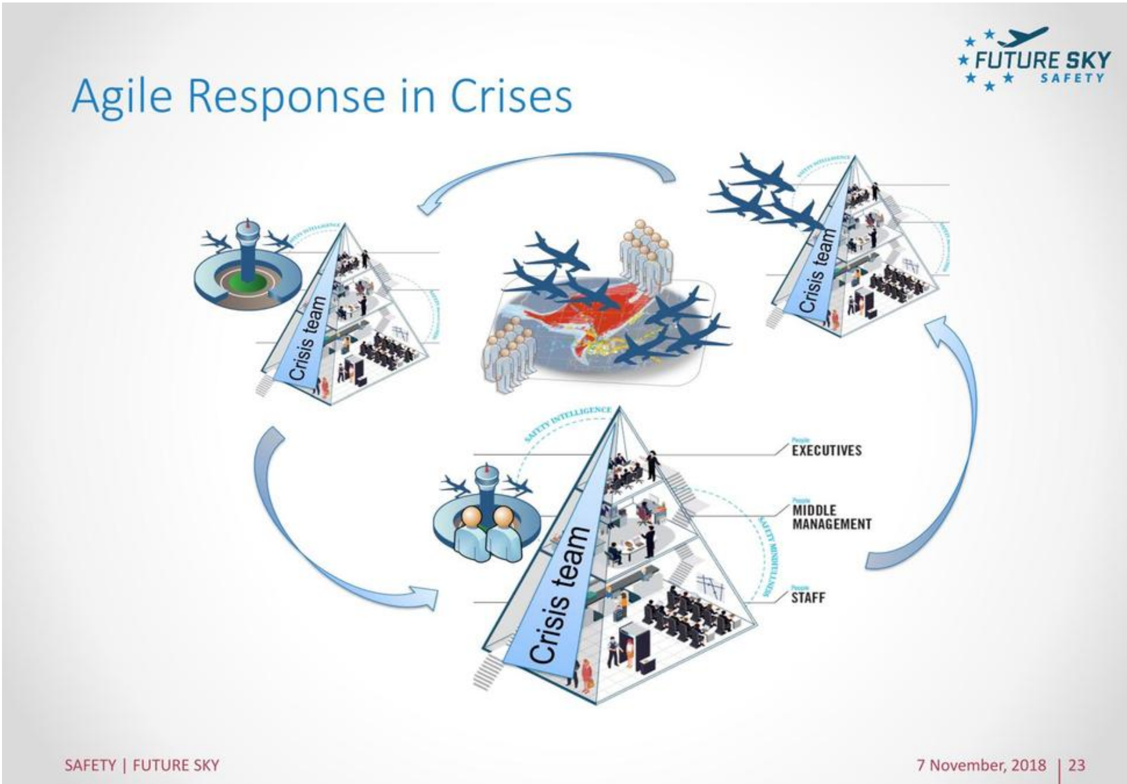
Agile Response in Crises
FUTURE SKY SAFETY
Crisis team
Crisis team
Crisis team
EXECUTIVES
MIDDLE MANAGEMENT
STAFF
SAFETY | FUTURE SKY
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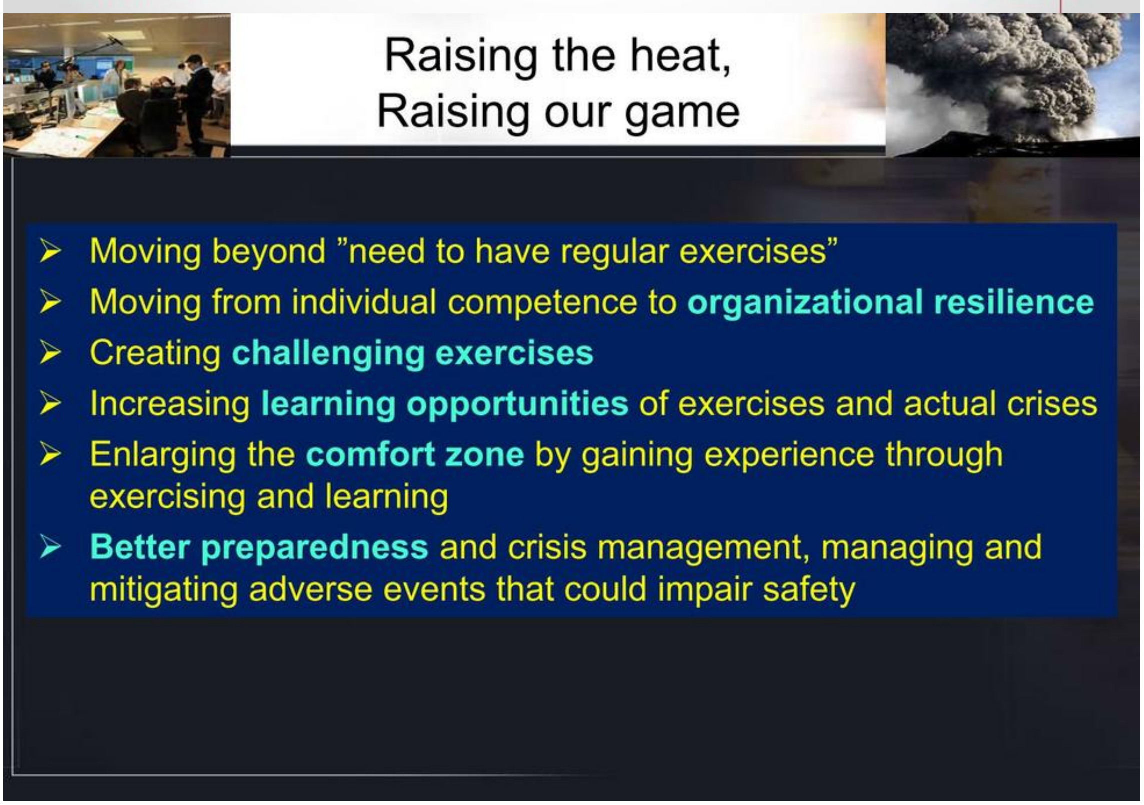
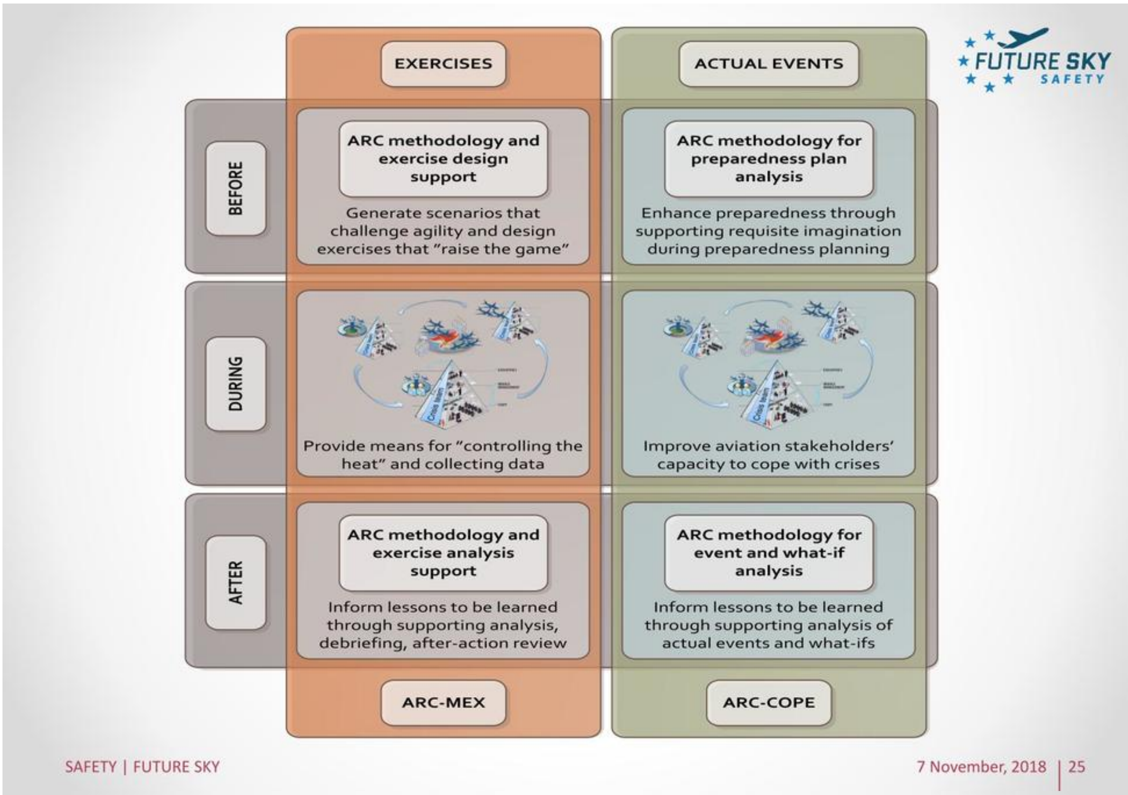

Raising the heat,
Raising our game
➢ Moving beyond "need to have regular exercises"
➢ Moving from individual competence to organizational resilience
➢ Creating challenging exercises
➢ Increasing learning opportunities of exercises and actual crises
➢ Enlarging the comfort zone by gaining experience through exercising and learning
➢ Better preparedness and crisis management, managing and mitigating adverse events that could impair safety



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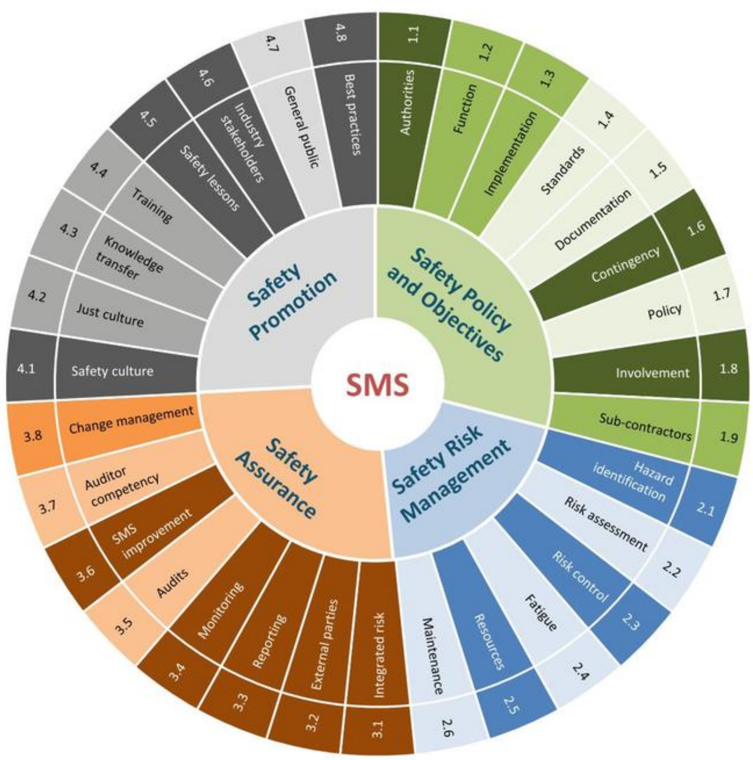

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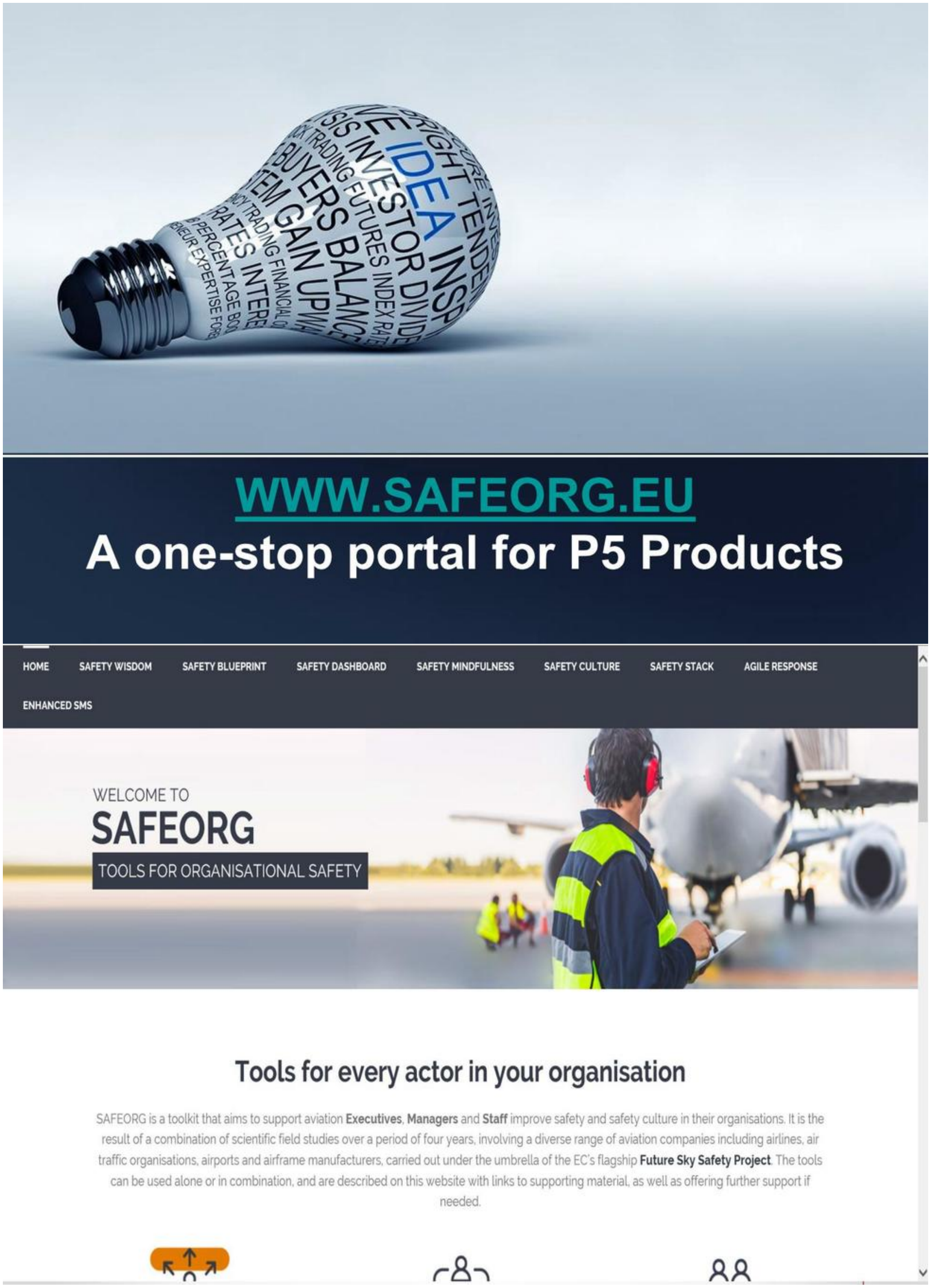
WWW.SAFEORG.EU
A one-stop portal for P5 Products
HOME
SAFETY WISDOM
SAFETY BLUEPRINT
SAFETY DASHBOARD
SAFETY MINDFULNESS
SAFETY CULTURE
SAFETY STACK
AGILE RESPONSE
ENHANCED SMS
WELCOME TO
SAFEORG
TOOLS FOR ORGANISATIONAL SAFETY
Tools for every actor in your organisation
SAFEORG is a toolkit that aims to support aviation Executives, Managers and Staff improve safety and safety culture in their organisations. It is the result of a combination of scientific field studies over a period of four years, involving a diverse range of aviation companies including airlines, air traffic organisations, airports and airframe manufacturers, carried out under the umbrella of the EC's flagship Future Sky Safety Project. The tools can be used alone or in combination, and are described on this website with links to supporting material, as well as offering further support if needed.

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Appendix B.13 "P5: Dave Cross (easyJet): LTN safety stack" – Liam Bolger, Luton Airport

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LTN Safety Stack

In 2015 an EU-funded project called Future Sky Safety was launched. One of its main aims was to adapt the EUROCONTROL safety culture approach, already used in air traffic organisations in more than 30 European countries, to the airline and airport side of the aviation operation. This was seen as strategic for safety, since there is significant cost pressure on the industry at present.

In 2016, London Luton Airport (LLA) and some of its key stakeholders participated in a Safety Culture Survey as part of an initiative funded by the European Commission under the Horizon 2020 Future Sky Safety Programme; this survey was conducted by the London School of Economics in collaboration with Eurocontrol. The primary objective of the survey was to identify safety culture across individual aviation stakeholder groups and to seek ways of enhancing safety across the aviation network. LLA hosted a two day workshop in January 2017 out of which the LTN Safety Stack was formed and several action points agreed by the stakeholder groups involved in the workshop.

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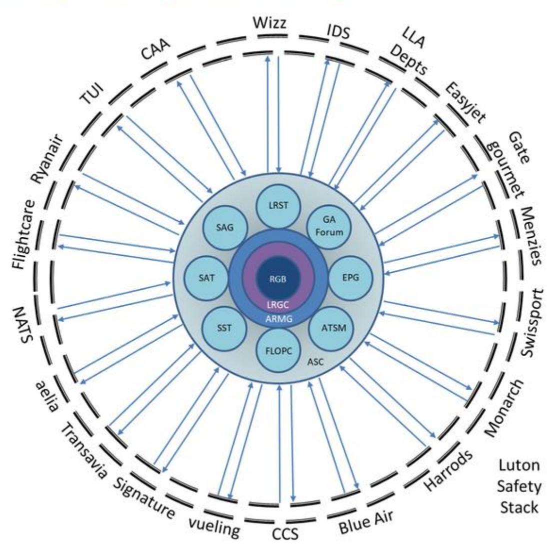
Key Points

1. We are not seeking to 'break down silos', every organisation has the right to run its business as it sees fit – we are seeking to create workable links across organisations and their individual component parts for the purpose of sharing and learning.

2. Organisations in a shared place, such as an airport, have the opportunity to meet to discuss problems and opportunities.

3. The Luton Safety Stack provides an example of a working collaborative initiative to help manage safety across interfaces, based on safety practice development and safety intelligence sharing initiatives between 15 organisations based at the airport.

Organising for safety intelligence sharing



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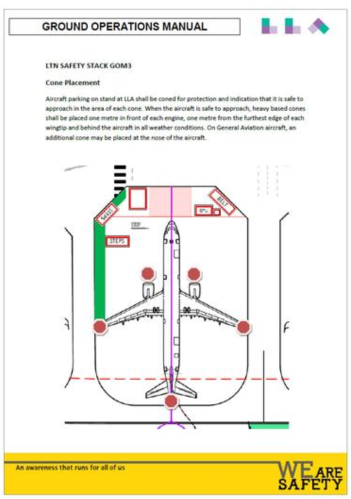
LTN Safety Stack Initiatives

1. Harmonisation of Ground Handling process through the adoption of the IGOM – in progress
2. Standardised emails for safety communication - completed
3. Shared safety dashboard – in progress
4. Safety culture and contracts management – replaced with Don't Panic
5. LTN Safety Stack video – Complete and due to be launched
6. Recognition and appreciation – in progress with the AOC
7. A day in the life – replaced with Safety Every Day
8. Pooled training – replaced with Just Culture
9. Safety Leaders Programme – in progress

LTN Safety Stack Initiatives

LTN GOMs:



GROUND OPERATIONS MANUAL

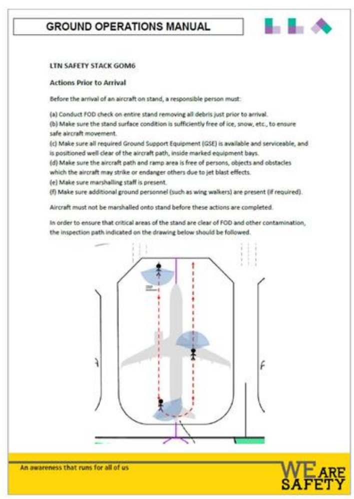
LTN SAFETY STACK GOM3

Cone Placement

Aircraft parking on stand at LLA shall be coned for protection and indication that it is safe to approach in the area of each cone. When the aircraft is safe to approach, heavy based cones shall be placed one metre in front of each engine, one metre from the furthest edge of each wingtip and behind the aircraft in all weather conditions. On General Aviation aircraft, an additional cone may be placed at the nose of the aircraft.

An awareness that runs for all of us

WE ARE SAFETY



GROUND OPERATIONS MANUAL

LTN SAFETY STACK GOM6

Actions Prior to Arrival

Before the arrival of an aircraft on stand, a responsible person must:

(a) Conduct FOD check on entire stand removing all debris just prior to arrival.
(b) Make sure the stand surface condition is sufficiently free of ice, snow, etc., to ensure safe aircraft movement.
(c) Make sure all required Ground Support Equipment (GSE) is available and serviceable, and is positioned well clear of the aircraft path, inside marked equipment bays.
(d) Make sure the aircraft path and ramp area is free of persons, objects and obstacles which the aircraft may strike or endanger others due to jet blast effects.
(e) Make sure marshalling staff is present.
(f) Make sure additional ground personnel (such as wing walkers) are present (if required).

Aircraft must not be marshalled onto stand before these actions are completed.

In order to ensure that critical areas of the stand are clear of FOD and other contamination, the inspection path indicated on the drawing below should be followed.

An awareness that runs for all of us

WE ARE SAFETY

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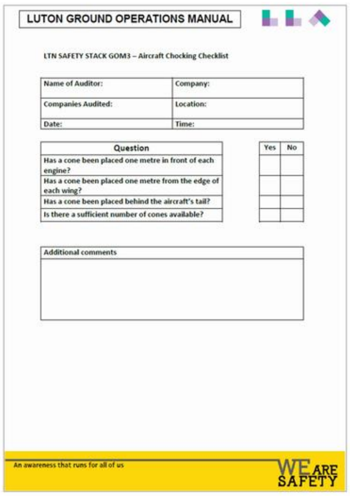
LTN Safety Stack Initiatives

LTN GOM Checklists:



LUTON GROUND OPERATIONS MANUAL

LTN SAFETY STACK GOM3 – Aircraft Chocking Checklist

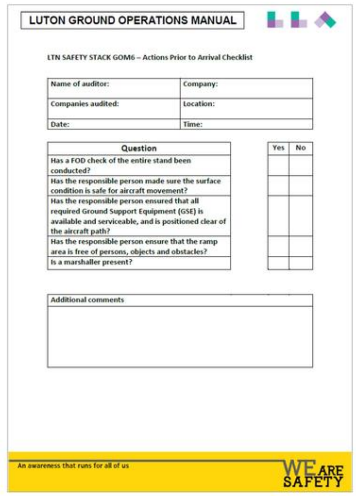
Name of Auditor:	Company:
Companies Audited:	Location:
Date:	Time:

Question	Yes	No
Has a cone been placed one metre in front of each engine?		
Has a cone been placed one metre from the edge of each wing?		
Has a cone been placed behind the aircraft's tail?		
Is there a sufficient number of cones available?		

Additional comments

An awareness that runs for all of us

WE ARE SAFETY



LUTON GROUND OPERATIONS MANUAL

LTN SAFETY STACK GOM6 – Actions Prior to Arrival Checklist

Name of auditor:	Company:
Companies audited:	Location:
Date:	Time:

Question	Yes	No
Has a FOD check of the entire stand been conducted?		
Has the responsible person made sure the surface condition is safe for aircraft movement?		
Has the responsible person ensured that all required Ground Support Equipment (GSE) is available and serviceable, and is positioned clear of the aircraft path?		
Has the responsible person ensure that the ramp area is free of persons, objects and obstacles?		
Is a marshaller present?		

Additional comments

An awareness that runs for all of us

WE ARE SAFETY

LTN Safety Stack 6th February 2018 Meeting Agenda:

LUTON SAFETY STACK MEETING
6TH FEBRUARY 2018

AGENDA

09:00	Welcome (Liam and Barry)
09:15	Storyboard for the Stack video (Jane Danser)
10:30	*Coffee*
10:45	Visualisation of Safety Dashboard (Carlo and Barry)
11:15	Presentation by Airport Labs (Ligiu Uiorean, Filip Chereches, Bogdan Stănescu, Ruben Sainiuc, Sabin Sanislav)
12:30	*Buffet Lunch*
13:15	Mission statement for the LTN Safety Stack and Safety Leader Values (Sian, Barry and Sarah)
13:30	Overview of Safety Survey Results and Safety Performance 2017 (Liam)
14:00	Update on Safety Stack actions from last meeting (All) · Terms of Reference for "We are Safety" to be agreed. · NO to amend the footer of the Branding for the Stack to include "An awareness that runs through us all". · SF to contact Neil Bradford to discuss the possibility of The Stack having a page on the Airport's Newletter 'Transform'.
14:15	Open Discussion on current Stack Initiatives and Progress (Sian, Dave, Gavin, Liam, All) Action Line 1: Harmonisation of Ground Handling process through the adoption of the IGOM Action Line 2: Standardised emails for safety communication Action Line 3: Shared safety dashboard Action Line 4: Safety culture and contracts management Action Line 5: LTN Safety Stack video Action Line 6: Recognition and appreciation Action Line 7: A day in the life Action Line 8: Pooled training Action Line 9: Safety Leaders Programme
15:00	*Close of Meeting*

AN AWARENESS THAT RUNS THROUGH US ALL

WE ARE SAFETY

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Safety Performance 2017

Airside Safety Events 2016 Vs 2017			
Aircraft Accidents	0%	MOR Airfield	↓ 29%
Airside Collisions	↓ 19%	MOR Airspace	↓ 26%
Airside Incidents	↓ 20%	Near Miss Reports	↓ 33%
Bird Strikes	+12%	Slip/Trip/Fall	+9%
Full Emergency	↓ 29%	Spillages	↓ 16%
Ground Incidents	+14%	Red Incidents	0%
Local Standby	+111%	Amber Incidents	↓ 31%
Safety Assurance checks carried out	↑ 35%	Safety Assurance check deficiencies	↓ 4%
Points of Engagement	↑ 350%	Self/Open Reporting	↑ 422%

Appendix B.14 "P5: KLM insights from a safety culture survey" – Jaap van den Berg, KLM

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RANK	AIRLINE	CODECS	COUNTRY	NEW RISK-INDEX 2018	ORDER
1	Emirates	UAE	United Arab Emirates	93,61 %	REPORT
2	Norwegian AS	NAX	Norway	93.26 %	REPORT
3	Virgin Atlantic AW	VIR	United Kingdom	92,87 %	REPORT
4	KLM	KLM	Netherlands	92,77 %	REPORT
5	EasyJet	EZY	United Kingdom	92,75 %	REPORT
6	Finnair	FIN	Finland	92,67 %	REPORT
7	Etihad Airways	ETD	United Arab Emirates	92,56 %	REPORT
8	Spirit Airlines	NKS	USA	92,18 %	REPORT
9	Jetstar Airways	JST	Australia	92,12 %	REPORT
10	Air Arabia	ABY	United Arab Emirates	92,09 %	REPORT
11	Vueling Airlines	VLG	Spain	92,02 %	REPORT

Future Sky Safety has received funding from the EU's Horizon 2020 Research and Innovation Programme, under Grant Agreement No. 640597.

Phase 1 : online survey

Generic

- 50 generic statements based upon 9 safety culture dimensions
  - developed & psychometric validated for European ATM
- Adapted for aviation in the Future Sky Safety project
  - Luton Airport stakeholders & European Cockpit Association research

KLM specific

- 30 KLM specific statements
- ISMS / KLM 5 Safety principles & 4 Safety domains

Open feedback

5

Phase 2 : workshops

Objective

1. Outcome & understanding online survey
   - ‘stories’ behind the stats
2. Find improvemenet of the (I)SMS
   - Feedback on the survey

Organization

- 9 workshops
  - Flight Operations, Inflight Services, Cargo, KLM Cityhopper, Fleet Services, Security Services, Operations Control, ISSO, S&SPP
- 5 – 15 employees per workshop, 2 – 3 hours

Content

- Introduction
- Presentation on division results & feedback
- Determine the gap
- Suggestions for improvement

6

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Phase 3 : interviews with senior management

Objective

1. Inform management on division results
2. Receive feedback on division results

Organization

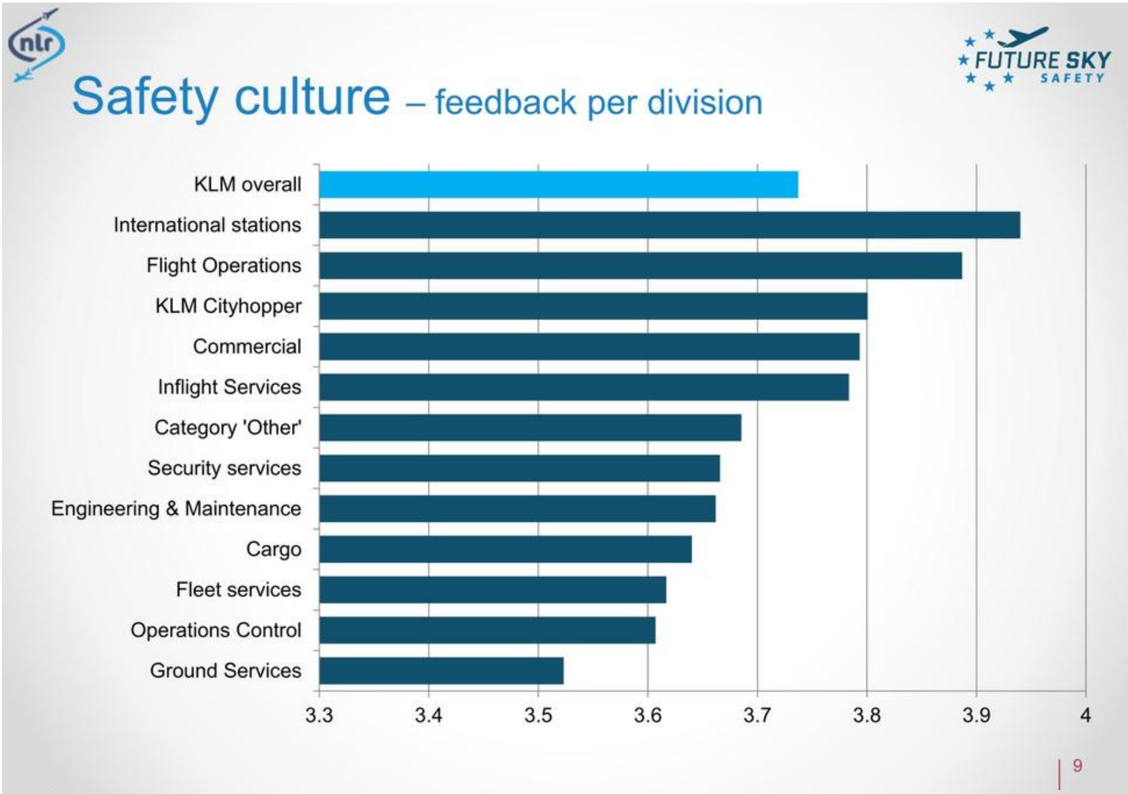
- 10 interviews
  - Fleet Services, E&M, ISSO, KLM Cityhopper, Flight Operations, Operations Control, Ground Services, Inflight Services, Cargo, International Stations
- Interviews on results, 30 – 60 minutes
- Review statements of the interviewees

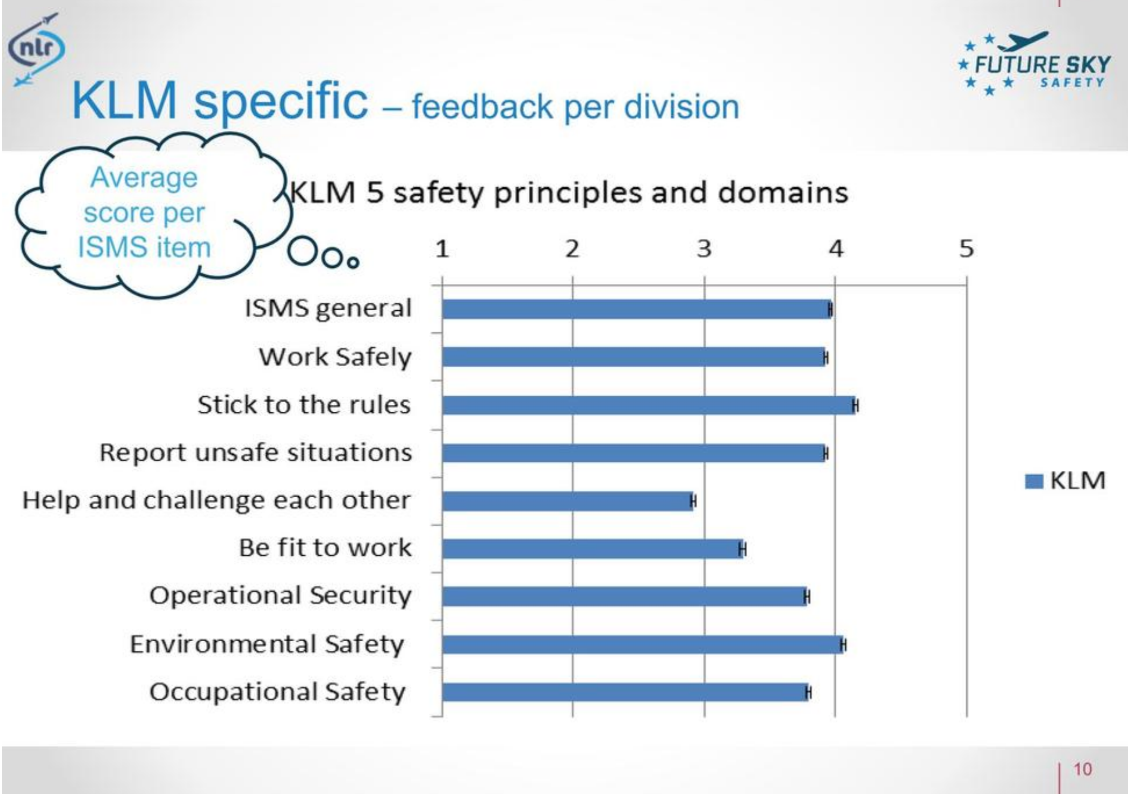
7

KLM Safety culture survey / participation

Divisie	# uitgenodigd	# e-mail gezien	# doorgeklikt	# deelnemers	Deelnemers%	Deelnemers% 2012
Flight Operations	2566	2262	889	782	30.5	38
Operations Control	52	46	42	37	71.2	64
Inflight Services	9288	8193	3945	3597	38.7	32
Ground Services	6286	3016	1619	1354	21.5	19
Cargo	1444	749	479	395	27.4	18
Fleet Services	24	22	16	14	58.3	64
Engineering & Maintenance	4720	2798	1978	1692	35.8	43
Security Services	124	78	57	49	39.5	70
KLM Cityhopper	1499	1300	549	477	31.8	50
Commercial	309	207	151	122	39.5	
International Stations	1.761	1.087	986	908	51.6	
Totaal	**32.370**	**22.338**	**12.647**	**11.041**	**34.1**	**33**

7





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Communicatie matrix Safety Promotie juli - december 2018 (status 24SEP18)

Month	General	Challenge	Be Fit	Reporting	Just Culture	Means & tools
June		Yammer blogs	1. OCC Health week 2. Fatigue Knowledge Lunch	Q-pass (ISSO & AV)	Symposium WeView	1. Newsapp 2. Yammer blogs
July	ISMS process scheme (animation)		KLM Cargo Tour de France		Filming COO & NP's	1. Newsapp 2. Yammer blogs
August	Article Veiligheid Magazine			*See it, say it* campagne	Filming COO & NP's	1. Newsapp 2. Yammer blogs 3. Gadgets 4. Monitors
September		Start Show & Tell CGO	1. Dam tot Dam run 2. Dam tot Dam walk		Filming COO & NP's	1. Newsapp 2. Yammer 3. Monitors 4. Posters
October	1. Safety portal live 2. ISSO Open House 3. MOC process scheme	Management Group challenge	Health Portal live (31/10)	Reporting Vlogs (TLO & IFS)	1. JC film live 2. JC workshop with KLM WC	1. Newsapp 2. Yammer 3. Blauw article (December)
November	1. ISSO Hackaton 2. Safety day management trainees	ID challenge	Theme 24/7 (OCC)		1. JC division vids 2. JC Safety day & RAF	
December	**Blauw** magazine	Computer challenge	Walk & Talk meeting	Reporting campagne & **See it, say it! @pp live**	JC & Reporting	Campagne a/o 1. Newsapp 2. Monitors 3. Video (what happens with my report)

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Appendix B.15 "P5: Ensuring the right safety view at the top–executive level Safety Dashboards" – Carlo Valbonesi, Deep Blue

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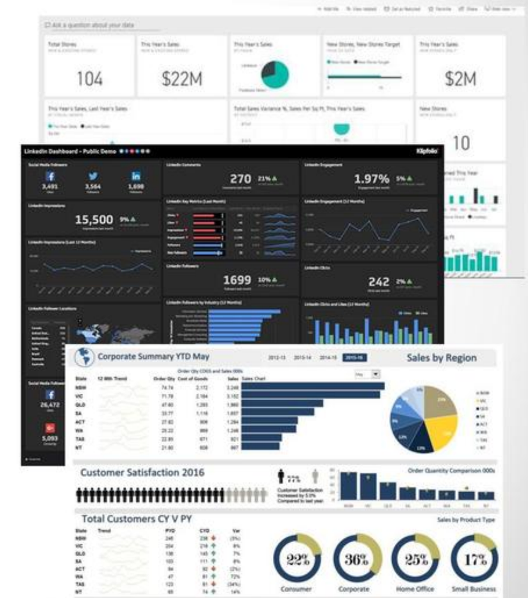
Safety dashboard: what and why

"Dashboards […] are ***tools*** *that improve your* ***"span of control"*** *over* ***a lot*** *of business* ***data****.*

These tools help people ***visually identify trends, patterns*** *and* ***anomalies, reason about what they see, help guide them toward effective decisions****"*. (R. Brath & M. Peters)*



*Richard Brath and Michael Peters, "Dashboard Design: Why Design is Important", DM Direct, October 2004

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Who are we designing for?

Safety manager	**The Executive Board**
Allow data exploration to find patterns and causes	Provide actionable information

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Safety dashboards for ANSP

Safety Dashboard User group:

- Safety Directors / Managers
- In-person interviews + workshop

NATS, skyguide, austro CONTROL, ENAV, EUROCONTROL, AVINOR

To understand the state of play:

- Users
- Data
- Content
- Platform
- Level of interactivity
- …

…And come up with a prototype

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Safety dashboards for ANSP

- A first version of the SDB was presented at the FSS Brussels public workshop in April 2017
- Meanwhile, interactions with SDB UG members continued in order to validate the dashboard prototype
- This is the result of the iteration…

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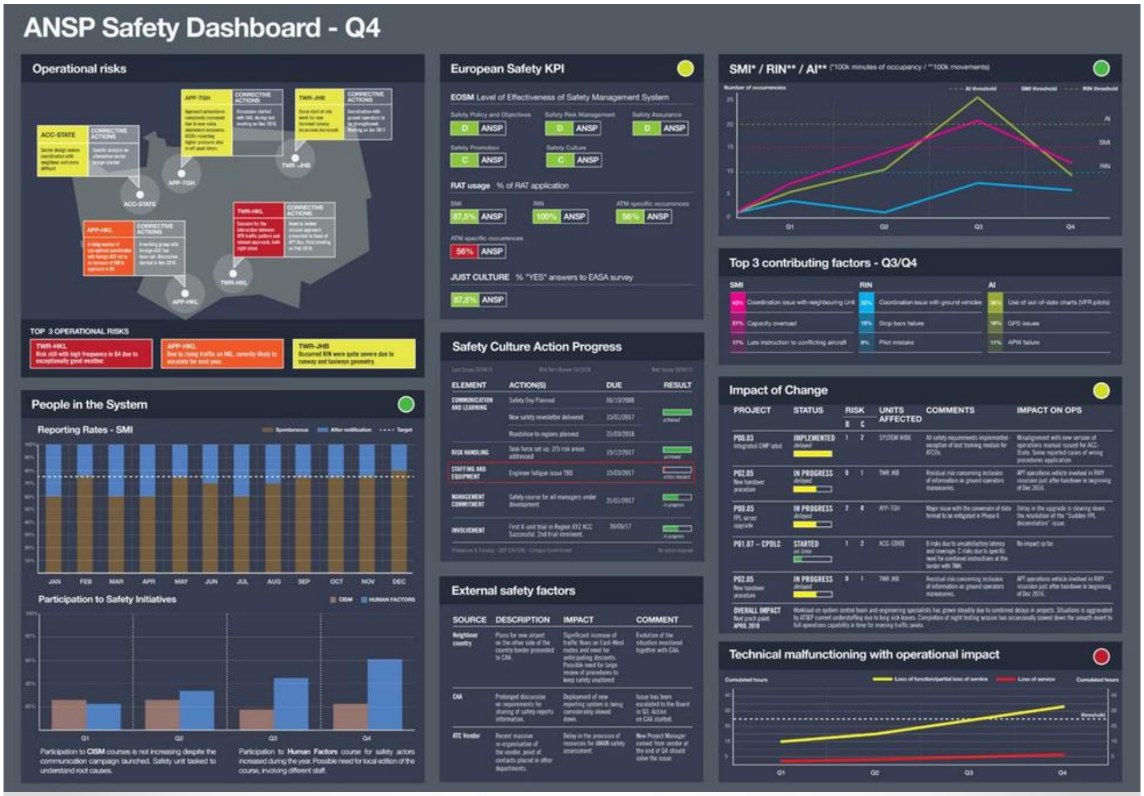

What has been done so far

- All this work found endorsement by **ECTL Safety team**
- Two meetings were held in Q1 2018 to further **refine** and **validate** the safety dashboard

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What then?

- At the end of the last SDB meeting, ENAIRE volunteered to start a collaboration with P5 to develop a **digital SDB for Executives**
  - ENAV expressed interest as well
- Two meetings so far in ENAIRE, May and August 2018

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The work done with ENAIRE

- **Starting point:** the current SDB presented to the Board
  - A PPT slide collating graphs created in Excel
- **Needs:**
  - Make data feeding automatic (backend)
  - Make data visualisation interactive (e.g. select time interval, filter by risk etc.)
  - Make visualisations intuitive and compelling
- **User:**
  - Executive Board
- **Owner:**
  - The Safety Manager

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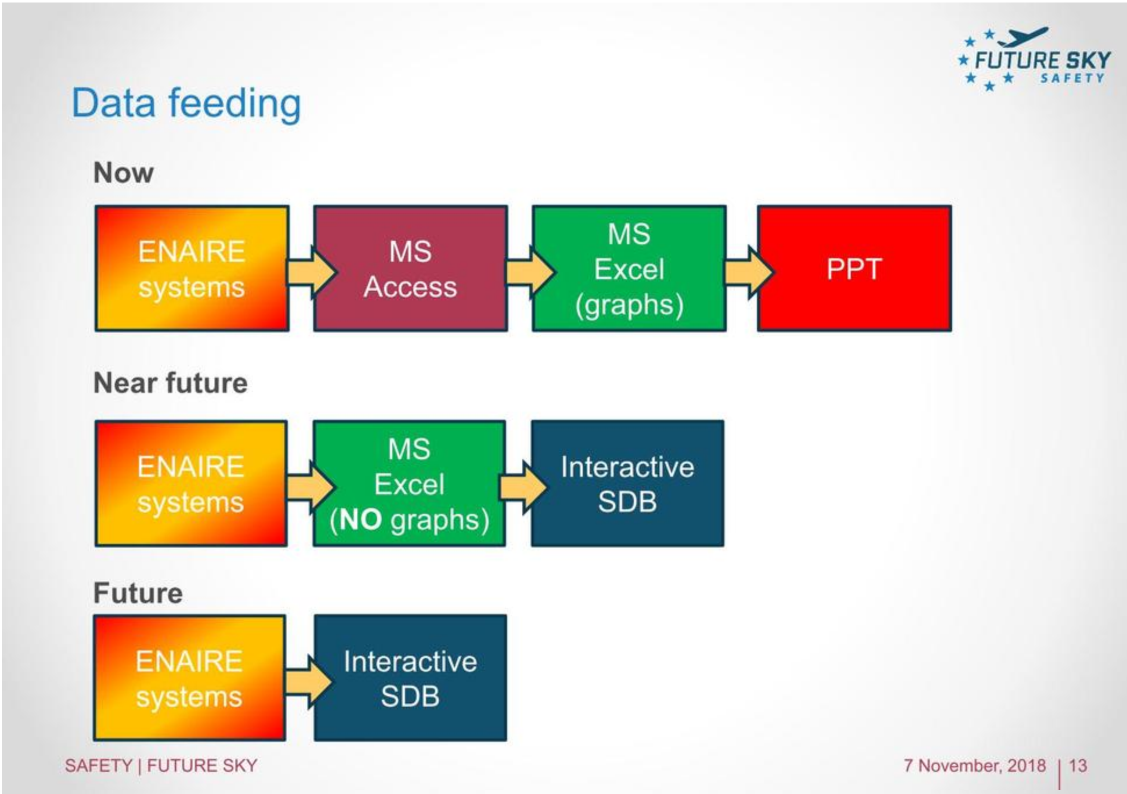

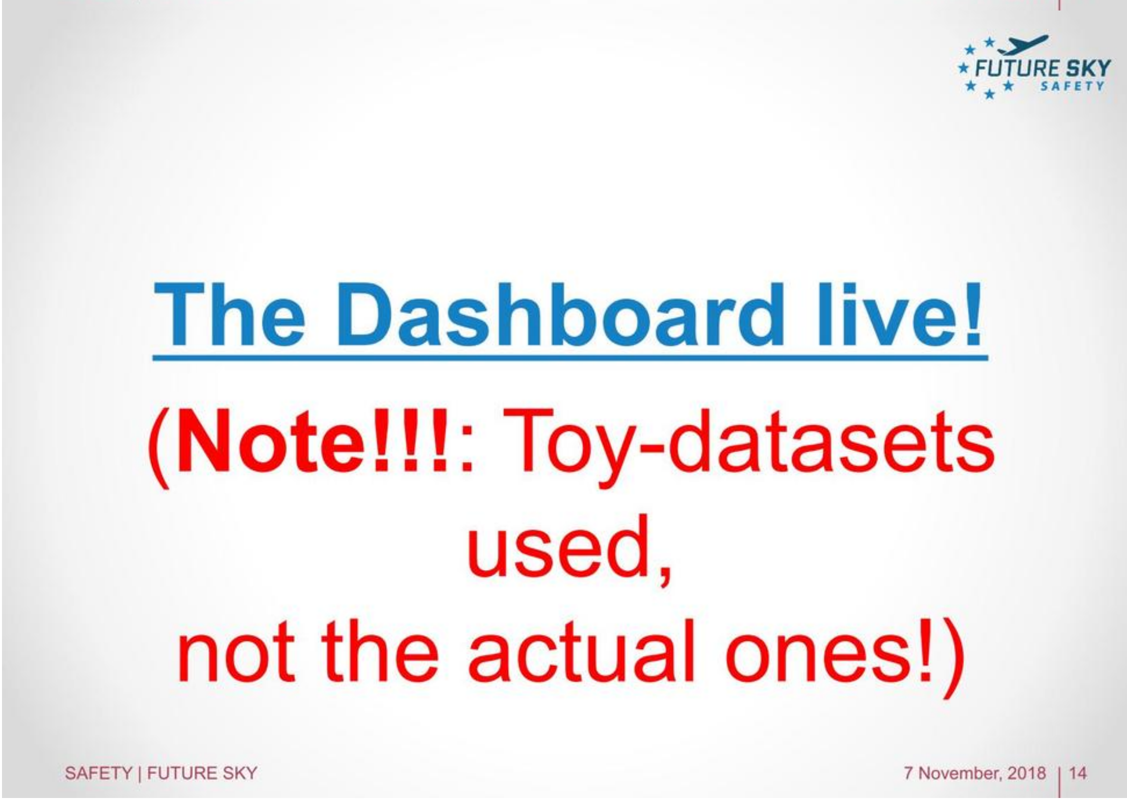

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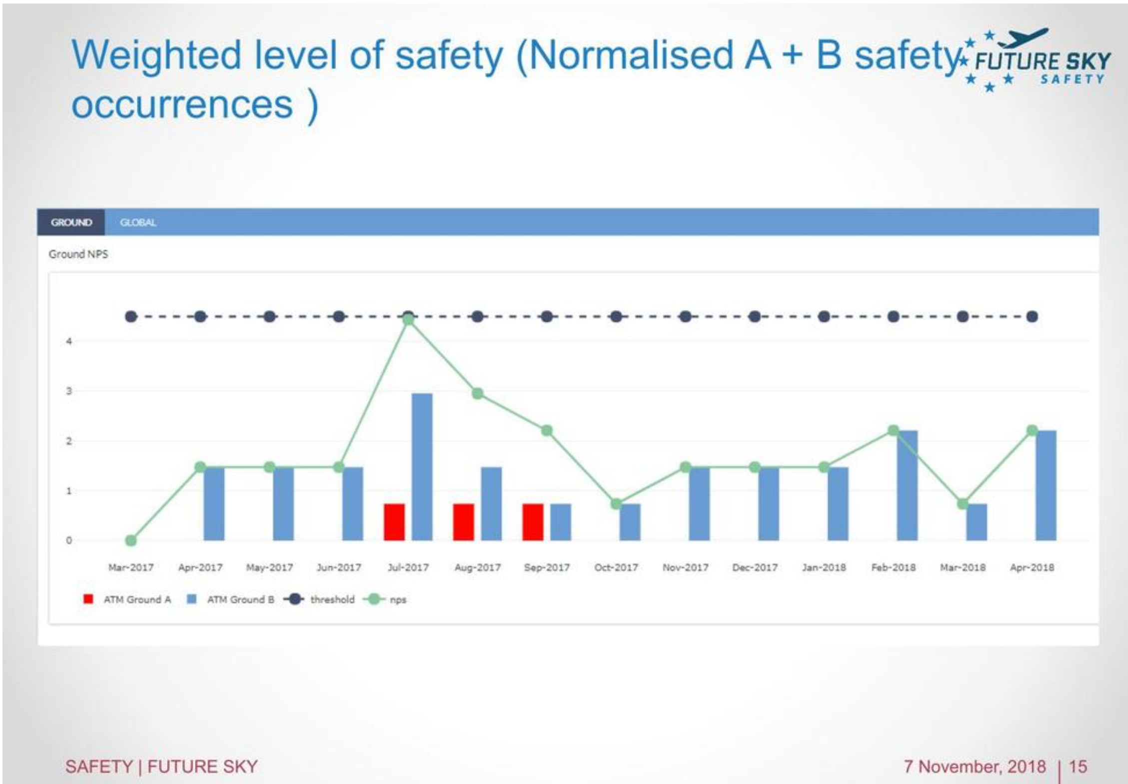

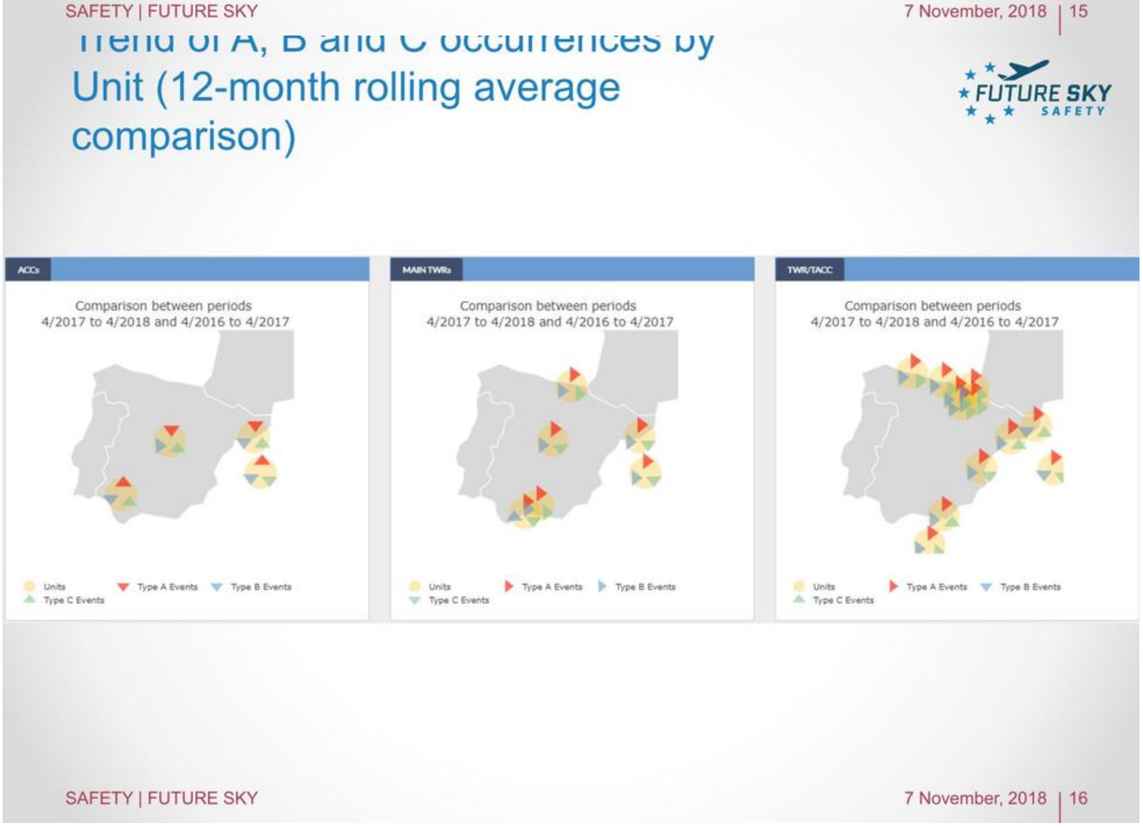

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Safety recommendations and incidents highlights

TOP 5 SAFETY RECOMMENDATIONS

Recommendation	Rationale	Related Evidence
Upgrade SNETs with DAPs (e.g. SFL)	More incidents due to missed alerts	1 A SMI incident in the last month (GCCC). 3 B SMI incidents in the last 3 months (LECM).
Installation of ground radar in LECO	New routes for vehicles increased chances for error	1 A and 2 B RI in the last three months
Partial re-design of LECP procedures	More encounters due to new flows from Marseille ACC	From 0 to 5 B SMI in the last 6 months
Discuss with ATC system vendor	CWP HMI issues as contributing factors to misperception	From 0 to 3 B AI in the last 6 months
Acquisition of new reporting system	Decreasing reporting rates due to usability issues	Last 2 quarters negative data on reporting

RECOMMENDATIONS FROM EXTERNAL BODIES

Source	Recommendation	Status
NSA	Revise requirements for sharing of safety reports information	Ongoing
EASA	Focus on Just Culture activities considering result of last survey	In Progress - Delayed
Ministry of Defense	Coordination with military to be reviewed in light of new joint framework agreement	On Hold

NARRATIVE

- 1 B incident in April (global and ground) in LECM TMA (LEMDRNS).
- 1 B incident (global and ground) on 02/06 in LECP, preliminary evaluation.
- 6 global B with ATM contribution and 6 ground B in the first quarter of the year
- 0 incidents A/B global in May
- 1 incident C global - B ground in Jun in LECM
- 1 incident C global – B ground in July in GCXO, scaled up to B global – B ground

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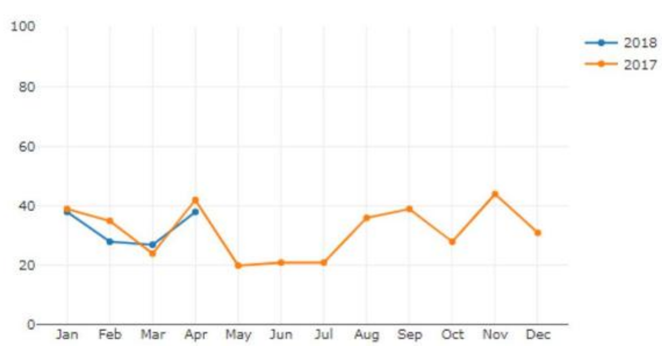
Reporting trends

REPORTING TREND



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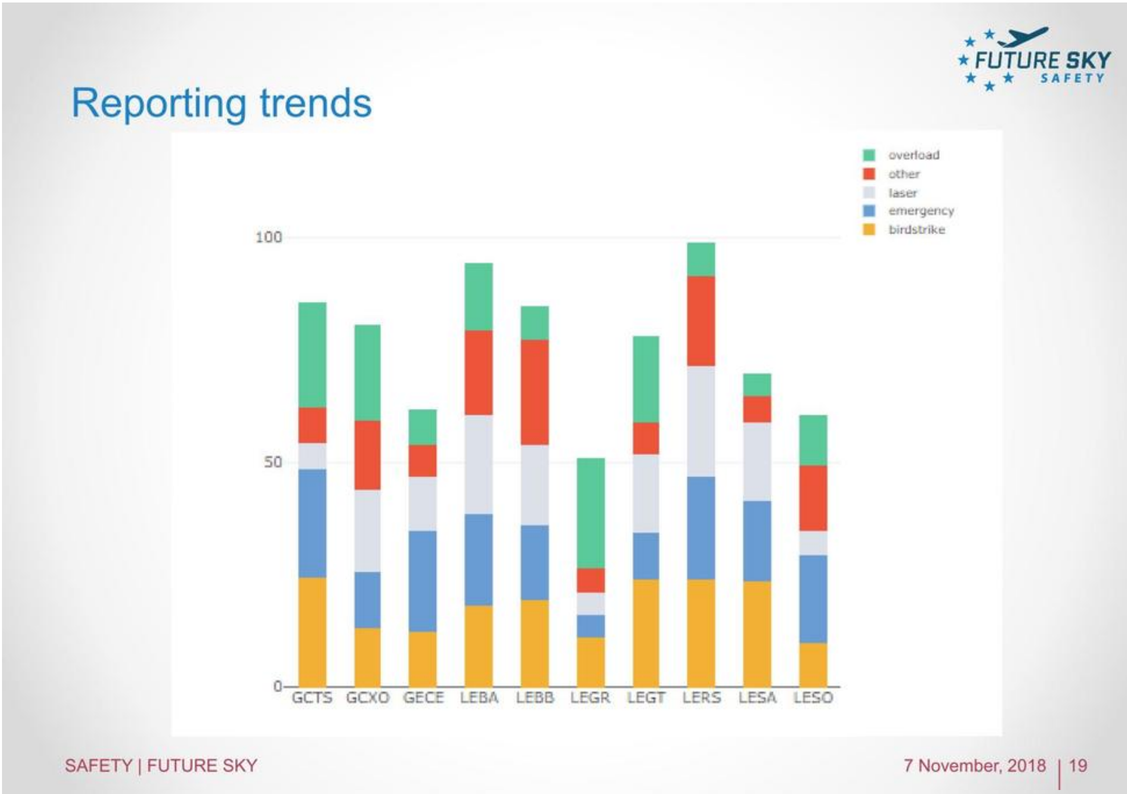

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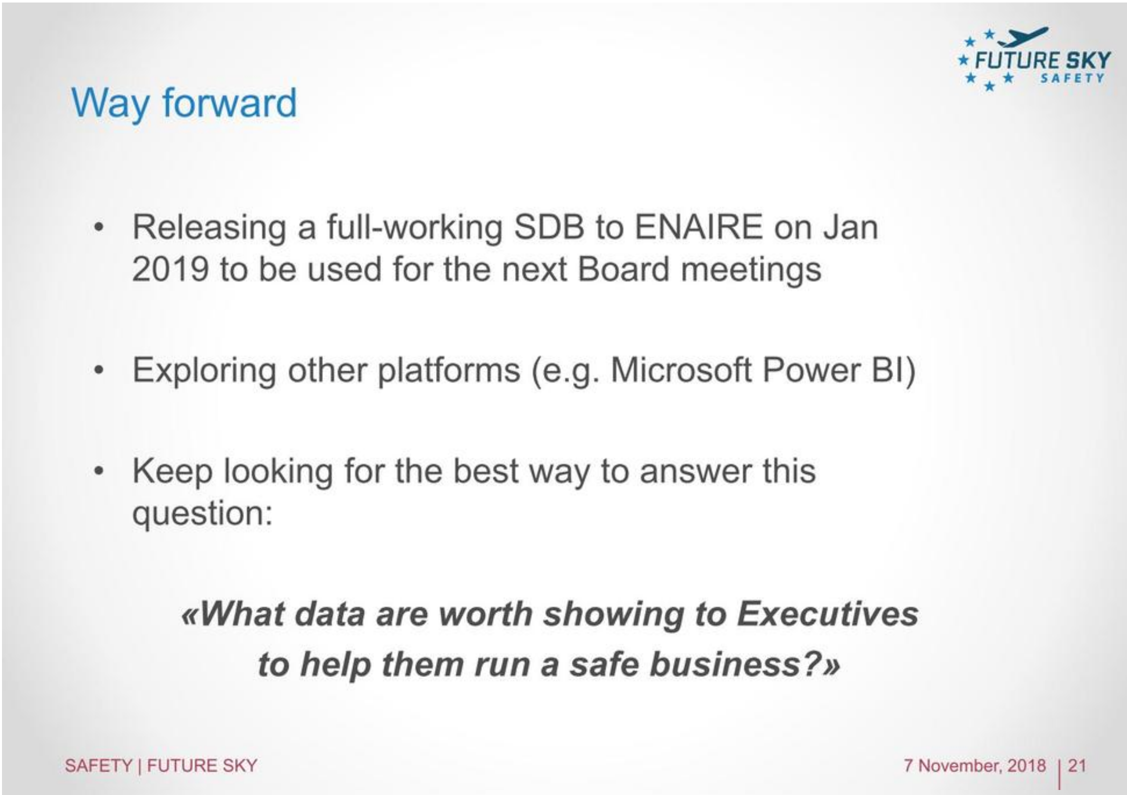

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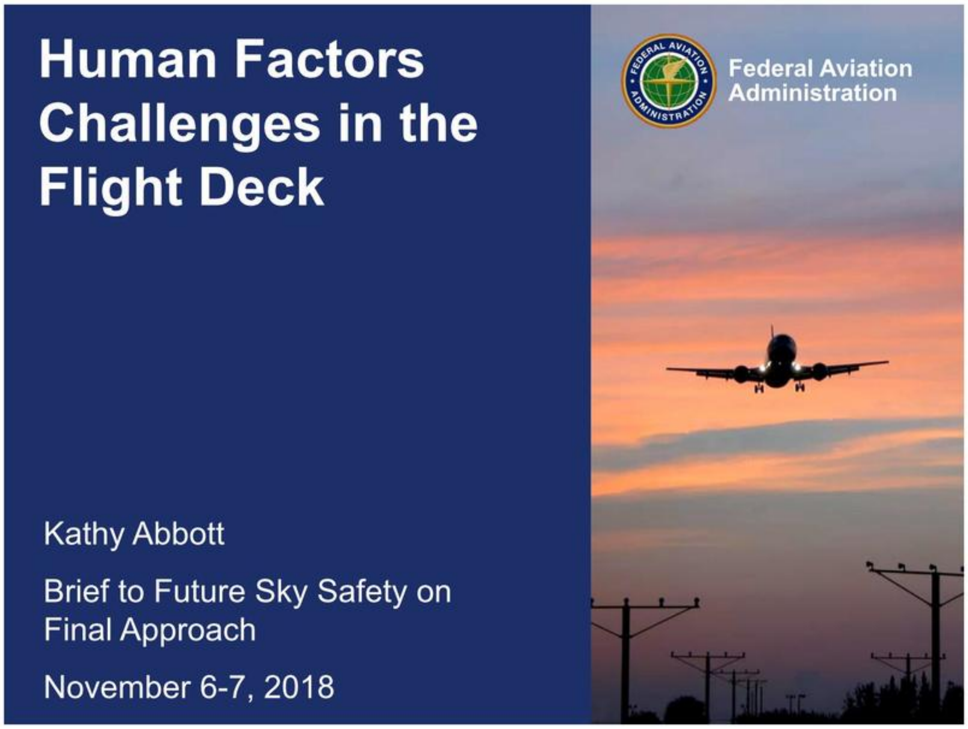
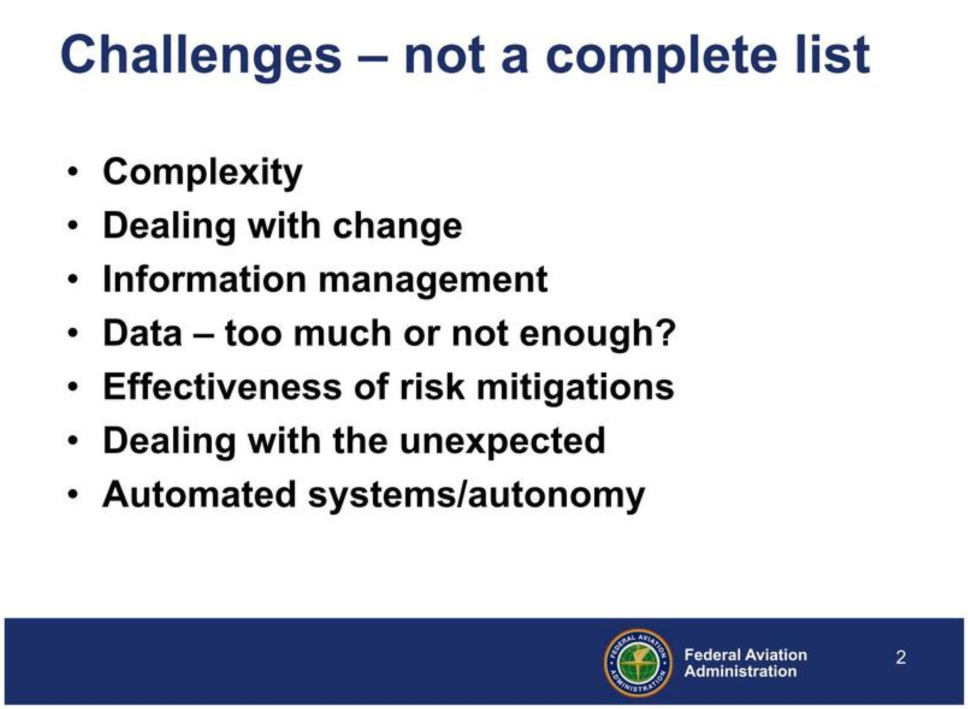
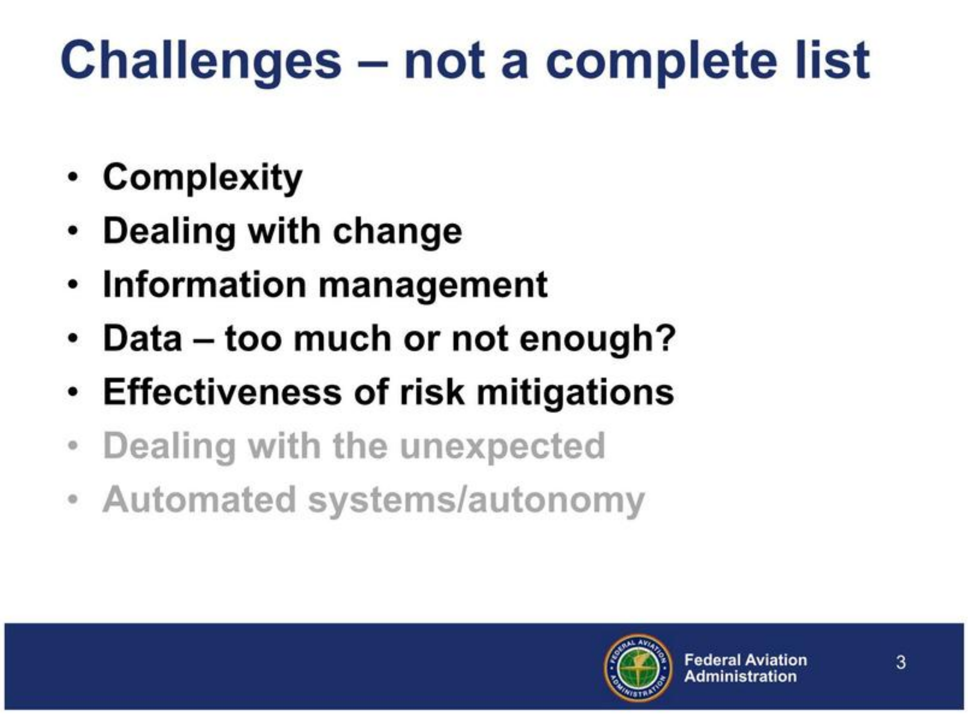
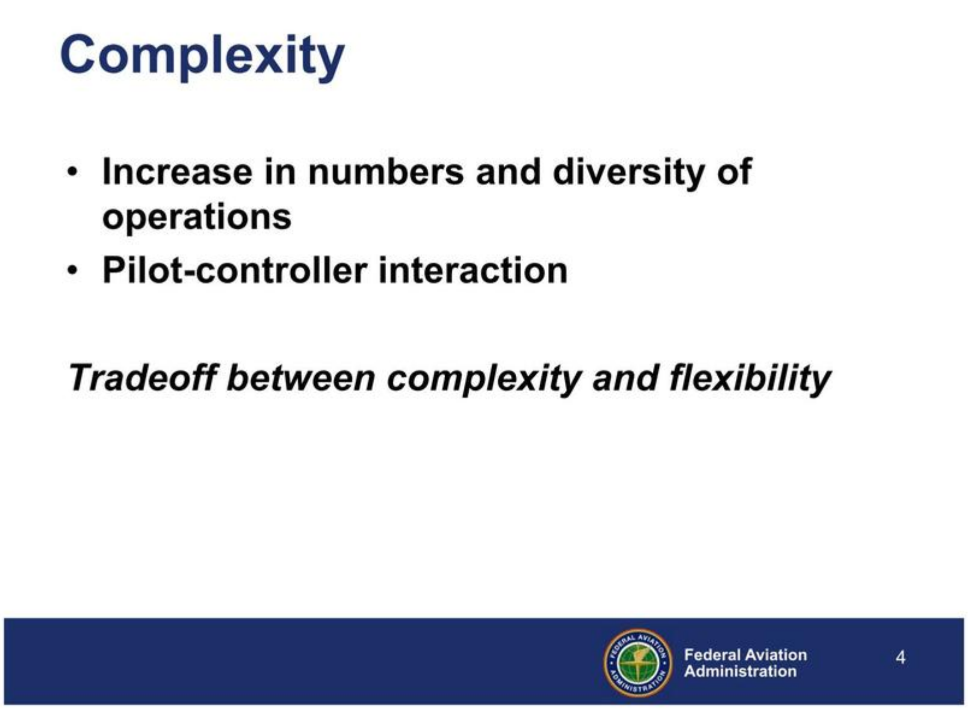
Appendix B.16 "P6: Human Factors challenges in the flight deck" – Kathy Abbott, FAA




Challenges – not a complete list
• Complexity
• Dealing with change
• Information management
• Data – too much or not enough?
• Effectiveness of risk mitigations
• Dealing with the unexpected
• Automated systems/autonomy
Federal Aviation Administration
2


Challenges – not a complete list
• Complexity
• Dealing with change
• Information management
• Data – too much or not enough?
• Effectiveness of risk mitigations
• Dealing with the unexpected
• Automated systems/autonomy
Federal Aviation Administration
3


Complexity
• Increase in numbers and diversity of operations
• Pilot-controller interaction
Tradeoff between complexity and flexibility
Federal Aviation Administration
4


A Lot to Manage
Air Agency Certificates: 6,219
811 Pilot Training Schools
4,907 Repair Stations
177 Maintenance Training Schools
324 Pilot Training Centers
Air Operator Certificates: 5,068
70 Major Air Carriers -- (e.g. United Airlines)
1,936 Commuter Air Carriers/On Demand Air Taxis
85 Commercial Operators (e.g. Baltimore Orioles)
486 Foreign Air Carriers (e.g. Lufthansa)
354 External Load (Logging/Oil Platform)
1,807 Agricultural Operators
330 Public Use Authorities (State/City/Police)
Mechanics with Inspection Authority: 22,460
Approved Manufacturers: 1,539
• Designees: 9,089
•2,844 Aircraft Certification
3,627 Flight Standards
2,618 Aerospace Medicine
•Non-Pilot Air Personnel: 696,676
•321,308 Mechanics & repairmen
25,454 Control Tower Operator
222,037 Flight Attendant
66,423 Ground instructors
61,454 other (dispatchers/flight navigators/parachute riggers/flight engineers)
National Transportation Safety Board: 621
39 Safety Recommendations (avg/yr based on last 5 yrs)
337 Formal NTSB requested for FAA research & info
245 Open NTSB Safety Recommendations
ATCS Medical Clearance Exams: 13,895
•13,802 Air Traffic Controller Workforce
93 Flight Service Station Workforce
Airmen Medical Examinations: 384,798
•32,776 Special Issuances
341,470 Standard Issuances
Aviation Industry Entities Covered by Anti-Drug & Alcohol Programs: 6,829
Aircraft: 309,423
7,631 Air Carrier Aircraft
710 Commuter Air Carrier Aircraft
8,621 On Demand Air Taxi Aircraft
213,905 General Aviation Aircraft
Aviation Authorities - other countries: 427
48 Countries covered by Bilateral Agreements
192 Foreign Carrier Aviation Authorities
187 Accident Investigation Authorities
Check Airmen: 9,071
•5,573 Part 121
117 Parts 121/135
3,381 Part 135
Active Pilots: 736,461
• 167,556 ATP
• 115,816 Commercial
• 175,762 Private
• 147 Recreational
•6,245 Sport
•167,636 Student
•40,699 Foreign Pilot
•106,026 UAS Remote Pilots
AOV Credentials: 17,257
•12,649 ATCS Credentials
•4,415 ATSS Credentials
•193 AIS Credentials
Flight Instructors: 108,273
UAS Registrations: 1,223,073
•958,505 Hobby
•257,970 Commercial
•6,598 Paper Registration
Federal Aviation Administration
5

Pilot-Controller Interaction – Selected Examples

- Half-degree waypoint issue in North Atlantic Tracks
- Late runway changes
- Go-around from visual approach
- Defining stabilized approaches
- Airspace procedure complexity
- Complex clearances
- Conditional clearances

Federal Aviation Administration 6

Operational Factors – Complexity of Instrument Flight Procedures (IFPs)

ATC Intervention (such as)

- (Late) route amendments
- Unpublished restrictions
- Vectors
- etc…

Aircraft Factors

- Lack or unreliability of automated systems
- Performance characteristics

Crew Factors

- (Standard) expectations
- Fatigue
- Communication style
- Distractions
- Local area familiarity
- Familiarity with different types of IFPs

Operator Factors

- Independence vs. dependence on Dispatch
- Clarity and consistency of PF/PM roles in reviewing IFPs

Environment Factors

- Terrain
- Traffic
- Weather (Wind or IMC)
- Prohibited airspace

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Complex clearances

Example format: "Cleared direct (fix), (crossing altitude if necessary), change to runway (runway number), descend via (STAR), expect (instrument approach)"

Legal, but complex

Federal Aviation Administration 8

Conditional Clearances

- **On the ground**
  - "Line up and Wait after landing aircraft (or behind departing aircraft)" or "After landing aircraft, line up and wait, after landing aircraft"

  Note: Conditional clearances involving runway operations are not used in the US

- **In the air**
  - AT [time/position] CLIMB/DESCEND TO [level] or *AT [time/position] CLIMB/DESCEND TO AND MAINTAIN [altitude] (Note: Text displayed depends on implementation)*
  - Debated in international circles for years: Pilots hate them, controllers say that their airspace can't function well without them

Federal Aviation Administration 9

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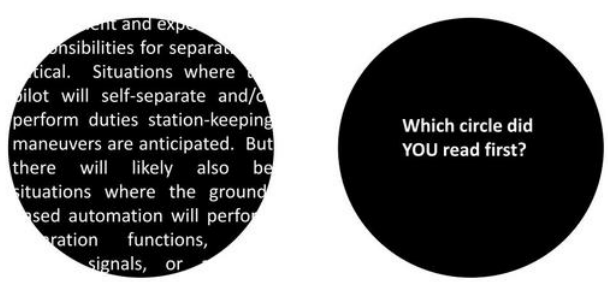
Our Brains are Set Up to:

Process information in the most efficient way

- Seeing what we expect to see
- More likely to process information that conforms to our expectations
- Focus on the most salient information

Federal Aviation Administration 10



Courtesy K. Cardosi, Volpe

Federal Aviation Administration

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Drivers of Change in the System

A more globally connected system

Aviation is an **increasingly global** enterprise under increasingly complex and decentralized business models

Growing aviation demand & diversity

Projected growth in demand and diversity from conventional customers as well as new entrants in non-traditional areas

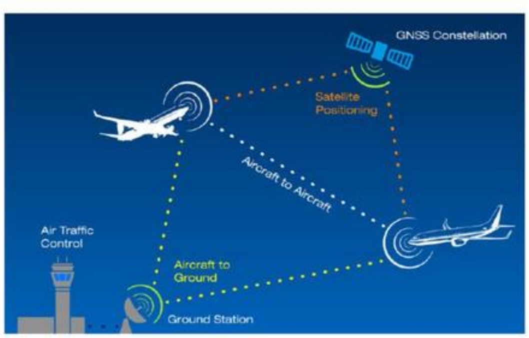
Ever increasing safety expectations

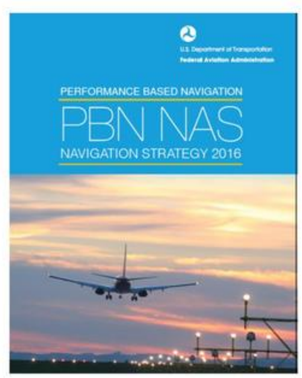
The public has internalized the **unprecedented levels of aviation safety**

Federal Aviation Administration 12

How Are Flight Operations Changing?

- **New ways to do Communications, Navigation and Surveillance**





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New Technologies and Operators

Federal Aviation Administration 14

Change in Aviation

- **Change management**
- **Change fatigue**
- **Change can bring risk**

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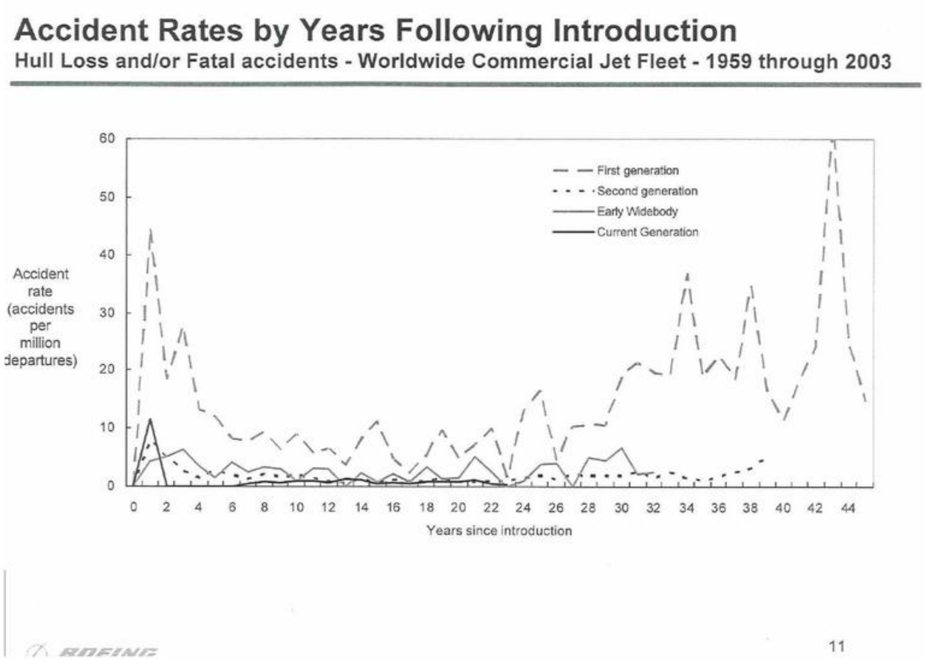

How are things changing for pilots?

- Sometime simpler, sometimes more complex
- More tasks
- Different errors
- More use of automated systems
- More information

Federal Aviation Administration 17

Flight Deck Information

Federal Aviation Administration 18

Outside the Flight Deck: Operational Data – Too Much or Not Enough?

- More data
- Better data? Sometimes yes, sometimes no
- Every data source has strengths and weakness
- Still major gaps
- Remember - absence of evidence is not evidence of absence
- Data still mainly from the "front line"

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Scary Stuff

Federal Aviation Administration 20

Risk Mitigations
(in decreasing order of effectiveness)

- Eliminate hazard
- Alter design
- Incorporate engineered features or safety devices
- Provide warning devices
- Incorporate signage, procedures, training

Decreasing effectiveness

Source: MIL-STD-882E System Safety Handbook

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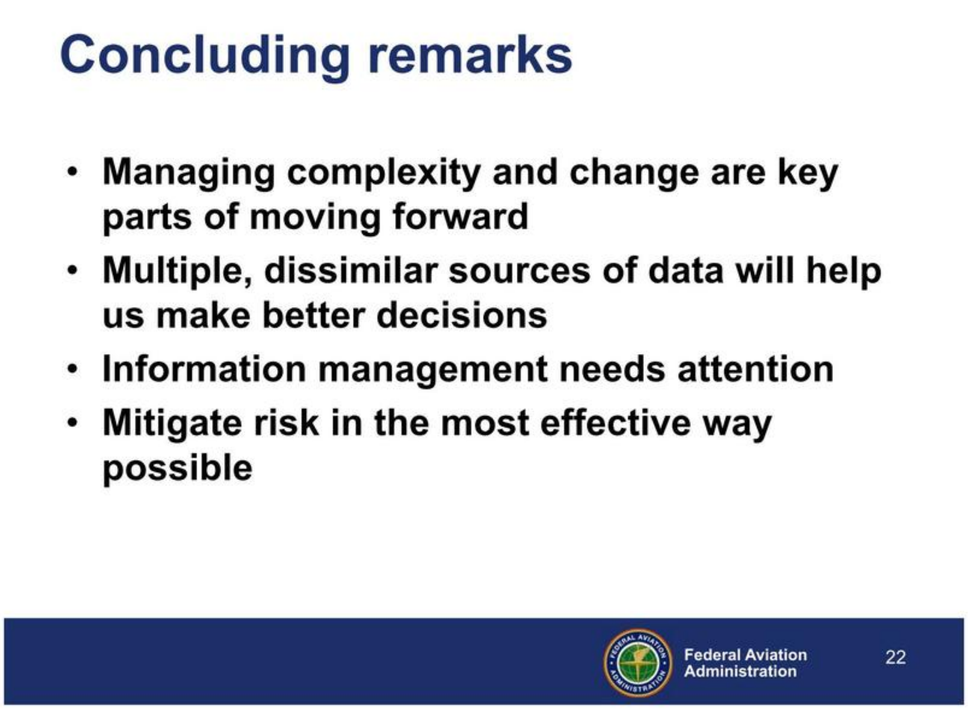

Appendix B.17 "P6: Controllers on the edge: graceful degradation in ATM and the human performance envelope" – Tamsyn Edwards, NASA

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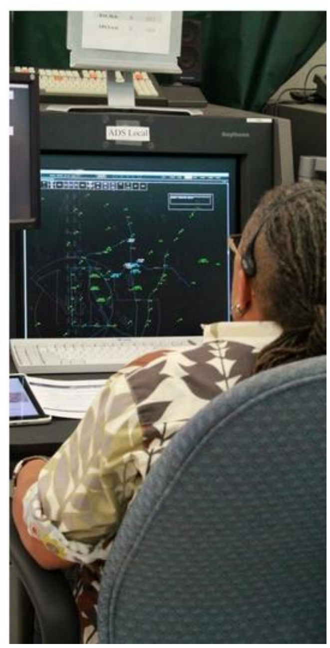
Project overview

- Research and technology advancements enable significant change to ATM
- Changes may include:
  - Narrower tolerances
  - More precise trajectories
  - Strategic vs tactical control
- System resilience is a critical issue
- Future systems must be able to degrade gracefully to maintain safety



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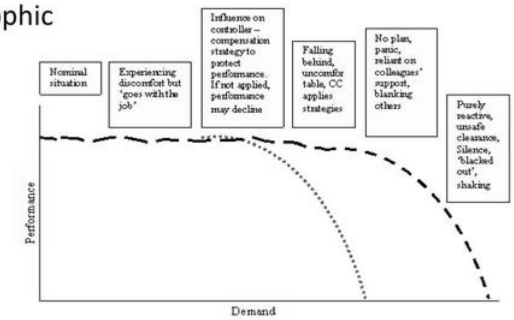
What is graceful degradation?

- Graceful degradation describes the ability to tolerate failures
  - Reduced functionality vs catastrophic failure
- Human tend to fail gracefully; machines usually do not
- Previous research has tended to focus on graceful degradation of machines
- To design graceful degradation into future systems, need to understand degradation in ATC operations



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Project Aims

- Identify causes of degradation in ATC
- Investigate relationships between degradation causes
- Inform understanding of the role of the controller in graceful degradation
- Identify ATCO degradation prevention and mitigation strategies

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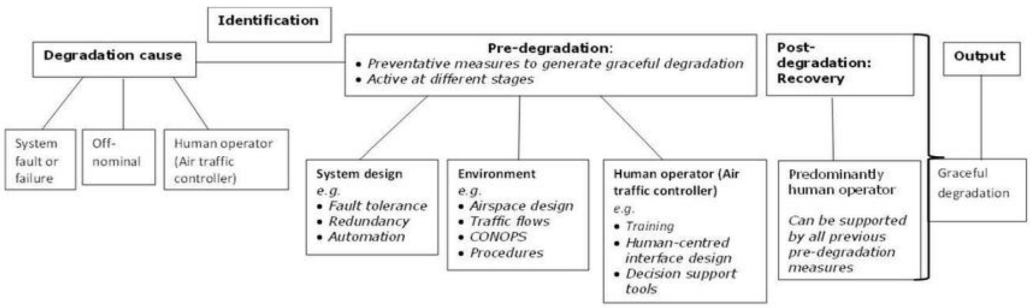
Initial framework of graceful degradation



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Method

- Semi-structured interview (2 hours)
- Participants: 12 Retired controllers
  - TRACON and En-route, worked in California
  - Median age 63 years, experience range 20-35 years
- Example questions:
  - "What has caused 'bad day' for you in operations?"
  - "What are your control strategies for an aircraft emergency?"
- Interviews transcribed; analysed using thematic analysis



Result 1: Causes of degradation - Technology

- Failure – Radar, Communications

“Everything is working fine and then it doesn’t work. Can you keep up with the phone and radio calls?”

- Unreliability

“If it doesn’t work we just say forget it. It’s unreliable…Until someone proves to me that it’s going to work I’m not going to base my career on accidentally running an airplane into another guy’s sector”

- Reduction of flexibility

“Engineers designing routes will say, he’s doing 160 knots and that’s this many miles per minute, so he gets here then. [But] there’s weather, there’s emergencies, there’s pilot errors”




Result 1: Causes of degradation - Environment

- Weather
- Aircraft emergencies
- Pilot requests

“They say we want to deviate left. When they say deviate left, now I'm really having to focus on that...”

- Complexity factors:
  - Sector features

  “You've got to make your turns exactly right, your climbs, your speed, so you've got to be on everything”

  - Location of sector

  “The pilot says, ‘Can we deviate to the right around it?’ I don't have any traffic out there, that's an easy thunderstorm”

  - Traffic level and complexity of traffic

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Result 1: Causes of degradation - Human operator

- Errors (usually as a result of):
- Human-performance influencing factors, e.g.
  - Workload – underload and overload

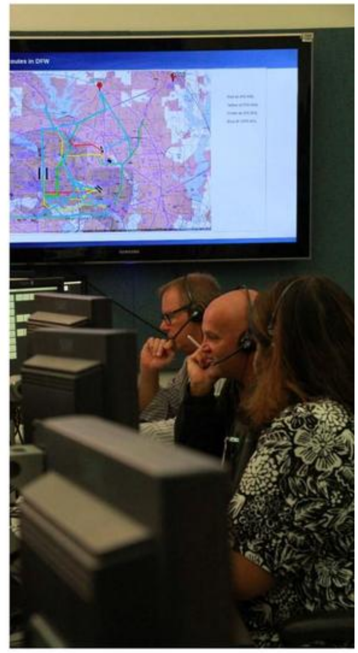
"There's a lot of times when you're probably too relaxed, then all of the sudden you're going, I better wake up here"

  - Fatigue

"You do start to feel that mental fatigue, and you're falling behind"

  - Situation Awareness

"Somebody misses his turn and you are busy someplace else and meanwhile he has gone way past where he is supposed to go"



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Result 2: Degradation cause and system effect

- Causes not sufficient to understand system impact
- Relationship between cause and effect is often moderated
  - Expected or unexpected cause

"You did have a plan. Now you don't have a plan. You're reacting "

  - Sudden or gradual cause

"If I see the weather coming, I'm pre-planning the solution in my head, whereas if all of a sudden, I'm hit with the emergency, then I don't have time to pre-plan"

  - Duration

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Result 3: Relationships between causes of degradation

- Co-occurrence or association
- Between or within degradation categories

"We had about 17 or 18 operations. It was IFR weather. Maintenance took the radar. I just barely had the picture - If I had looked away I would have lost that"

Examples of associations between human factors

Factors	Quotations
Workload and Stress	Well, whenever your workload goes up your stress goes up. It kind of goes hand in hand (Participant 7)
Teamwork and Trust	"Working with somebody that you know just so smooth. So easy going. You trust that guy. He trusts you. He trusts you to make the right decisions and he knows what to do as far as coordination" (Participant 8)
Teamwork and Workload	"Low traffic teamwork really doesn't come into play. It is when the stress levels move up and the work is harder and there is more going on that is when the teamwork really comes into – into play" (Participant 8)
Fatigue and Workload	I wouldn't want to go back into the pressure cooker you know what I am saying with a 15-minute break. I wouldn't want to (Participant 10)
Stress and Vigilance	I think you wind up overlooking things, not noticing little variable that can turn into something worse later on because your mind is stressed (Participant 9)
Workload and Vigilance	somebody misses his turn and you are busy someplace else and meanwhile he has gone way past where he is supposed to go so now you are getting him back and trying to get him back quickly, so a couple of those and then it can just all start to snowball (Participant 10)
Fatigue and SA	Sitting there at a busy radar sector… my fourth shift of the week, I've already had the quick turn to the day, and then I came in, and I probably got out of bed at 3:30 that morning to come to work, and I'm on my fifth cup of coffee for the day, and I remember just feeling like I'm barely hanging on by my fingernails for dear life (Participant 9)

Result 3: Relationships between causes of degradation

- Co-occurrence or association
- Between or within degradation categories

"We had about 17 or 18 operations. It was IFR weather. Maintenance took the radar. I just barely had the picture - If I had looked away I would have lost that"

- Interactions can result in a cumulative impact

"We're very good jugglers. Something goes wrong, you can handle it. Then something else happened. Here comes another ball. Pretty soon, you're going to drop a ball"

"It starts to be exponential as things happen, it never seems to be linear, it just goes a lot faster"

- Understanding interactions is critical:
  - Design of systems capable of graceful degradation design
  - Predicting, preventing and mitigating degradation

Result 3(Cont.): Function Failure

- Occurs as a result of interactions between technology and context
- Examples:
  - Datalink communications and environmental off-nominal events

    "Direct communications are extremely important. Using automation in a normal flow of traffic is fine. But in emergency situations or heavy traffic situations, it becomes a detriment"

  - Conflict alert in terminal environments

    "In a terminal environment, it's very unreliable. Rarely do we use [it]"

- Implications:
  - ATCO Overload
  - Risk assessment
  - Future system design

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Result 4: Prevention and mitigation of system degradation

- Pre-degradation strategies

"You don't want to see a catastrophic failure. That there are safeguards that are built in that you have to rely on"

- In-time prevention and mitigation strategies
  - ATCOs change control strategies to make the system work
  - Strategies are learned through experience
  - Strategies are dependent on awareness



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Result 4 (Cont.): Prevention and mitigation of system degradation

- Mitigation strategies for **Technology**-related causes of degradation
  - Become more conservative
  - Increase safety buffers
  - 'Back to basics'

"First, make sure that everyone is separated, and then try and get everyone out of the sectors as quickly as possible"

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Mitigation strategies: **Technology** causes of degradation

Examples of mitigation strategies for radio outages

Strategy grouping	Strategy
Replace function	Coordinate with next center to find a frequency and contact aircraft
	Coordinate with next center to control affected airspace
	Passed information to center - alternative frequency
Prevent worsening situation	Ground or hold traffic in other sectors
	Re-route airborne traffic around the sector

Examples of mitigation strategies for Flight processing/data tag failure

Strategy grouping	Strategy
Control strategy	Resort to basics
	Conservative control
	Verbally ask pilots: Check altitudes
	Try and remember information
Prevent from getting worse	Slow down aircraft into sector call neighboring sector

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Result 4 (Cont.): Prevention and mitigation of system degradation

- Mitigation strategies for **Technology**-related causes of degradation
  - Become more conservative
  - Increase safety buffers
  - 'Back to basics'

"First, make sure that everyone is separated, and then try and get everyone out of the sectors as quickly as possible"

- Mitigation strategies for **Environment**-related causes of degradation
  - Separation – altitude, lateral distance, speed
  - Utilize surrounding airspace
  - Ground delay/ground stop

Mitigation strategies: **Environment** causes of degradation

Examples of mitigation strategies for thunderstorms

Strategy grouping	Strategy
Preplan (if possible)	Start organizing traffic early into manageable flows
	More conservative control prior to thunderstorm appearing to leave room for flexibility to change
Gathering information	From pilots: how far to maneuver around it an altitudes affected
	From pilots and/or weather repots: intensity (1-5)
	From weather reports: Location and movement pattern
	Look at basic weather data on radar scope

Strategy grouping	Strategy
Control changes	Back to basic scan – more focused
	Anticipate future: prevent getting behind
	Build new route: ask first pilot to deviate at direction; ask aircraft to follow
	Ask for spacing coming into sector
	Slow down the situation – create more space between aircraft
	Use altitudes to separate if spacing isn't sufficient
	Use neighboring sectors' airspace (point outs)
	Hold at lower altitudes
	Increase distance between aircraft
	More conservative
Stop traffic	Refuse to take handoffs/aircraft

Result 4 (Cont.): Prevention and mitigation of system degradation

- Mitigation strategies for **Technology**-related causes of degradation
  - Become more conservative
  - Increase safety buffers
  - 'Back to basics'

"First, make sure that everyone is separated, and then try and get everyone out of the sectors as quickly as possible"

- Mitigation strategies for **Environment**-related causes of degradation
  - Separation – altitude, lateral distance, speed
  - Utilize surrounding airspace
  - Ground delay/ground stop
- Mitigation strategies for **Human operator**-related causes of degradation
  - Strategies focused on reducing the impact of performance-influencing factors, such as workload and stress

Commonalities Between Strategies: Time and Space

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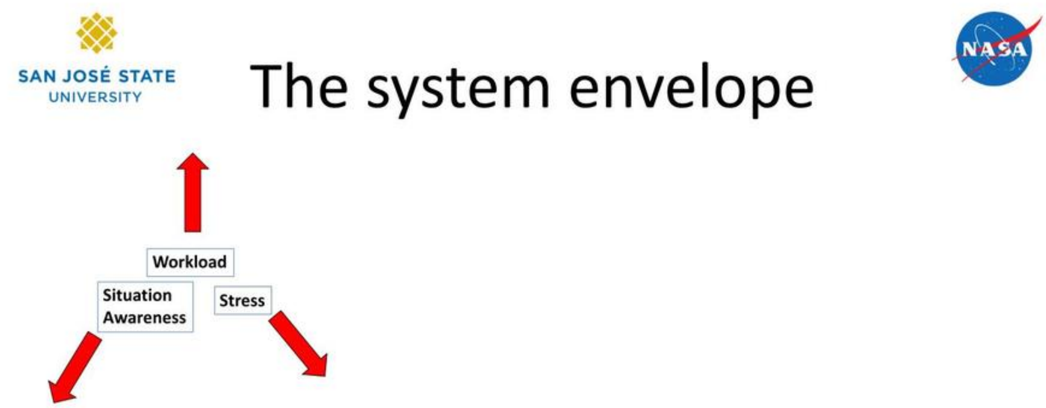

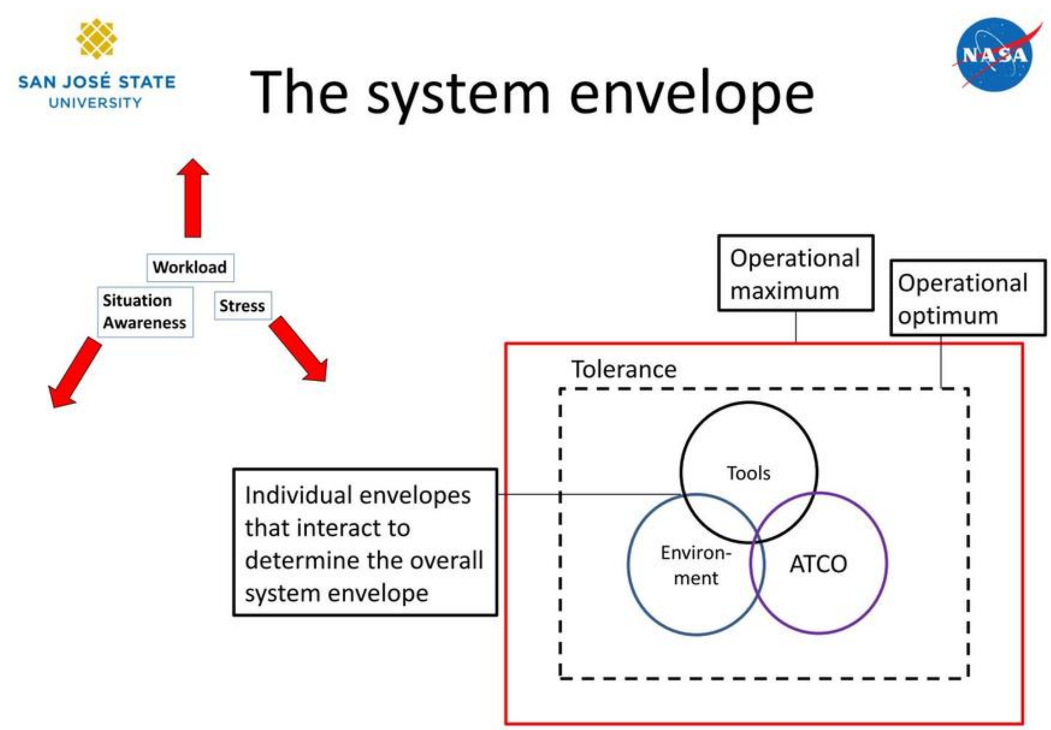

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Conclusions

- Graceful degradation is essential for system safety
- ATCOs have a critical role in graceful degradation
- Time and space are essential for online strategies
- Identification of interactions between degradation causes is necessary for future system design and risk prevention
- A System envelope framework may inform research and support designers to ensure the system stays within tolerance

Implications & future considerations

- Future system design needs to be flexible for ATCOs to use mitigative strategies
- Potential interactions should be identified and designed out or mitigated
  - Future design should take into account the context of tool use
- Reduction of interaction relationships through system design
- Implications for future consideration of Artificial intelligence in ATC

Thank you!

tamsyn.e.edwards@nasa.gov

Controllers on the Edge:

Graceful degradation in ATM and the human performance envelope

Dr. Tamsyn Edwards and Dr. Paul Lee

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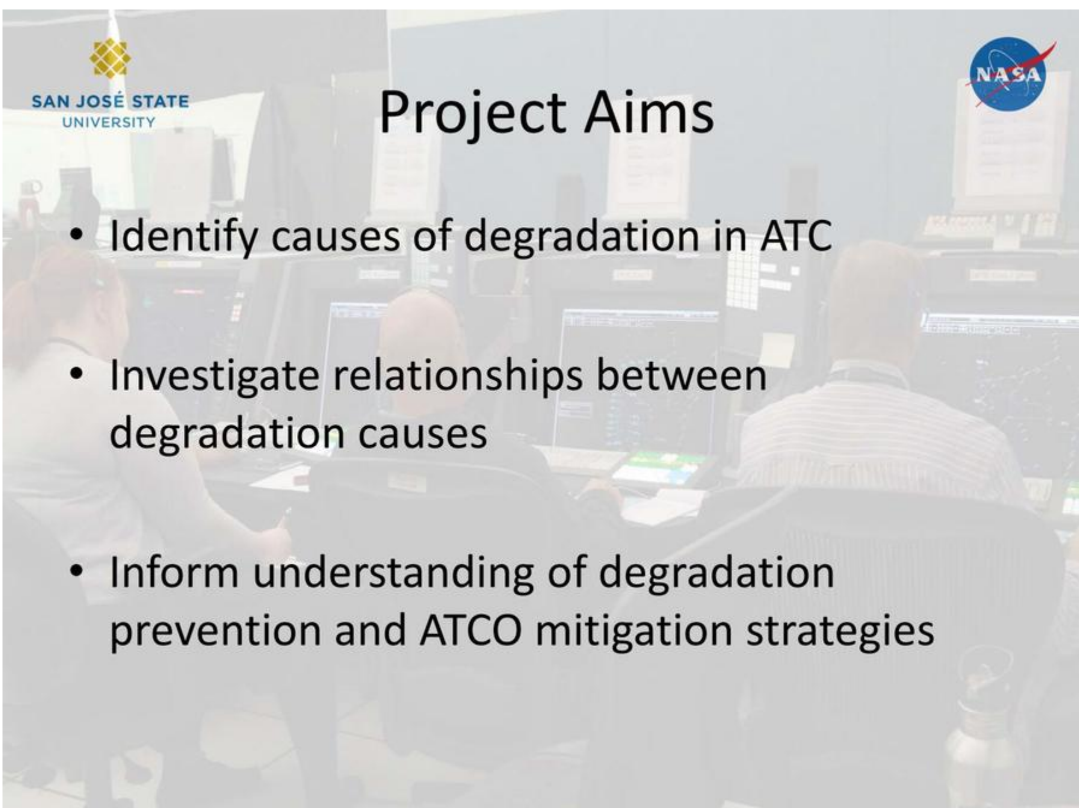
Back up slides



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Causes of degradation

Technology - related causes

Total equipment and tool failure	**Radar primary, secondary**
	Radio Transmitter/receiver
	Internal communication/phonelines
	Issues with aircraft VHF radio
	Weather prediction tool failure
Degraded technology	Flight plan data partial or complete failure
	Callsign failure (just leaving radar target)
Limitations of automated tools	Conflict probe and alert
	Auto hand-off
	Sequencing tools
	Inadequate design for human use
Technology resulting in a loss of flexibility	"In those situations where you need to have that flexibility and adjustment, sometimes it isn't there" (Participant 6).
Indirect concerns resulting from automation	Skill degradation
	Complacency
	Future traffic increases

Environment - related causes

Sector features	**Shape and size of airspace**
	Crossing routes/conflict points
	Mix of traffic (IFR and VFR)
	Climbing/descending traffic
	Traffic presentation i.e. Integration of arrival streams
Location of sector	Military airspace
	Mountains – takes away airspace/ flexibility
	Mountains – thunderstorms build quickly without notice
Traffic	Traffic amount and complexity

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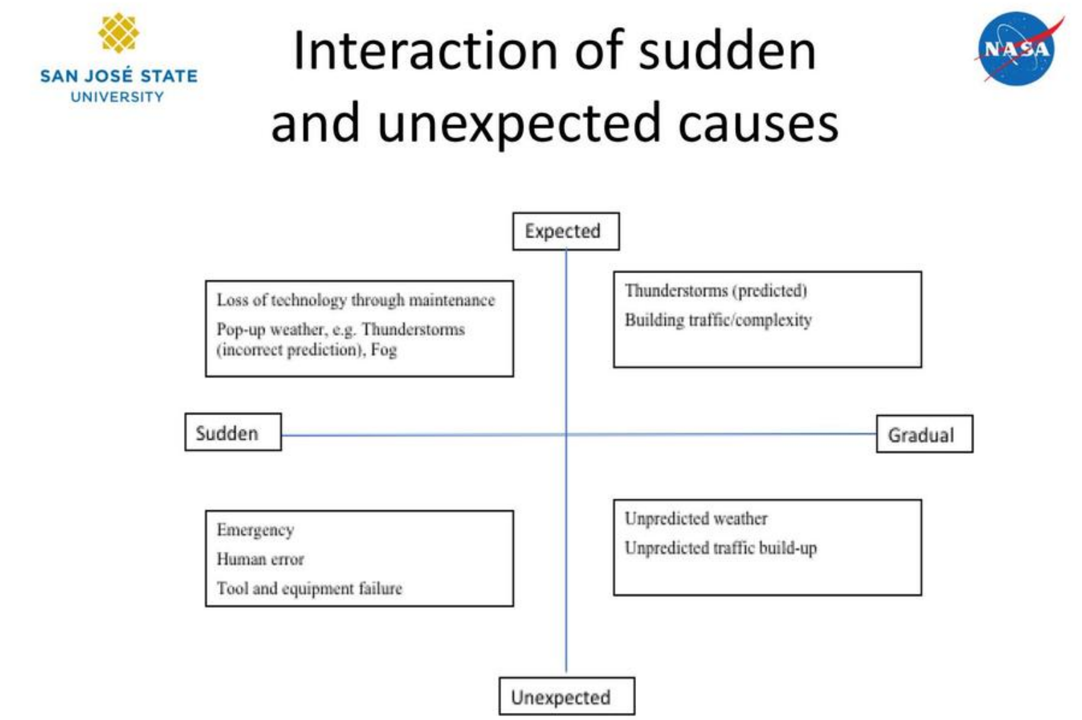
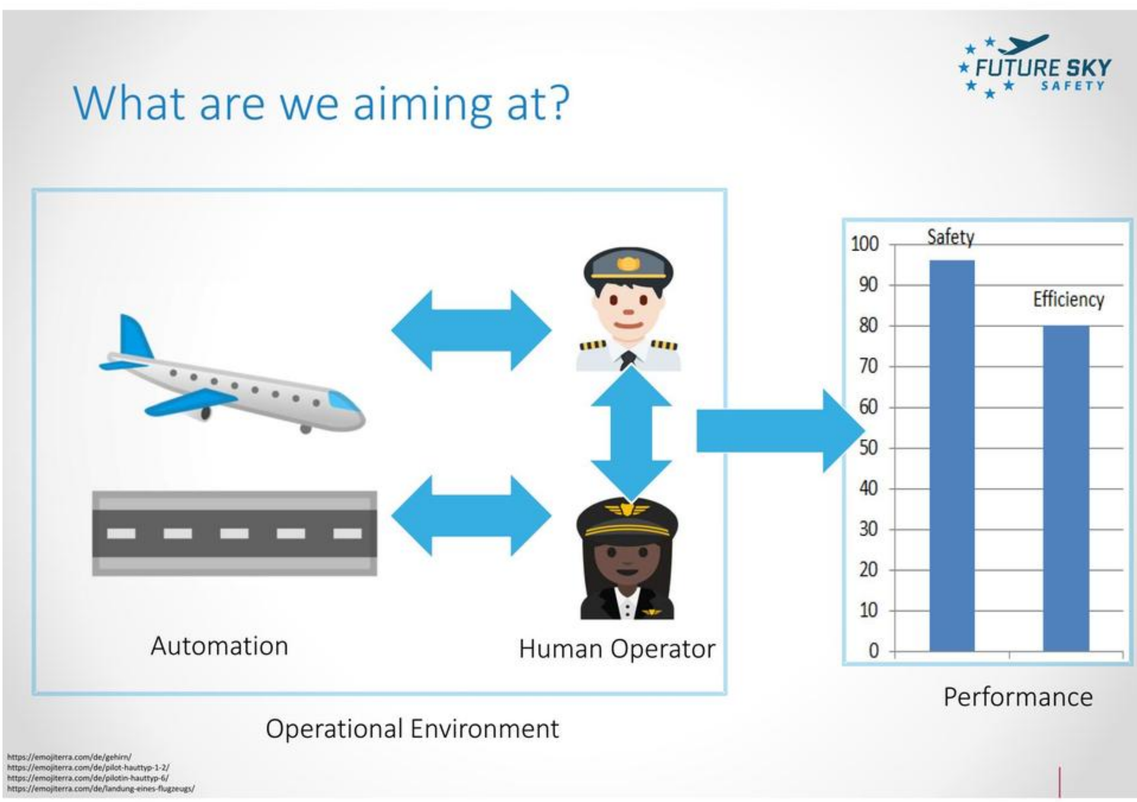
Causes of degradation (cont.)

Human factor related causes

Human Factor	Examples
Workload	Overload and underload
Inadequate Situation awareness	Incorrect mental picture
	Falling behind
Communications	Transposing callsigns
	Incorrect readback/hearback
	Missing calls
Fatigue	Slower at developing plan
	Slower to respond
	Don't perceive issues are quickly or clearly
Stress	Poor planning
	Inattention
Vigilance	Overlooking things
	Missing hand-offs
Inadequate Teamwork	Passive D-side – needs to be told what to do
	Uncooperative



Appendix B.18 "P6: Human Performance Envelope: overview of the project and technical results" – Marcus Biella, DLR



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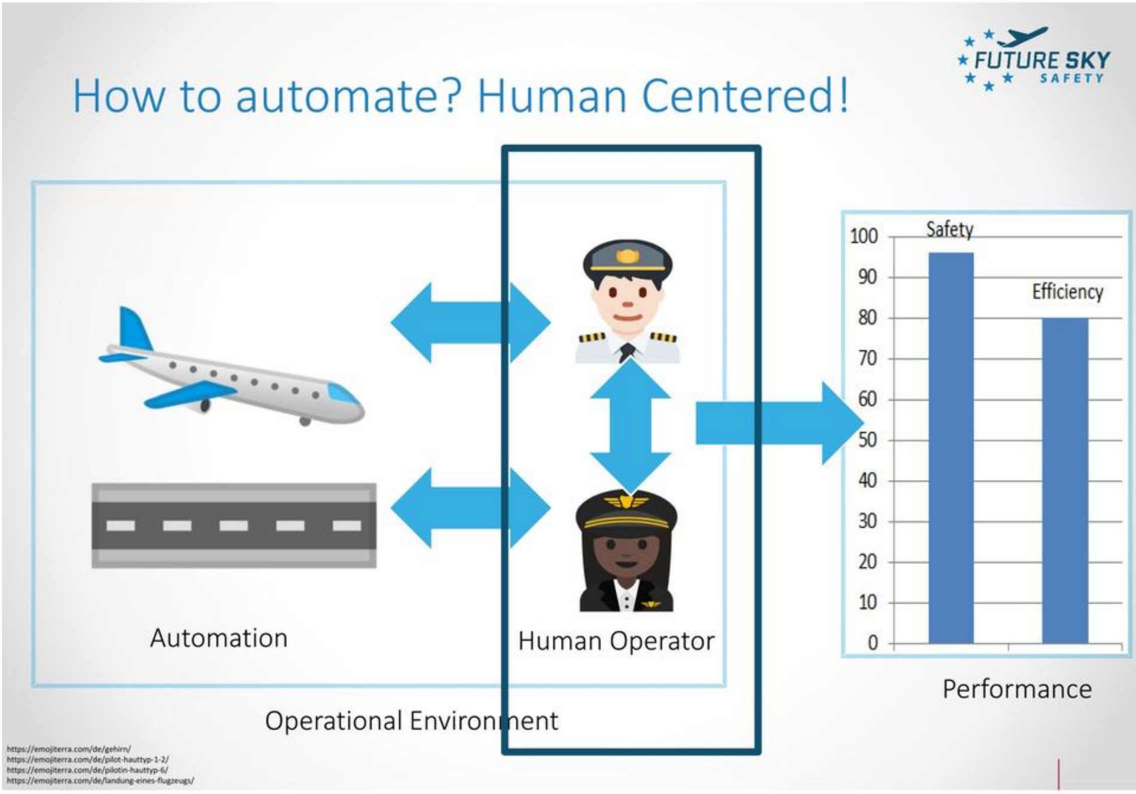
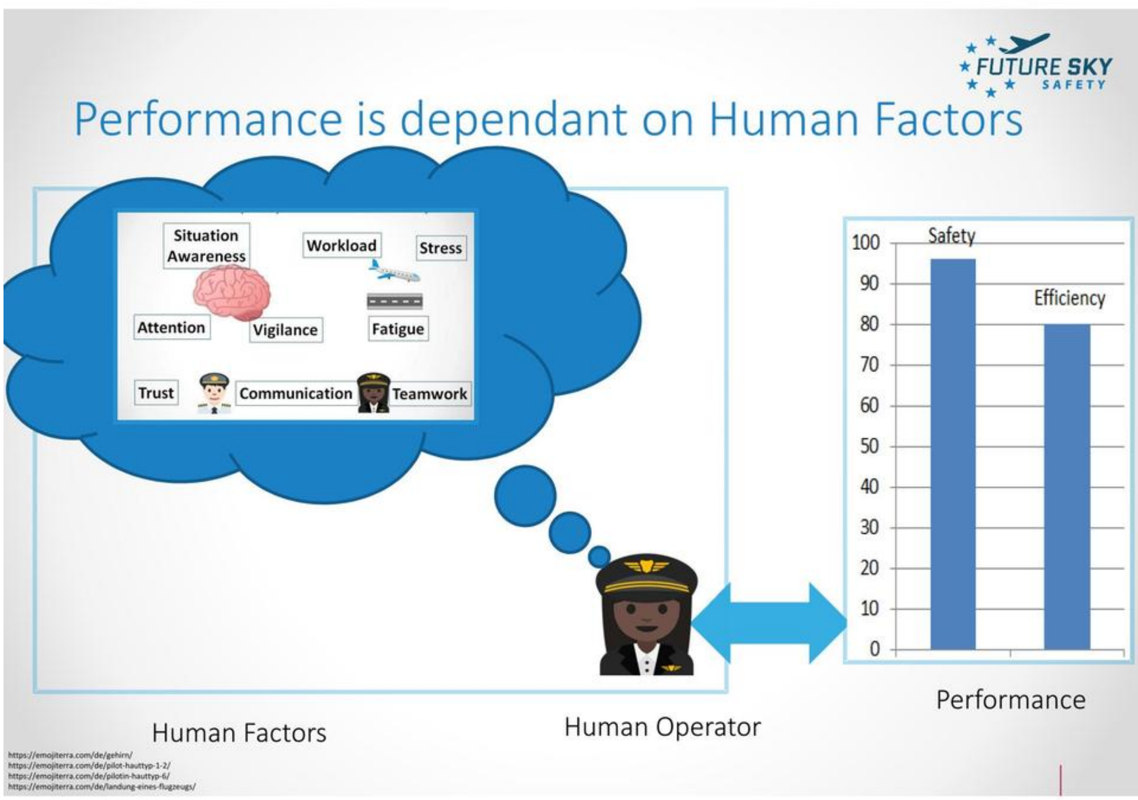

How to automate? Human Centered!
Automation
Human Operator
Operational Environment
Safety
Efficiency
100
90
80
70
60
50
40
30
20
10
0
Performance
https://emojiterra.com/de/gehirn/
https://emojiterra.com/de/pilot-hauttyp-1-2/
https://emojiterra.com/de/pilotin-hauttyp-6/
https://emojiterra.com/de/landung-eines-flugzeugs/


Performance is dependant on Human Factors
Situation Awareness
Workload
Stress
Attention
Vigilance
Fatigue
Trust
Communication
Teamwork
Human Factors
Human Operator
Safety
Efficiency
100
90
80
70
60
50
40
30
20
10
0
Performance
https://emojiterra.com/de/gehirn/
https://emojiterra.com/de/pilot-hauttyp-1-2/
https://emojiterra.com/de/pilotin-hauttyp-6/
https://emojiterra.com/de/landung-eines-flugzeugs/

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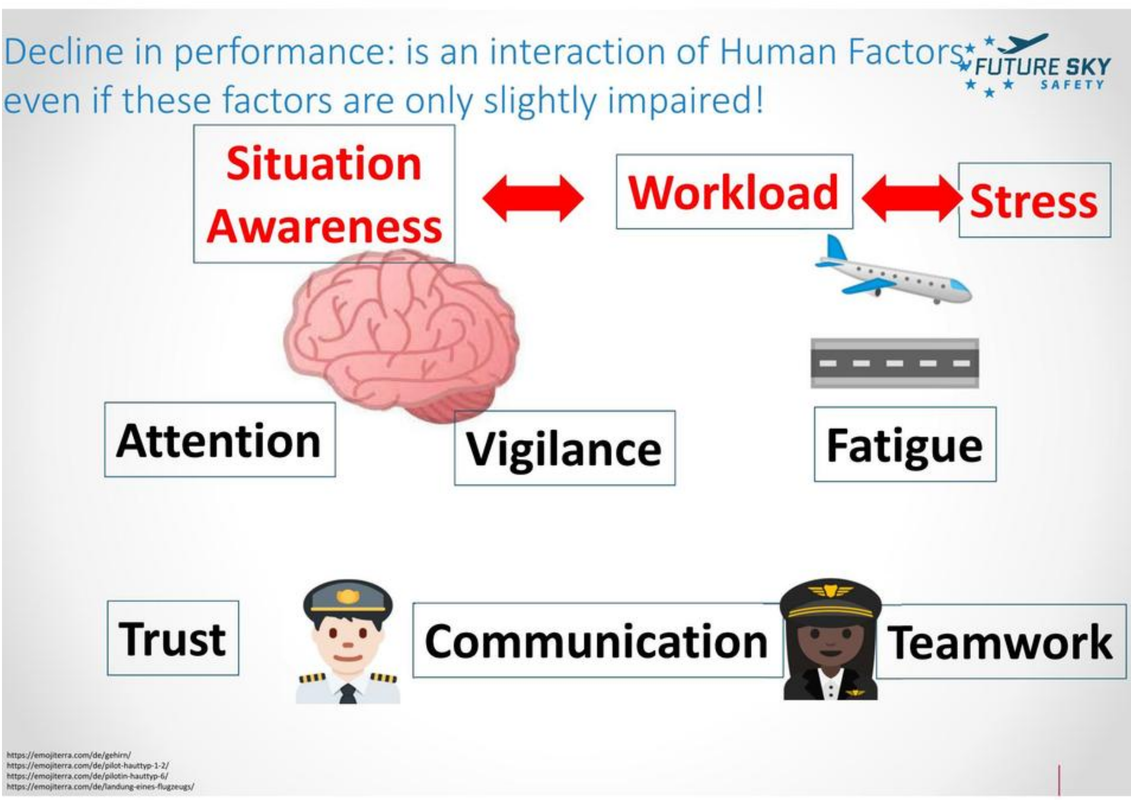
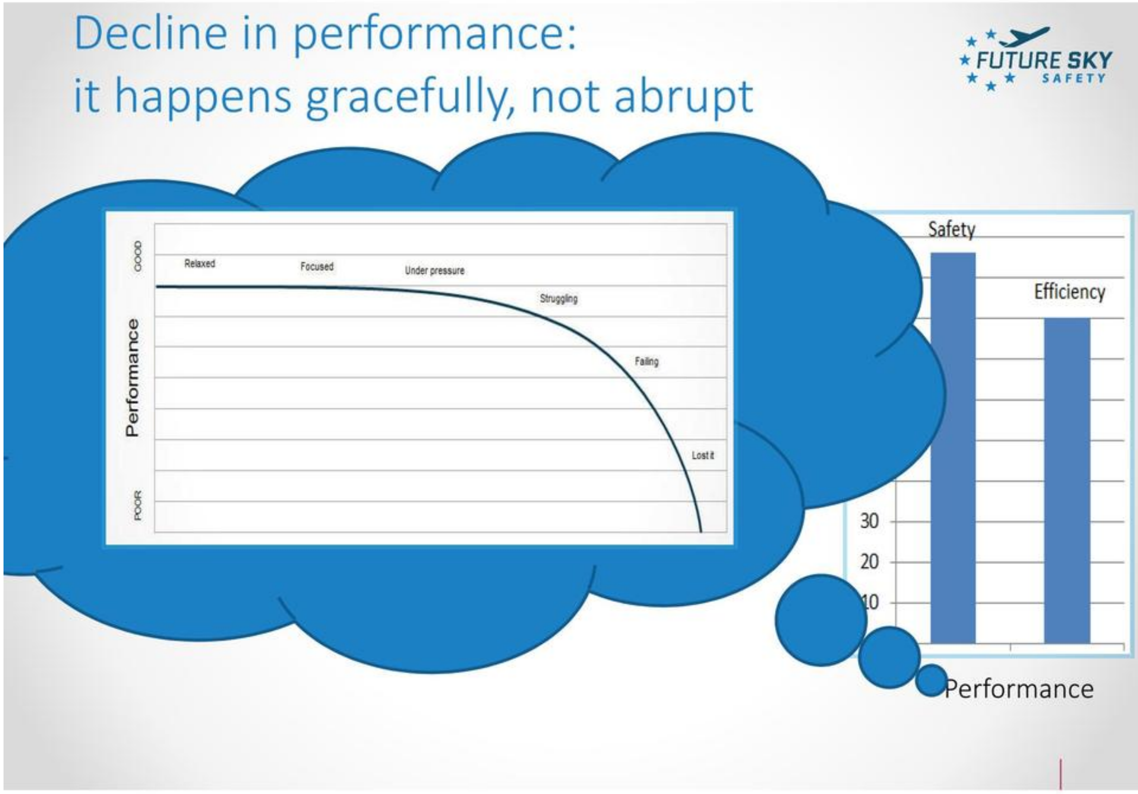
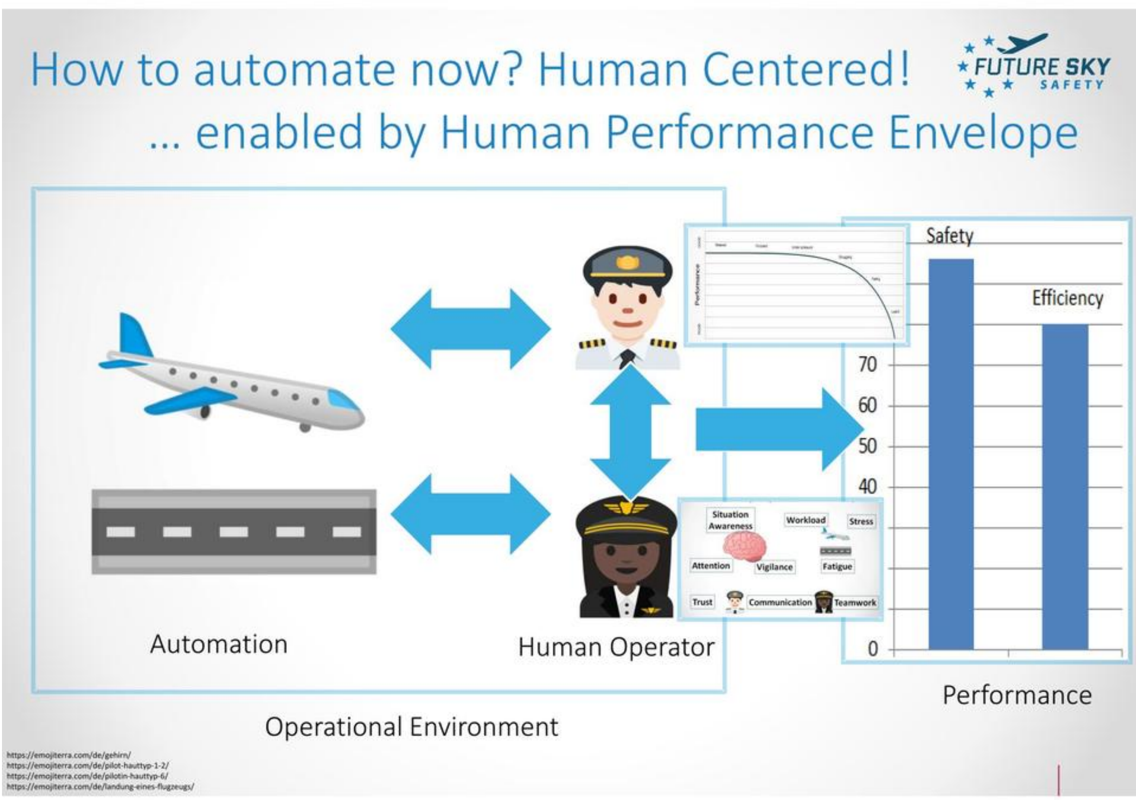
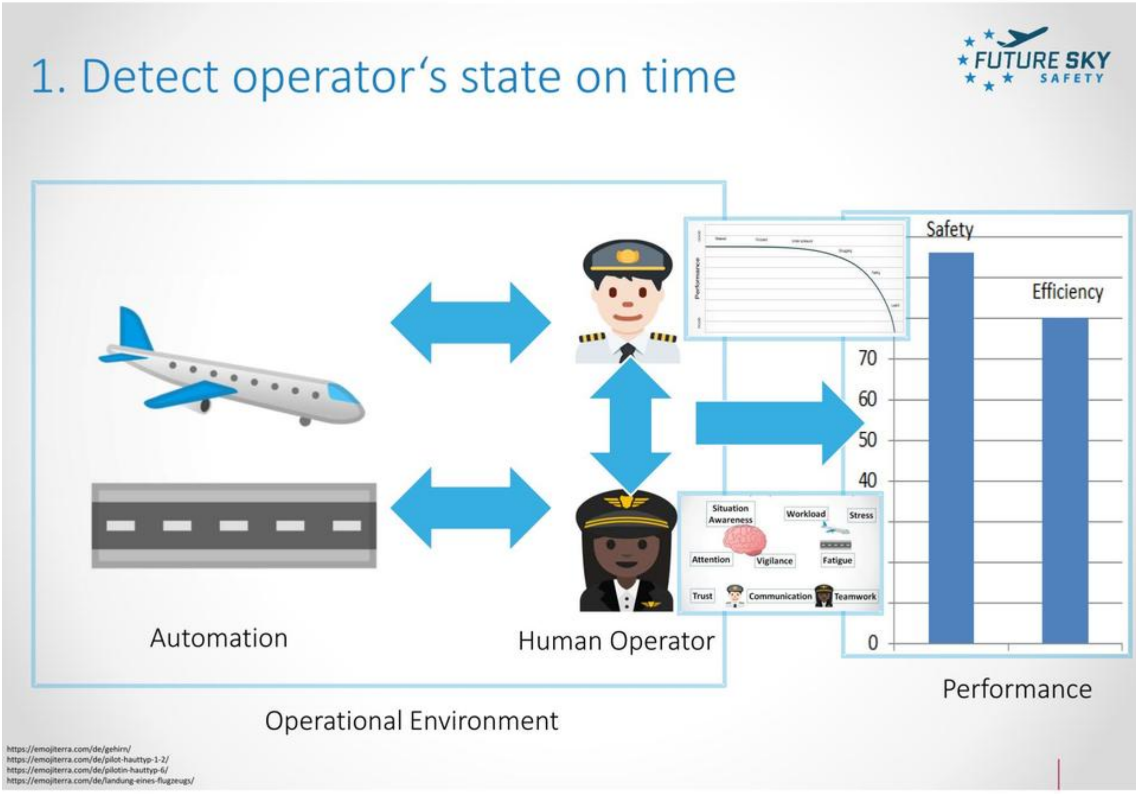
FUTURE SKY SAFETY
Situation Awareness
Workload
Stress
Attention
Vigilance
Fatigue
Trust
Communication
Teamwork
https://emojiterra.com/de/gehirn/
https://emojiterra.com/de/pilot-hauttyp-1-2/
https://emojiterra.com/de/pilotin-hauttyp-6/
https://emojiterra.com/de/landung-eines-flugzeugs/

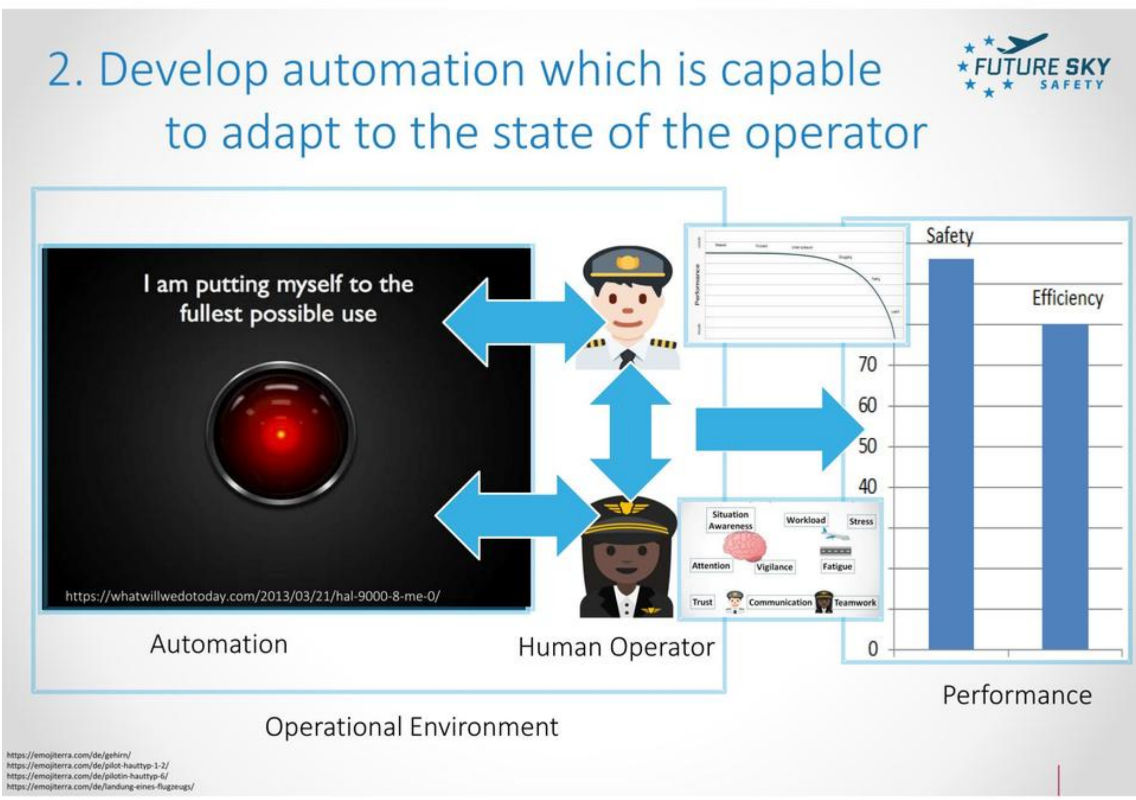

Decline in performance: is an interaction of Human Factors even if these factors are only slightly impaired!
FUTURE SKY SAFETY
Situation Awareness
Workload
Stress
Attention
Vigilance
Fatigue
Trust
Communication
Teamwork
https://emojiterra.com/de/gehirn/
https://emojiterra.com/de/pilot-hauttyp-1-2/
https://emojiterra.com/de/pilotin-hauttyp-6/
https://emojiterra.com/de/landung-eines-flugzeugs/

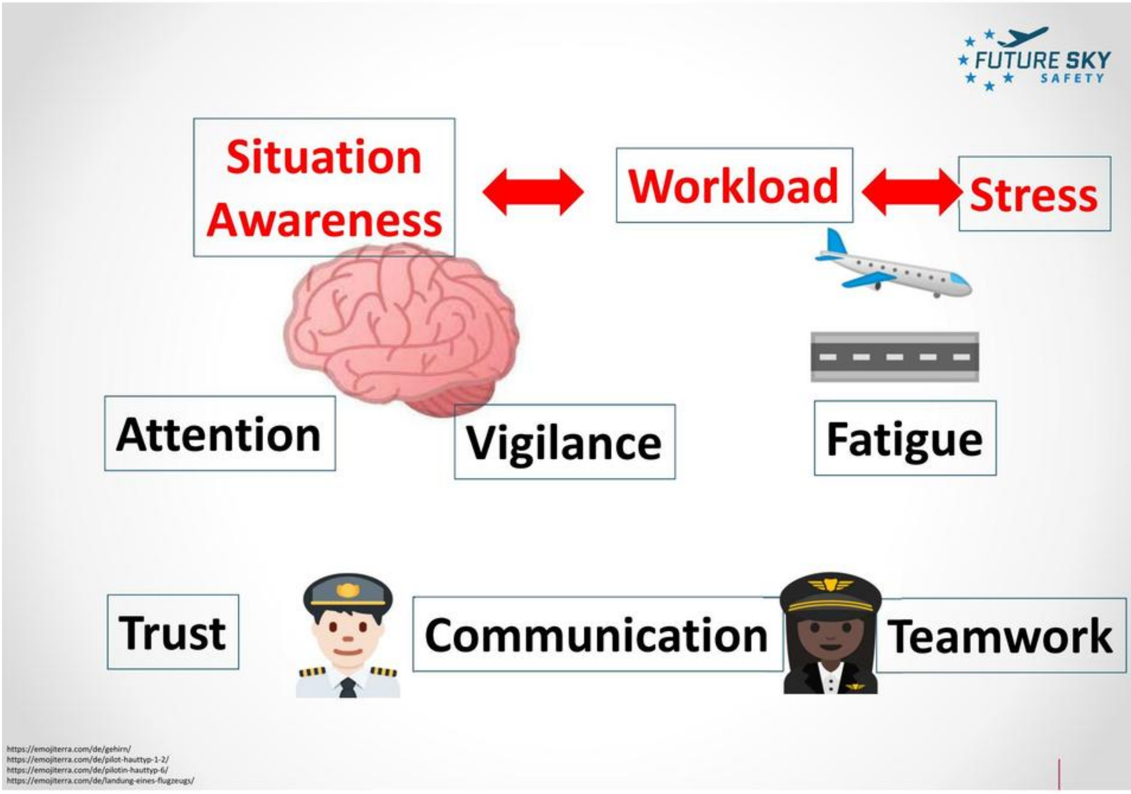


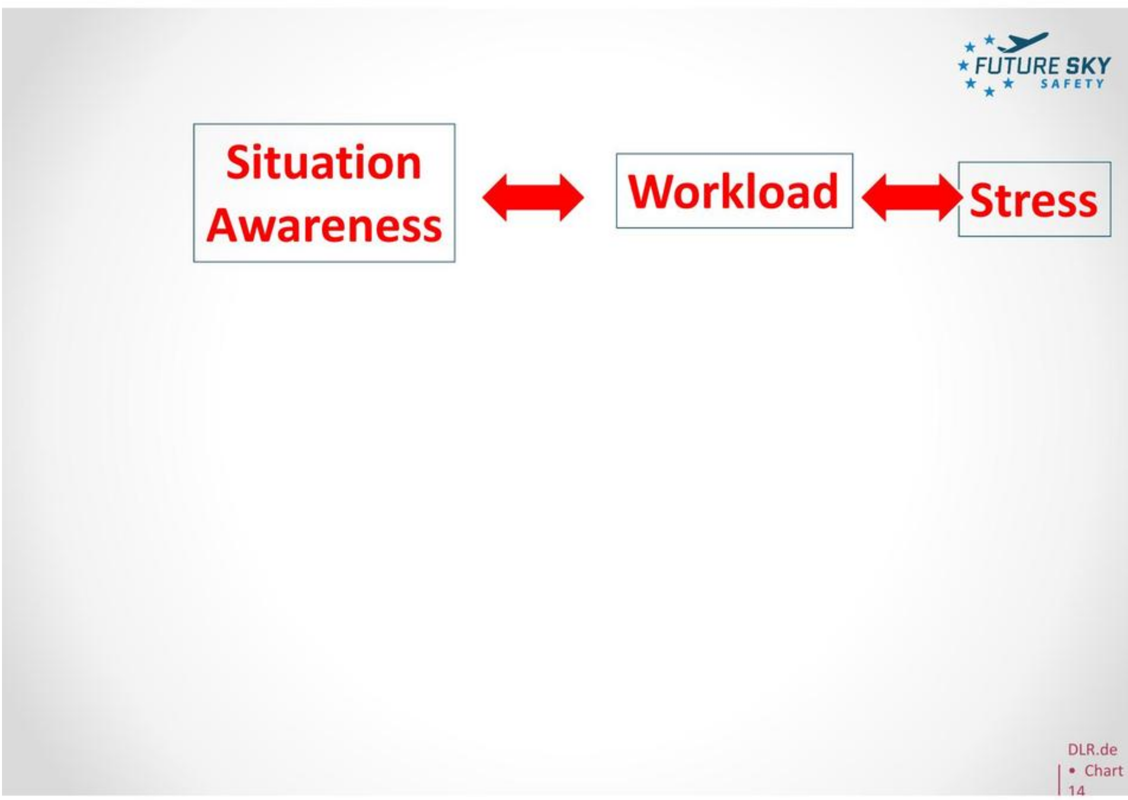


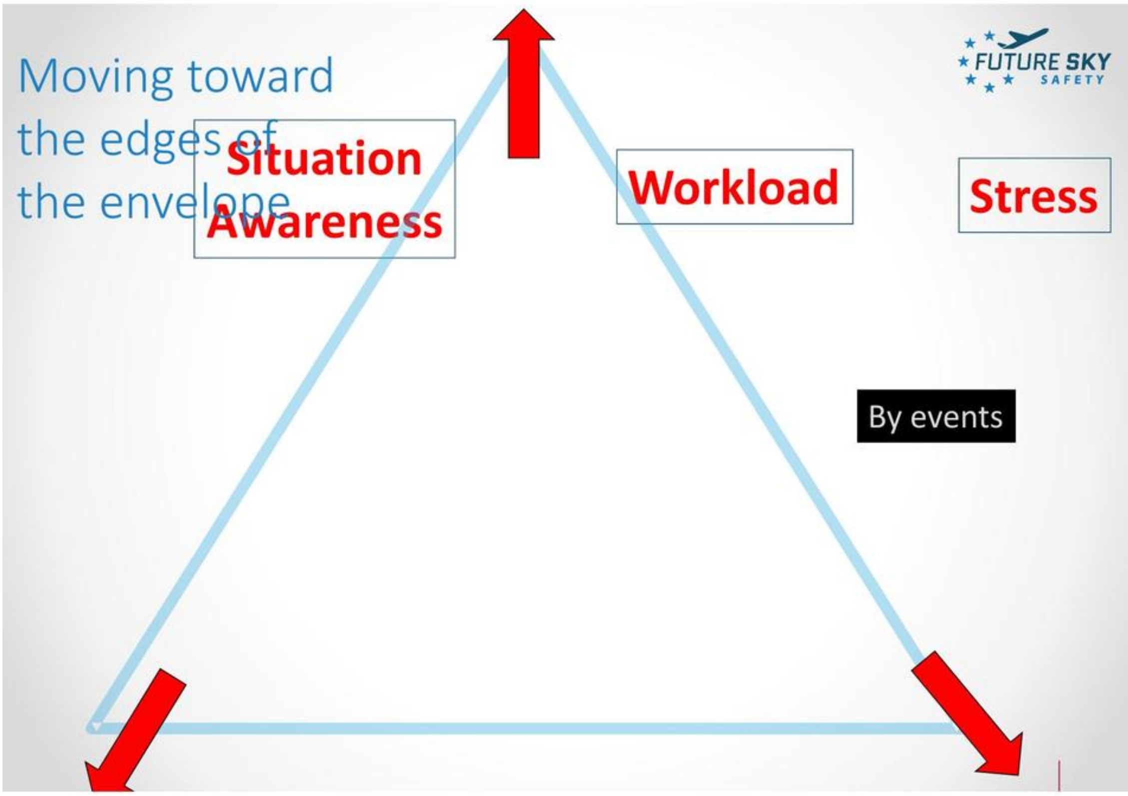
Future Sky Safety has received funding from the EU's Horizon 2020 Research and Innovation Programme, under Grant Agreement No. 640597.

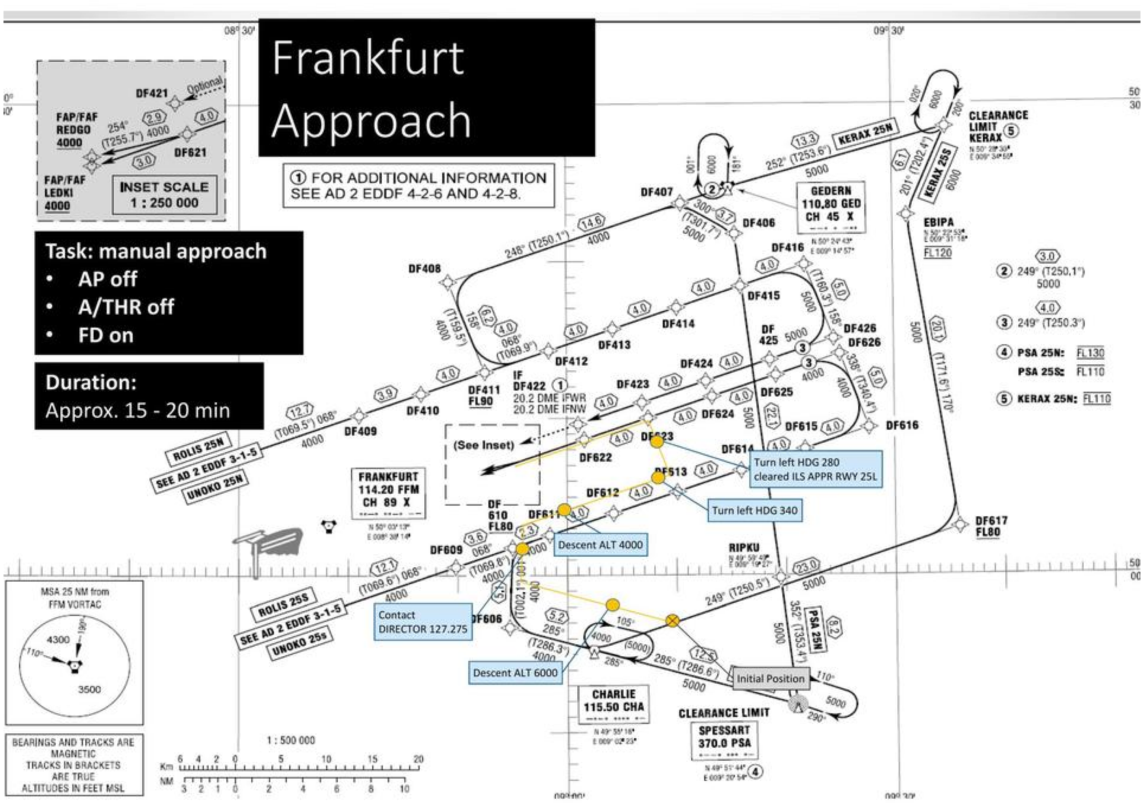

1. Detect operator's state on time
FUTURE SKY SAFETY
Safety
Efficiency
70
60
50
40
0
Situation Awareness
Workload
Stress
Attention
Vigilance
Fatigue
Trust
Communication
Teamwork
Automation
Human Operator
Performance
Operational Environment
https://emojiterra.com/de/gehirn/
https://emojiterra.com/de/pilot-hauttyp-1-2/
https://emojiterra.com/de/pilotin-hauttyp-6/
https://emojiterra.com/de/landung-eines-flugzeugs/


2. Develop automation which is capable to adapt to the state of the operator
FUTURE SKY SAFETY
I am putting myself to the fullest possible use
https://whatwillwedotoday.com/2013/03/21/hal-9000-8-me-0/
Safety
Efficiency
70
60
50
40
0
Situation Awareness
Workload
Stress
Attention
Vigilance
Fatigue
Trust
Communication
Teamwork
Automation
Human Operator
Performance
Operational Environment
https://emojiterra.com/de/gehirn/
https://emojiterra.com/de/pilot-hauttyp-1-2/
https://emojiterra.com/de/pilotin-hauttyp-6/
https://emojiterra.com/de/landung-eines-flugzeugs/


FUTURE SKY SAFETY
Situation Awareness
Workload
Stress
Attention
Vigilance
Fatigue
Trust
Communication
Teamwork
https://emojiterra.com/de/gehirn/
https://emojiterra.com/de/pilot-hauttyp-1-2/
https://emojiterra.com/de/pilotin-hauttyp-6/
https://emojiterra.com/de/landung-eines-flugzeugs/


FUTURE SKY SAFETY
Situation Awareness
Workload
Stress
DLR.de • Chart 14





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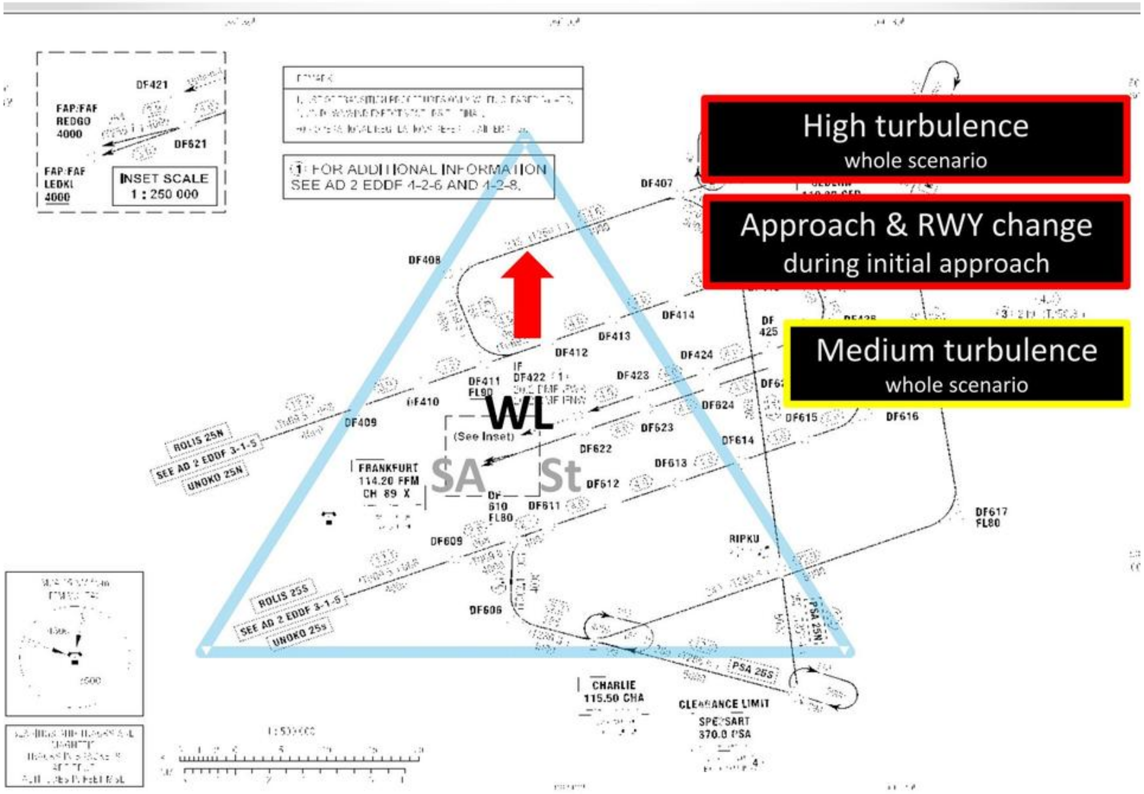
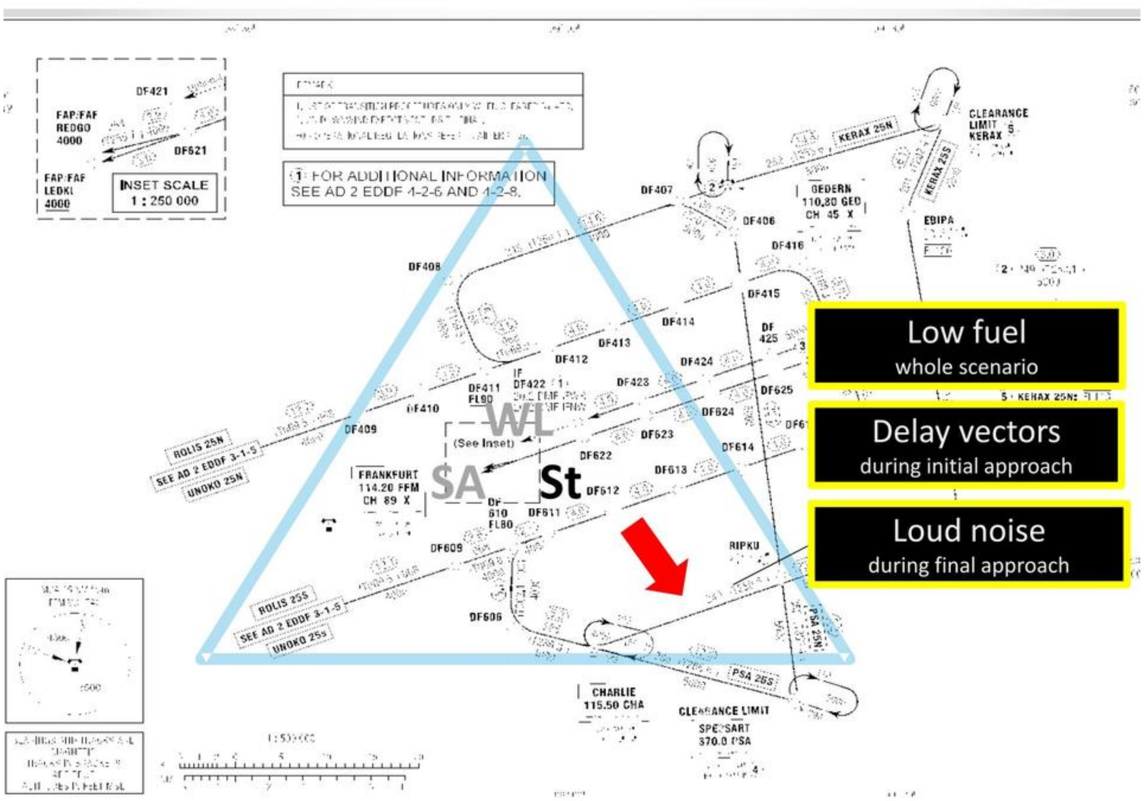
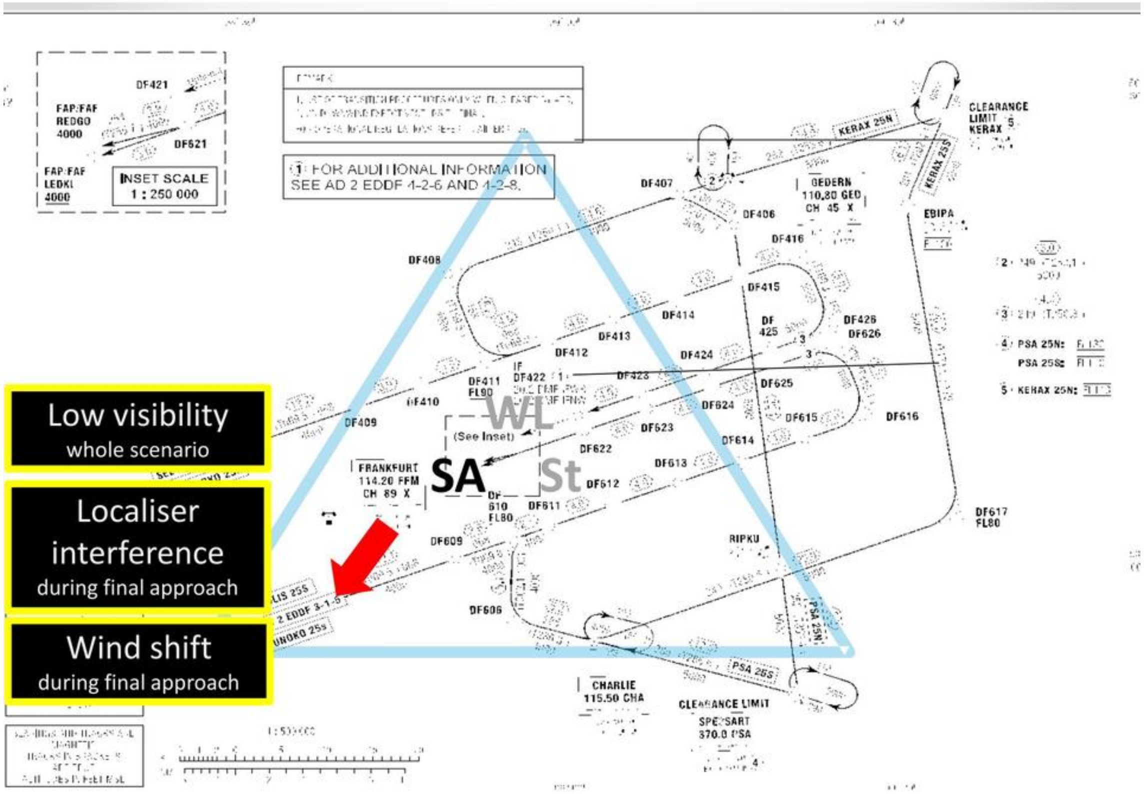

High turbulence
whole scenario
Approach & RWY change
during initial approach
Medium turbulence
whole scenario
WL
SA
St


Low fuel
whole scenario
Delay vectors
during initial approach
Loud noise
during final approach
WL
SA
St



Future Sky Safety has received funding from the EU's Horizon 2020 Research and Innovation Programme, under Grant Agreement No. 640597.

Measurements

Eye Tracking Data

- Point of Gaze
- Blink Rate
- Areas of Interest
- Pupil Diameter

Measurements

Physiological Data

- Heart Rate (HR)
- HR Variability (HRV)
- RR Intervals
- Breath Rate
- Perfusion Index

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Measurements

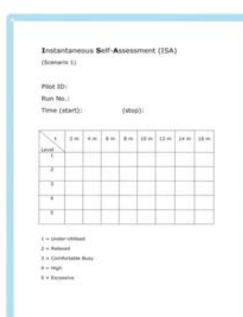
Performance Data

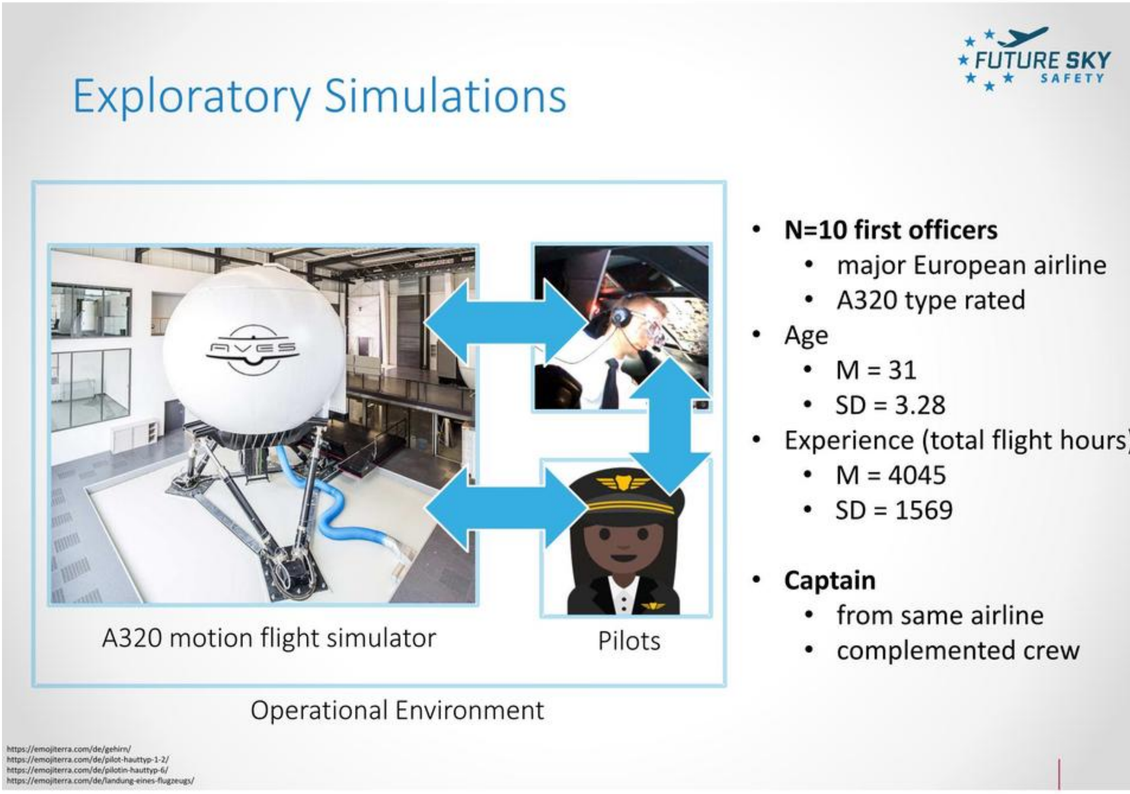
- Speed
- Heading
- Altitude
- Vertical speed
- Localiser glideslope deviations
- Point of touchdown

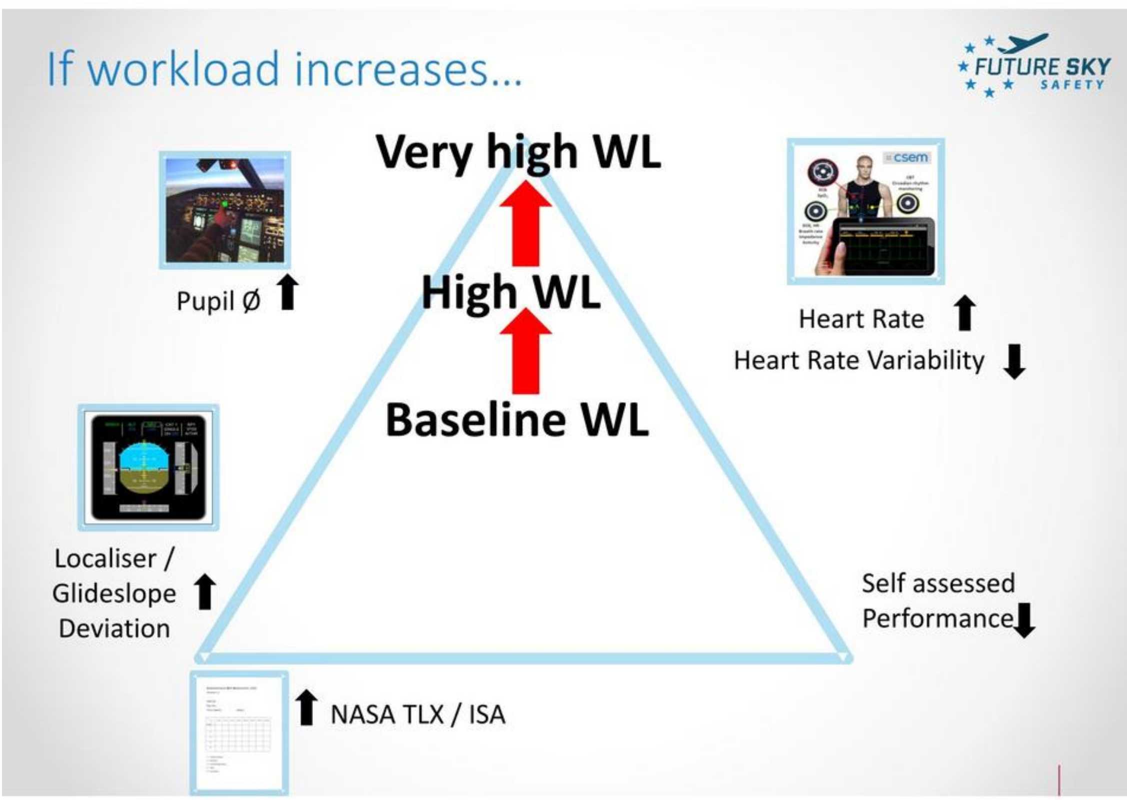
Measurements

Subjective Data

- Self assessed performance
  - ISA
- NASA-TLX
  - SACL
  - SART
- Samn-Perelli







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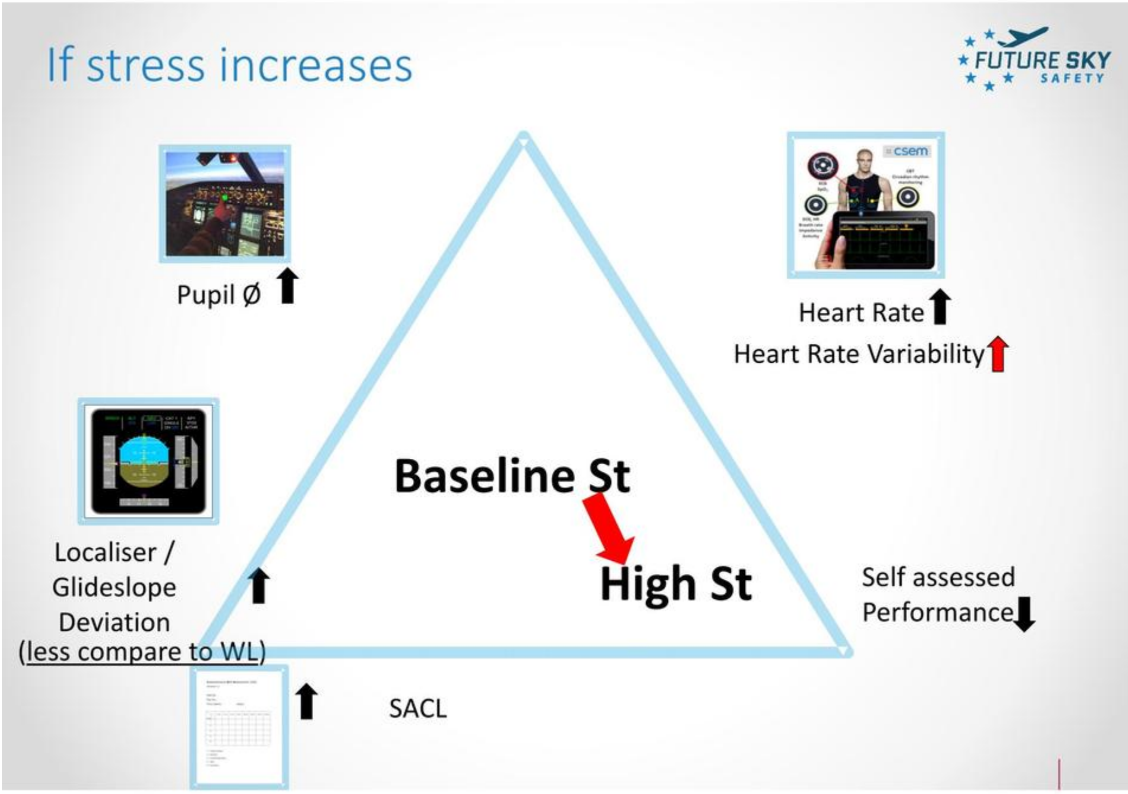

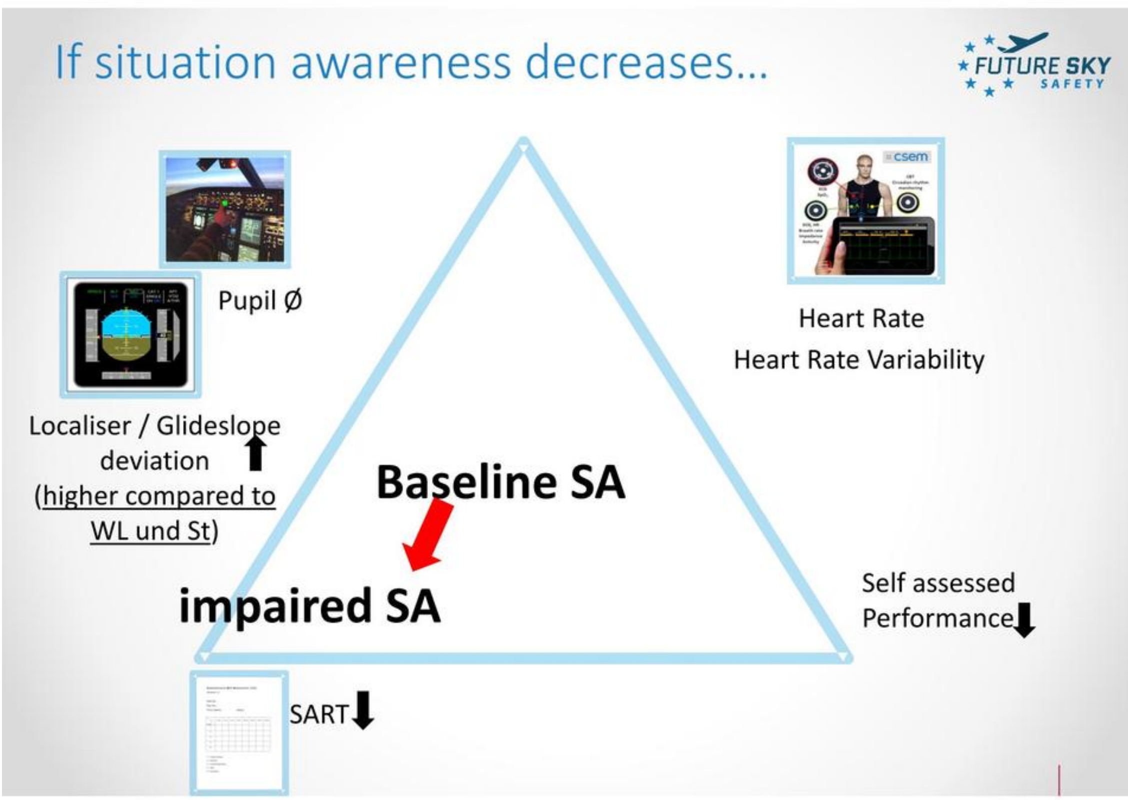

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Results: combined factors

HPE more severely reduced by combined factors

Pupil Ø

Low Frequency
HRV

Localiser /
Glideslope
Deviation

Design Philosophy

Pilots need to have information about:

- The status
- The limitations
- The consequences of the limitations for operation and the impact of the limitations on safety
  - To be aware about the risks
  - To understand the risks
  - To understand the options
- The options
- The consequences of the options
- How to implement the options

SAFETY | FUTURE SKY

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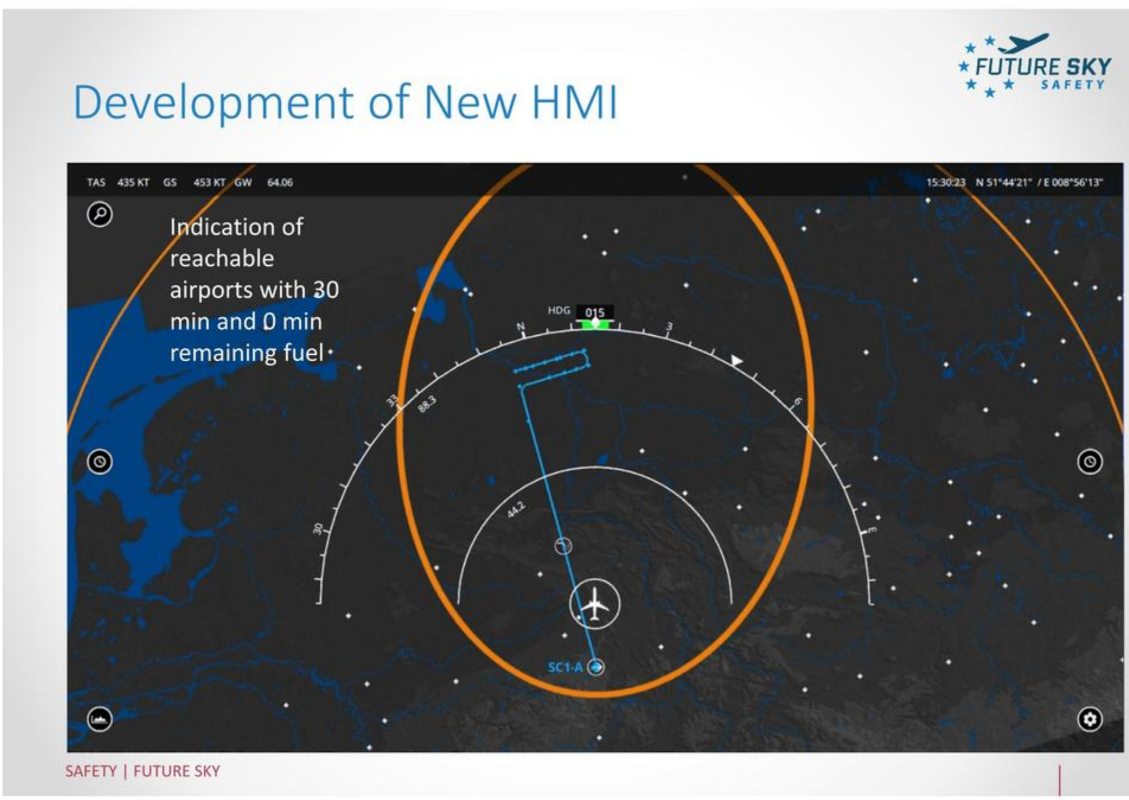

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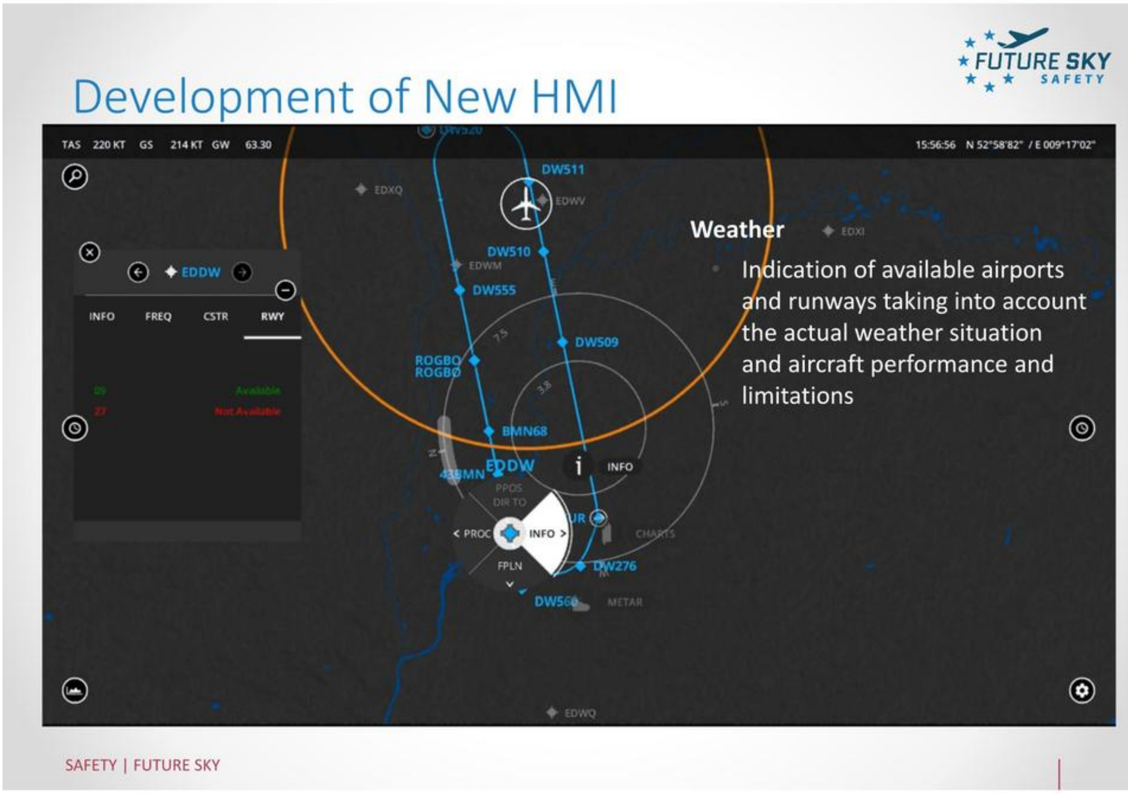

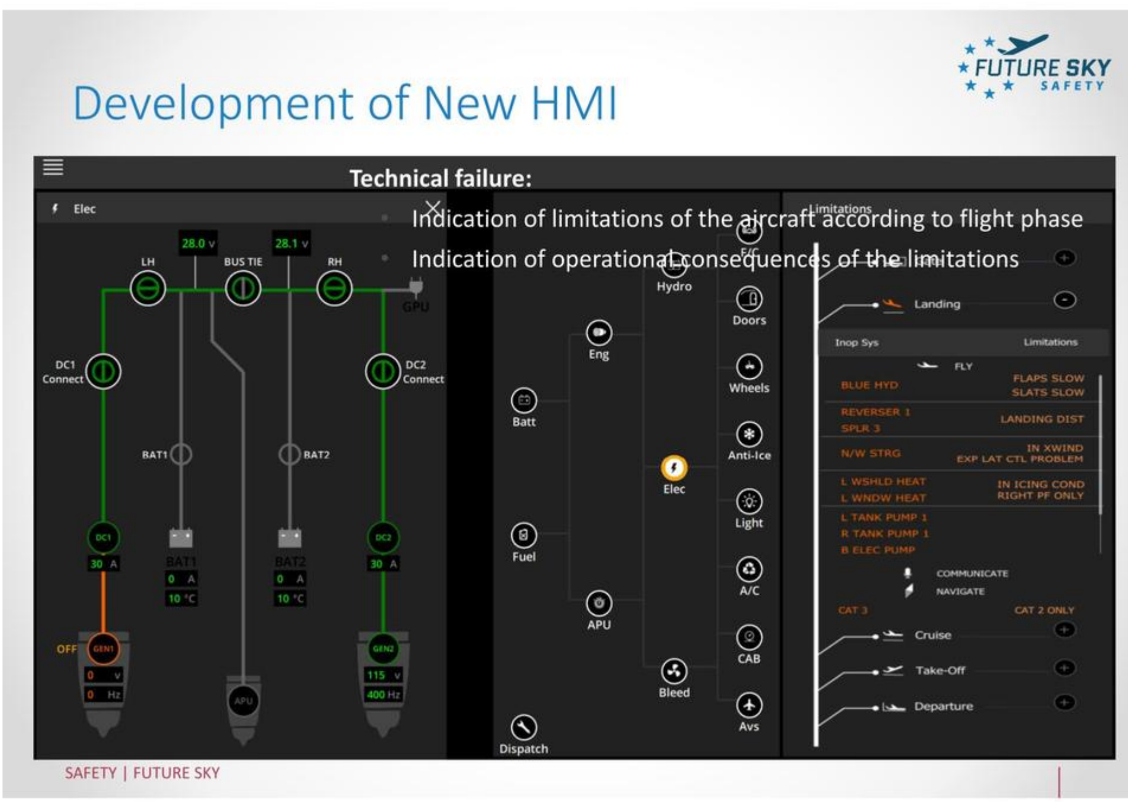

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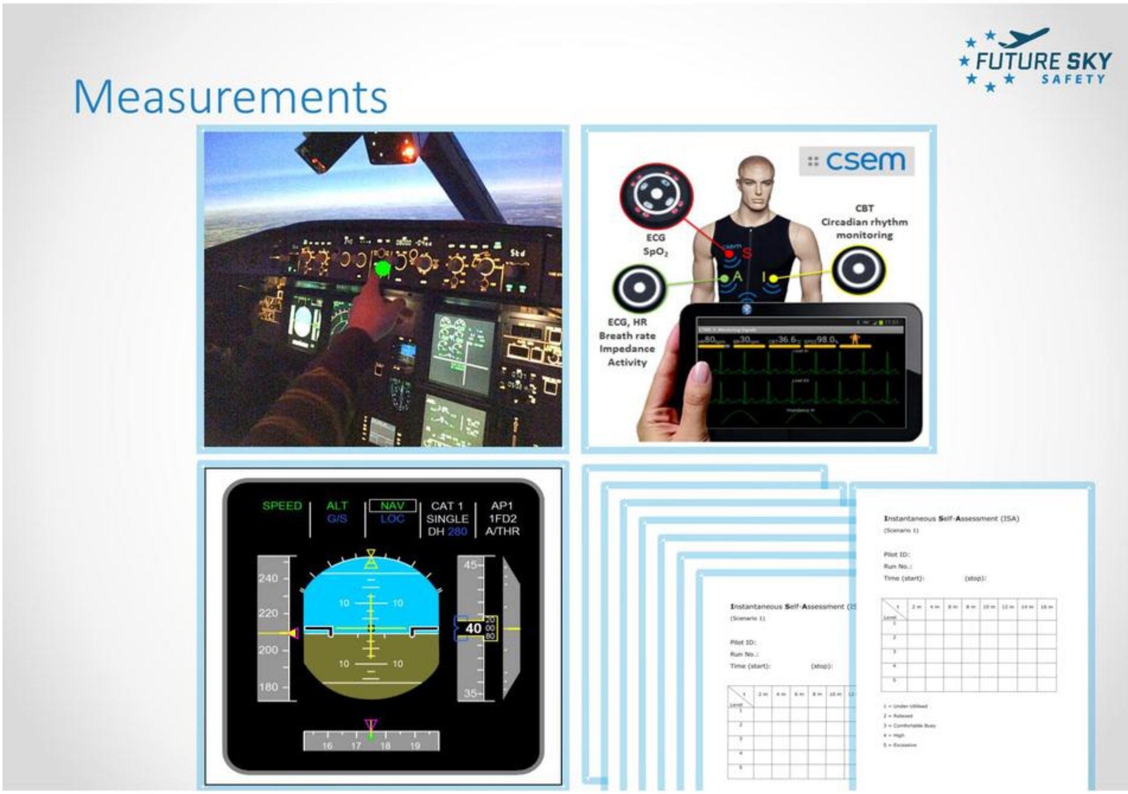
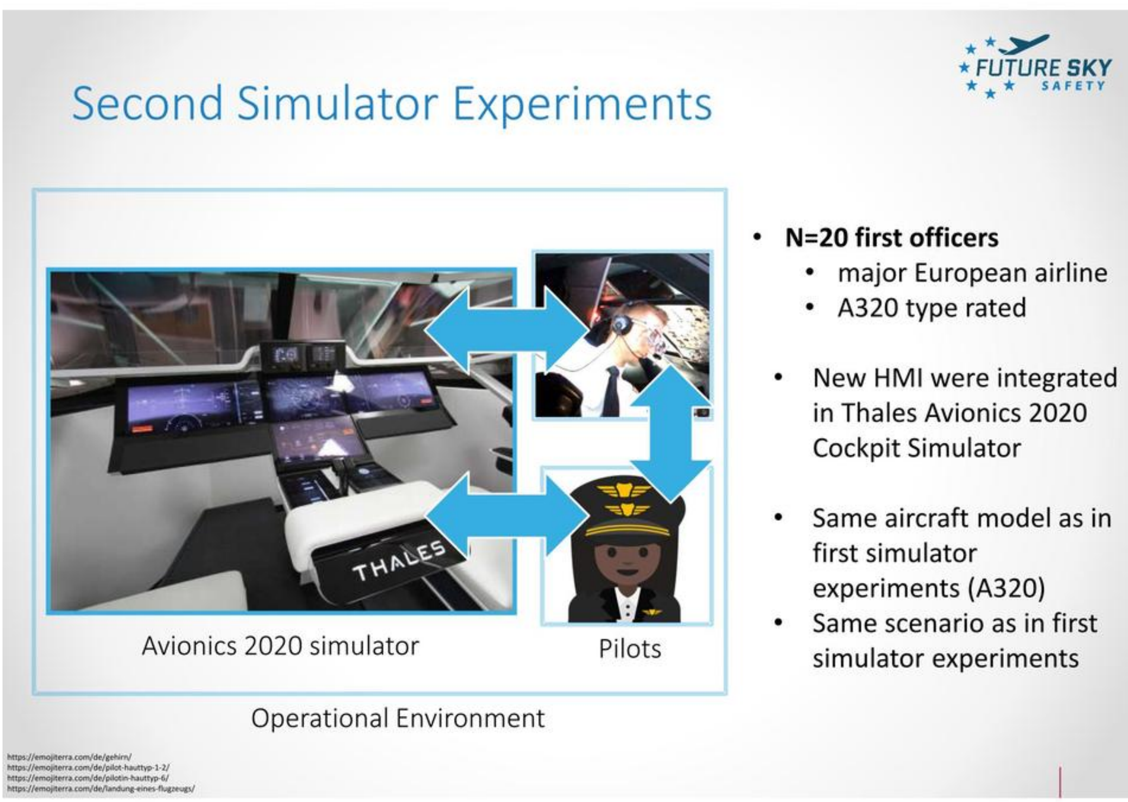
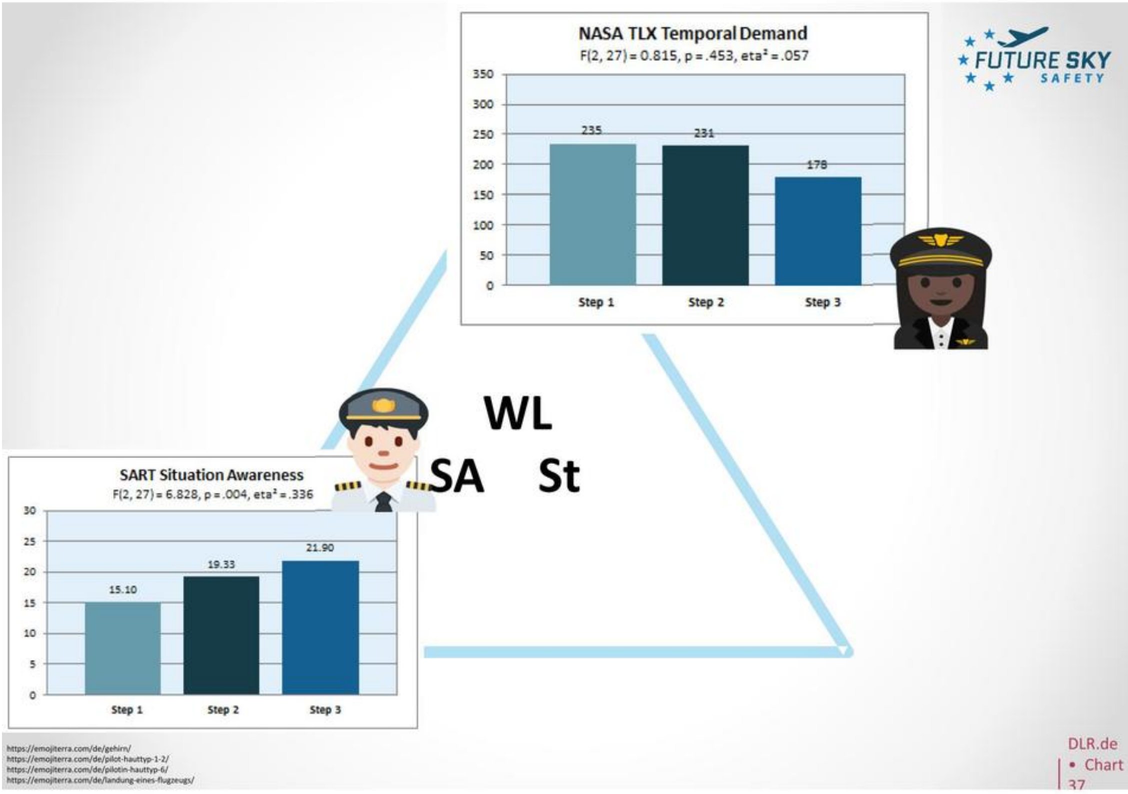

Measurements
csem
ECG
SpO2
CBT
Circadian rhythm
monitoring
ECG, HR
Breath rate
Impedance
Activity
SPEED
ALT
G/S
NAV
LOC
CAT 1
SINGLE
DH 280
AP1
1FD2
A/THR
Instantaneous Self-Assessment (ISA)
(Scenario 1)
Pilot ID:
Run No.:
Time (start): (stop):


Second Simulator Experiments
THALES
Avionics 2020 simulator
Pilots
Operational Environment
• N=20 first officers
• major European airline
• A320 type rated
• New HMI were integrated in Thales Avionics 2020 Cockpit Simulator
• Same aircraft model as in first simulator experiments (A320)
• Same scenario as in first simulator experiments
https://emojiterra.com/de/gehirn/
https://emojiterra.com/de/pilot-hauttyp-1-2/
https://emojiterra.com/de/pilotin-hauttyp-6/
https://emojiterra.com/de/landung-eines-flugzeugs/



Consortium

Stichting Nationaal Lucht- en Ruimtevaartlaboratorium
Deutsches Zentrum für Luft- und Raumfahrt
Office national d'études et de recherches aérospatiales
Centro para a Excelência e Inovação na Indústria Automóvel
Centro Italiano Ricerche Aerospaziali
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Sistemi Innovativi per il Controllo del Traffico Aereo

http://www.futuresky-safety.eu

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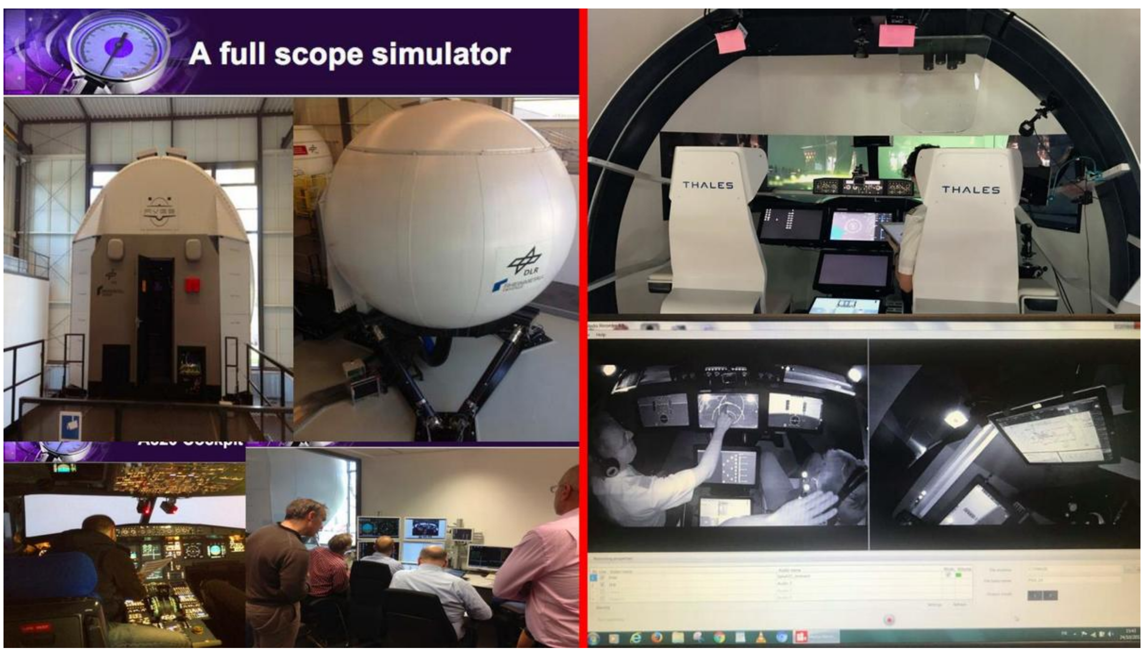
Appendix B.19 "P6: Development of new cockpit interfaces" – Carsten Schmidt-Moll, Lufthansa

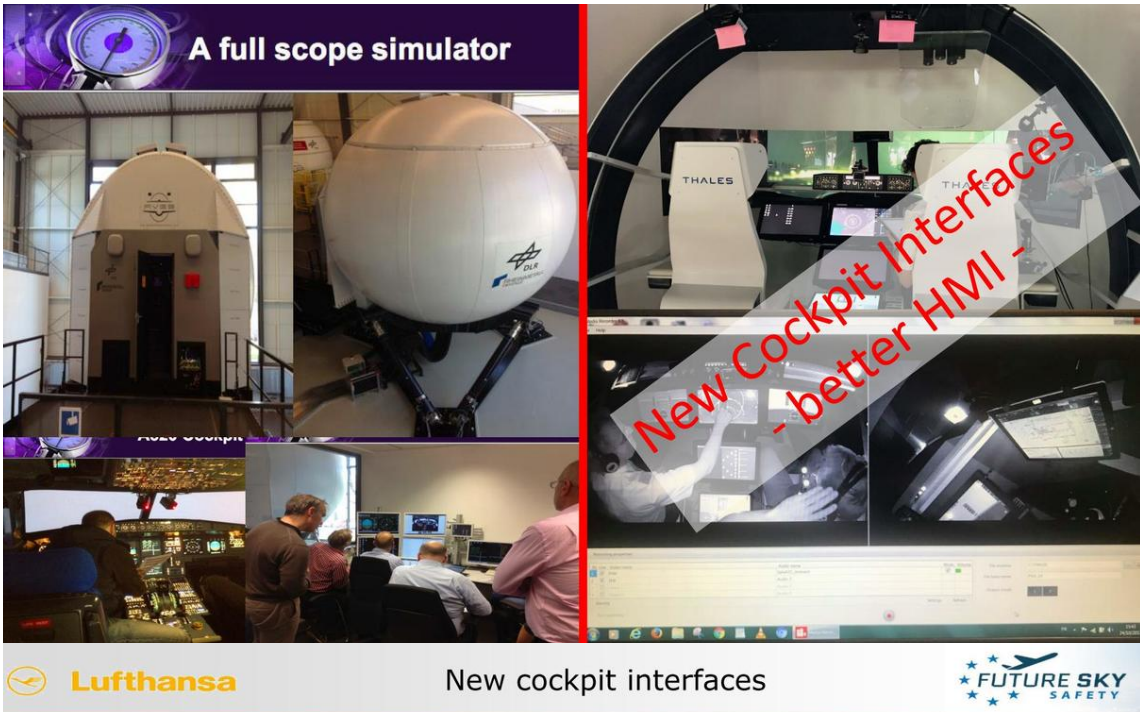
Lufthansa

P6: Development of new cockpit interfaces

Human Machine Interface (HMI)

Cpt. Carsten Schmidt-Moll
German Lufthansa AG





Simulator research: Technical abnormal

1. HMI: What kind of information?
2. HMI: How to get that information?
3. HMI: When to get the info and how long it takes (timing)?

P6: Development of new cockpit interfaces

Brussels, 07.12.2018 - 4

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Lufthansa

New cockpit interfaces

Simulator research: Technical abnormal

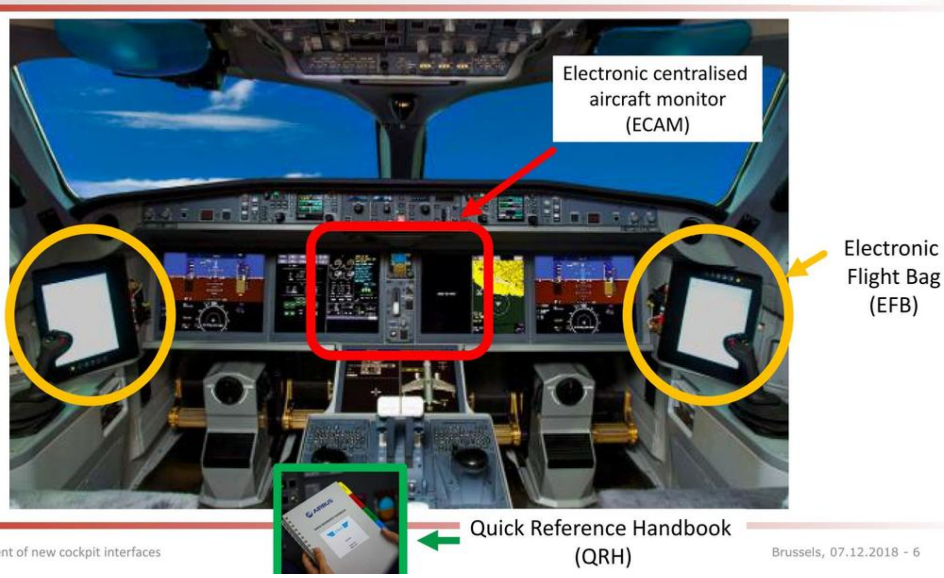
1. HMI: What kind of information?
2. HMI: How to get that information?
3. HMI: When to get the info and how long it takes (timing)?

P6: Development of new cockpit interfaces

Brussels, 07.12.2018 - 5

Lufthansa

Cockpit Interfaces



P6: Development of new cockpit interfaces

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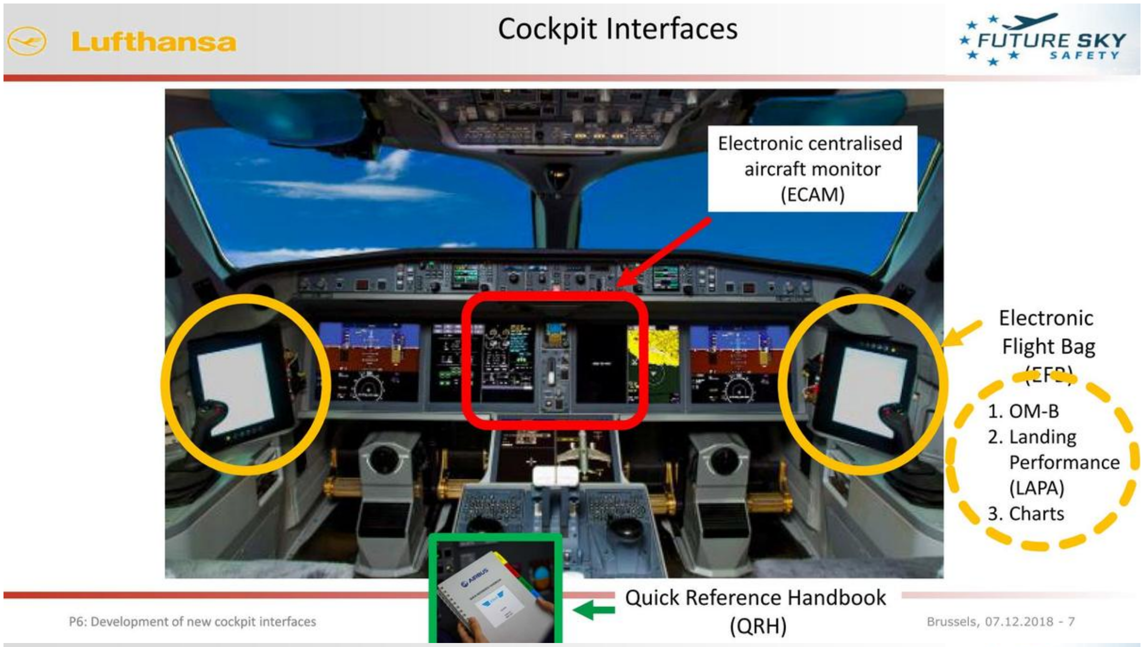

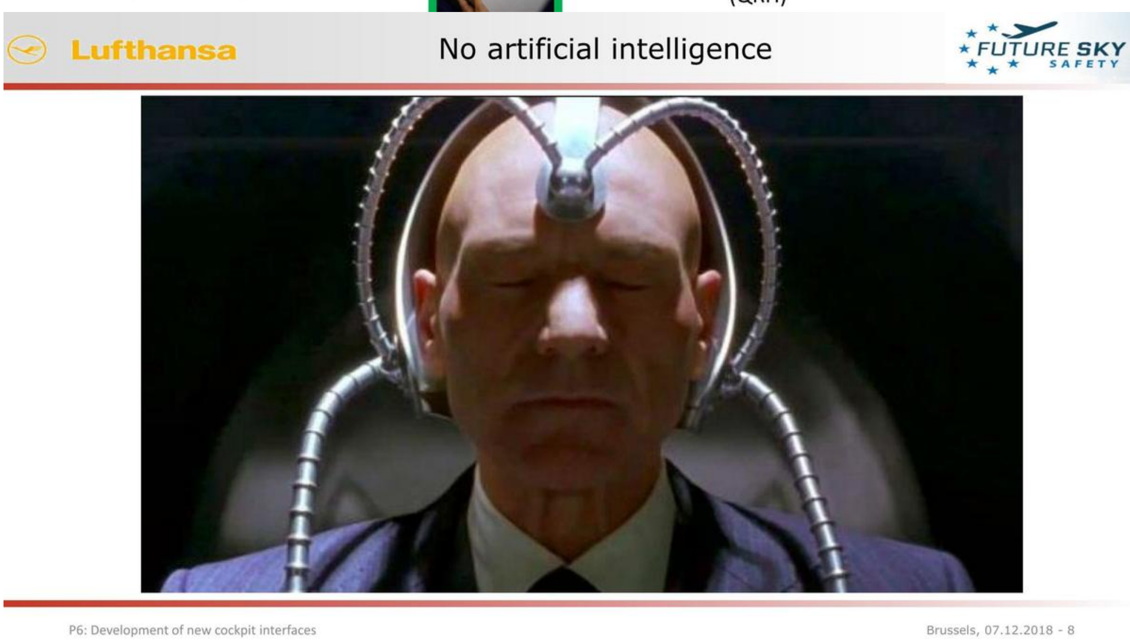

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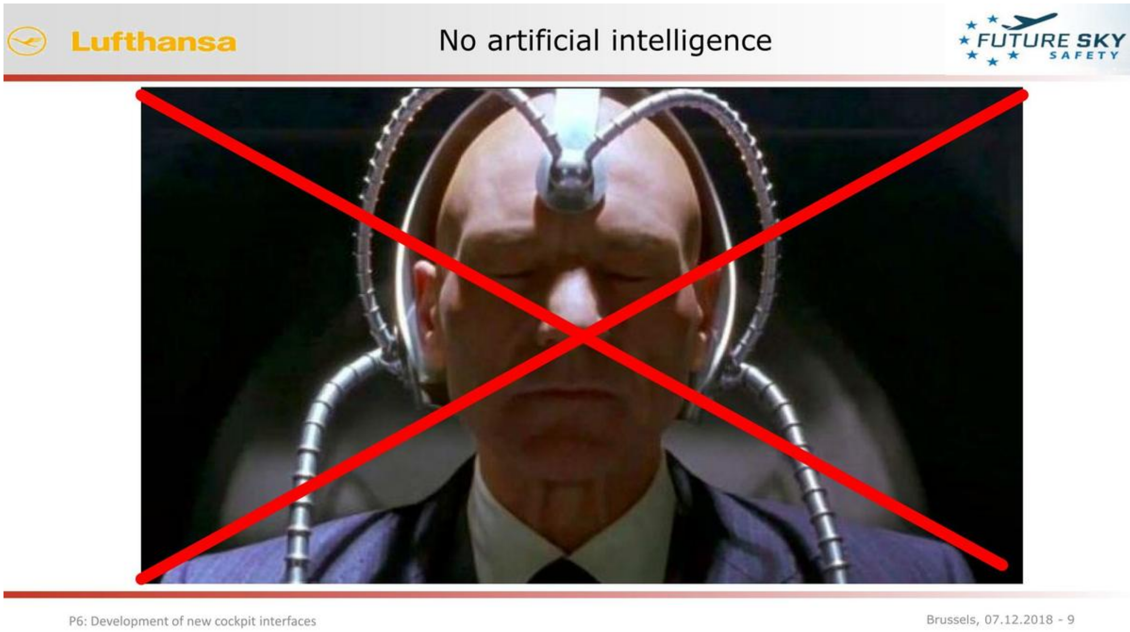
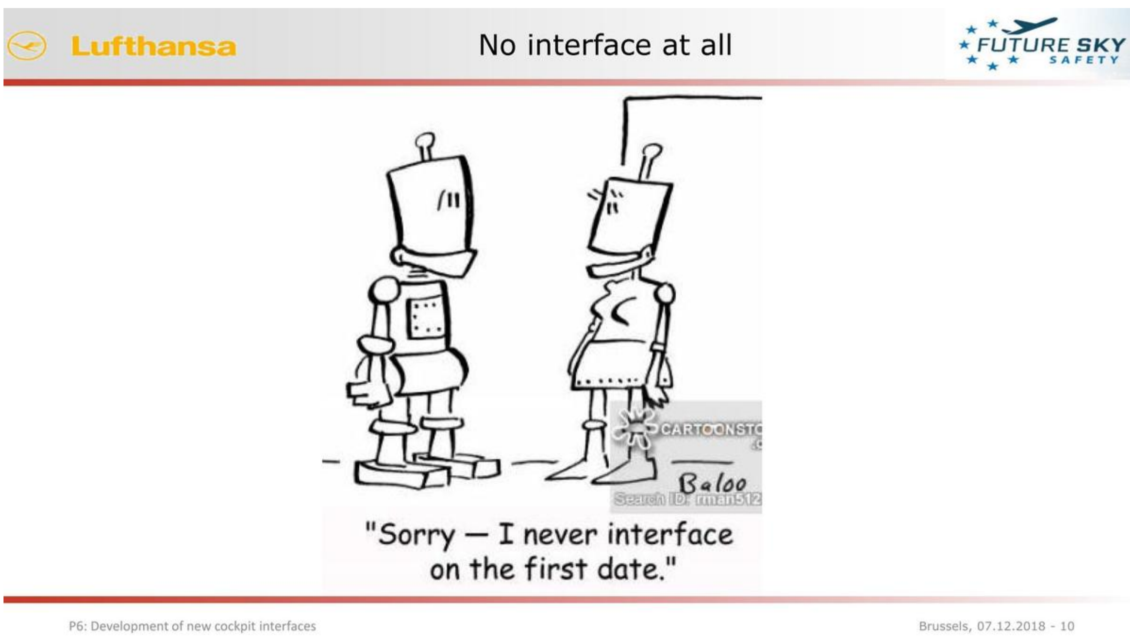
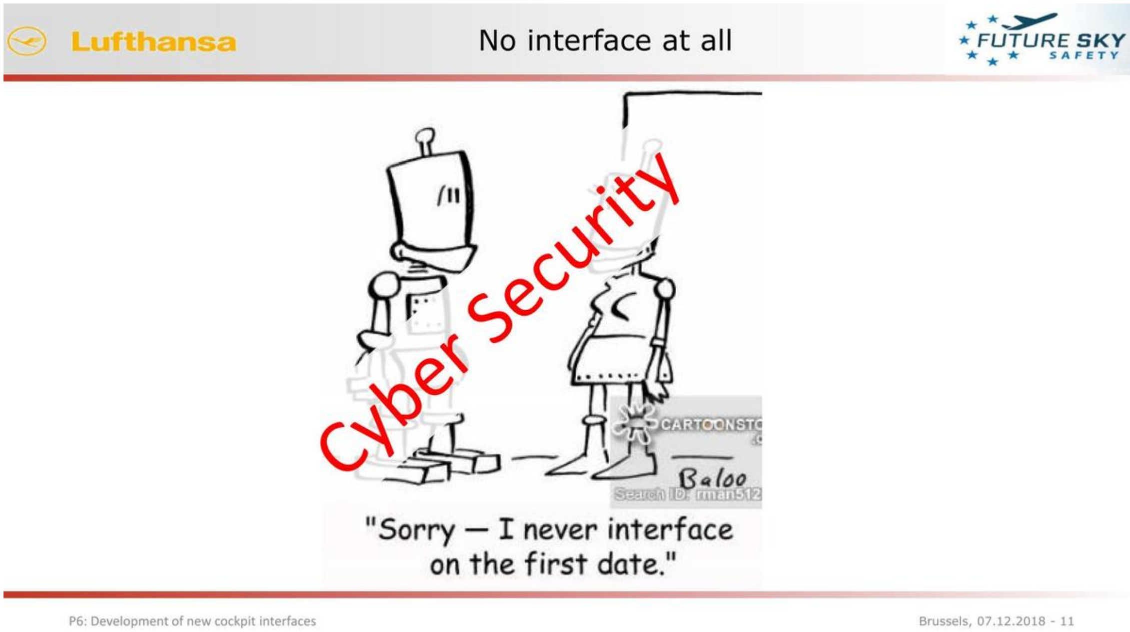
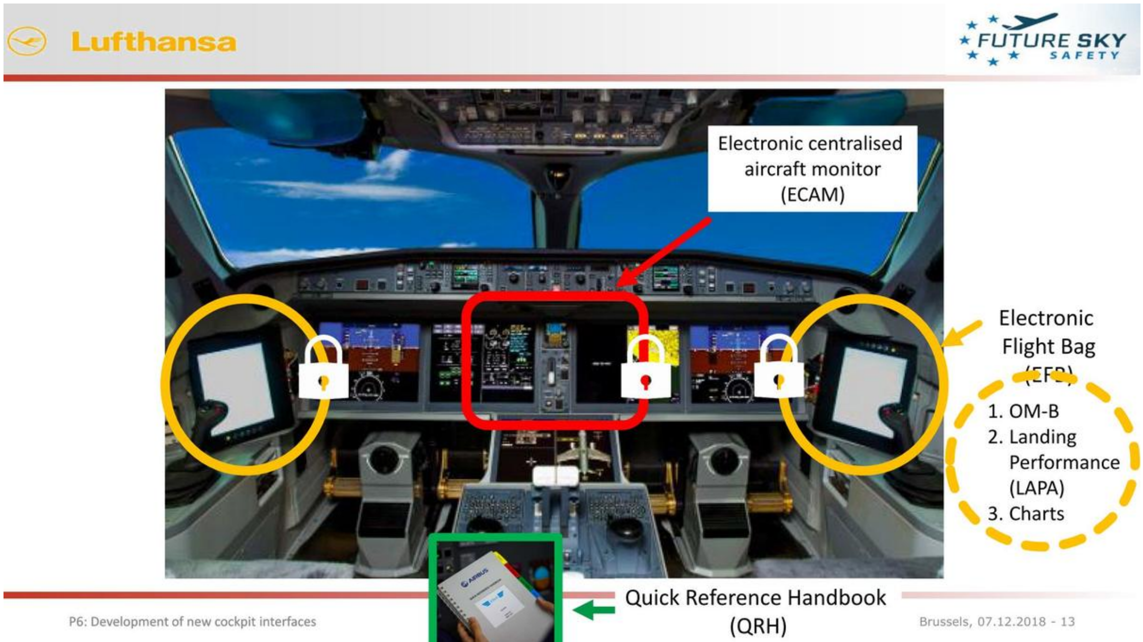

Lufthansa
No artificial intelligence
FUTURE SKY SAFETY
P6: Development of new cockpit interfaces
Brussels, 07.12.2018 - 9


Lufthansa
No interface at all
FUTURE SKY SAFETY
Baloo
"Sorry — I never interface on the first date."
P6: Development of new cockpit interfaces
Brussels, 07.12.2018 - 10


Lufthansa
No interface at all
FUTURE SKY SAFETY
Cyber Security
CARTOONSTO
Baloo
"Sorry — I never interface on the first date."
P6: Development of new cockpit interfaces
Brussels, 07.12.2018 - 11


Lufthansa
No interface at all
FUTURE SKY SAFETY
Cyber Security
"Sorry — I never interface on the first date."
P6: Development of new cockpit interfaces
Brussels, 07.12.2018 - 12


Lufthansa
FUTURE SKY SAFETY
Electronic centralised aircraft monitor (ECAM)
Electronic Flight Bag (EFB)
1. OM-B
2. Landing Performance (LAPA)
3. Charts
Quick Reference Handbook (QRH)
P6: Development of new cockpit interfaces
Brussels, 07.12.2018 - 13

Lufthansa **The changing environment**

1. Big data becomes available on board the aircraft (internet allow actual news airports, weather, etc.)
2. More people fly: larger aircraft go to smaller airports
3. New airports arise having less infrastructure
4. Competition increases and reliability puts pressure on crews
5. Airlines operating with less extra fuel (time pressure)
6. Airlines wish to reduce number of crews and pilots (fatigue)

➡ Increasing need for actual information

P6: Development of new cockpit interfaces Brussels, 07.12.2018 - 17

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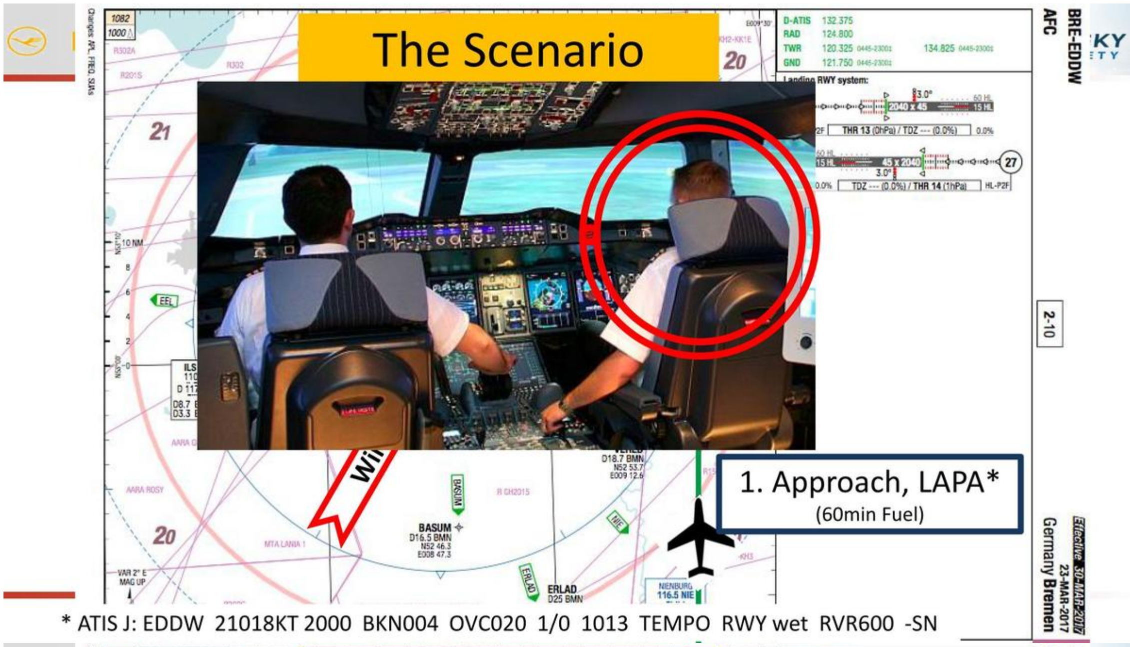

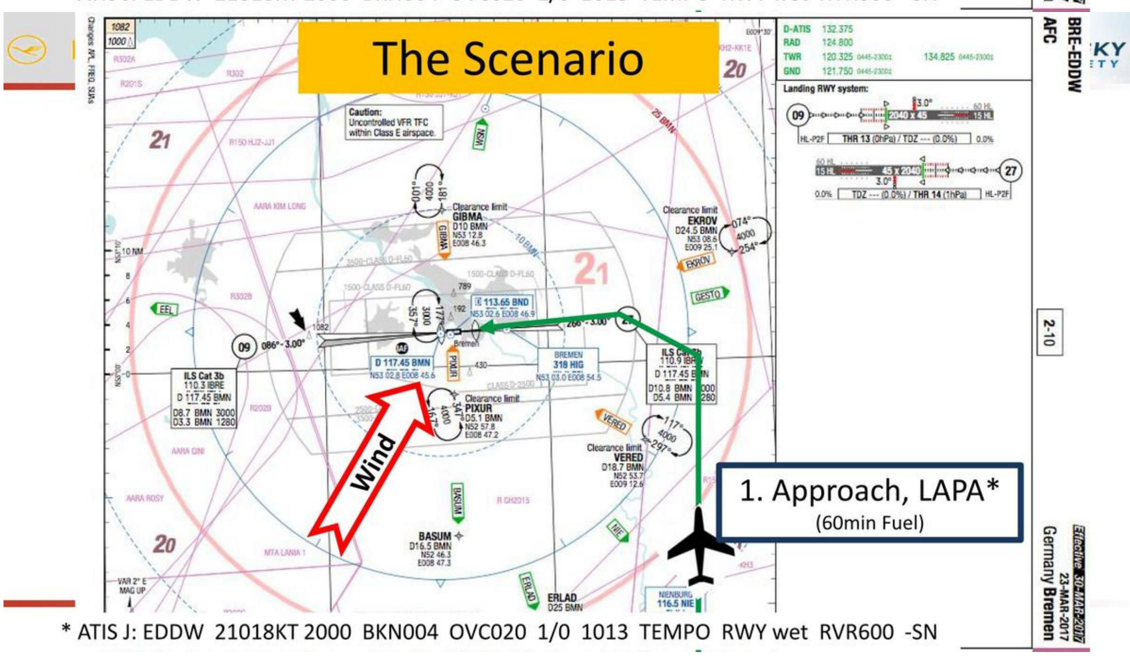

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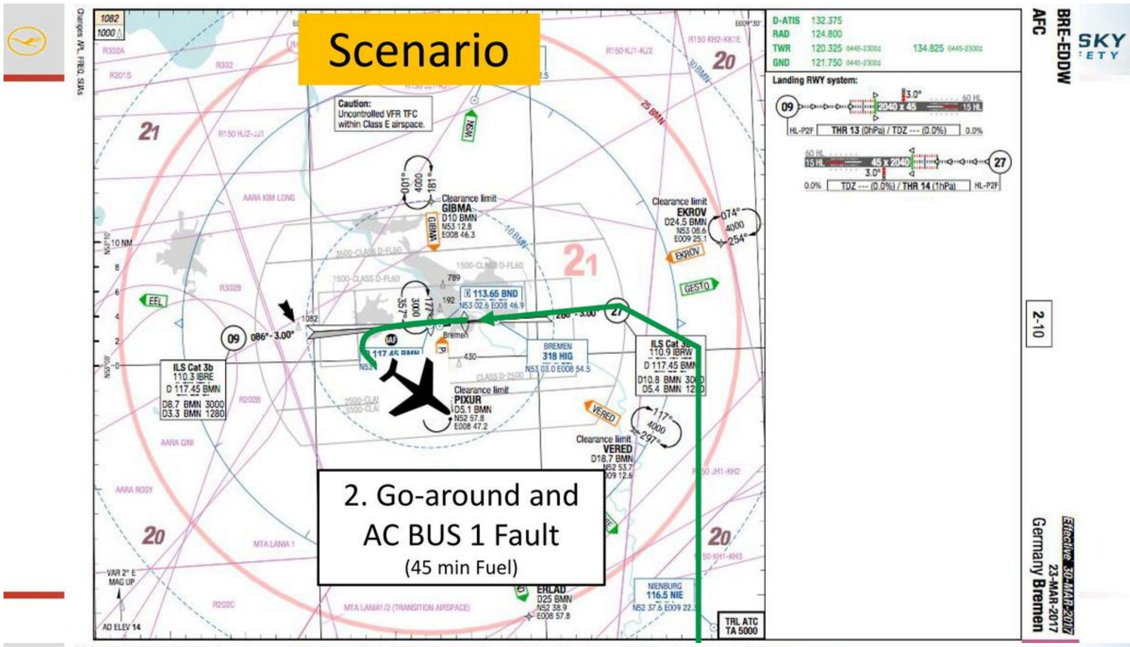
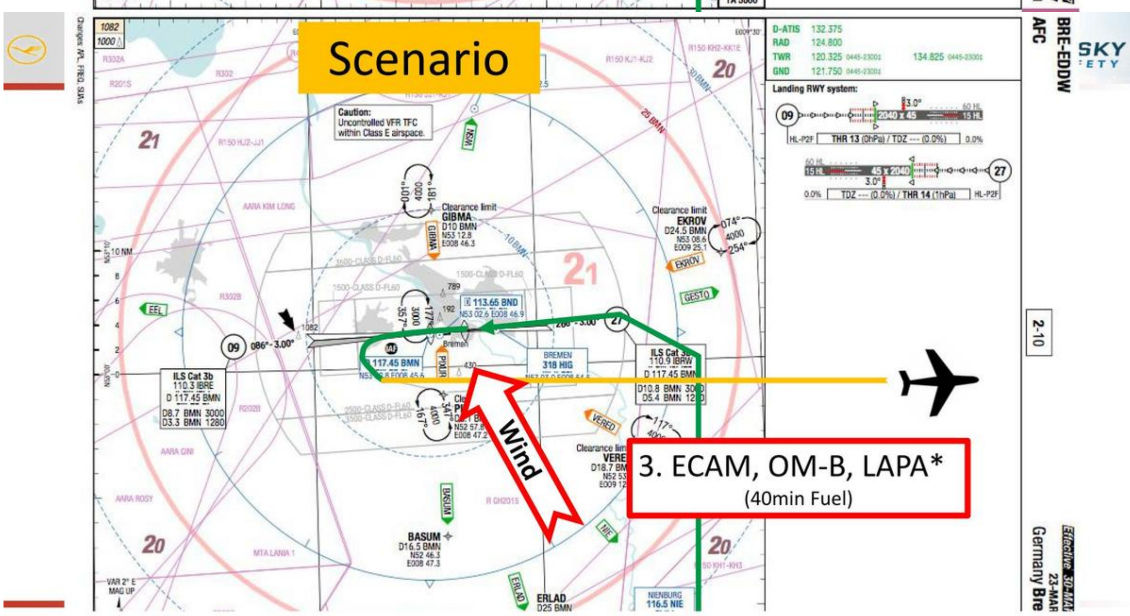
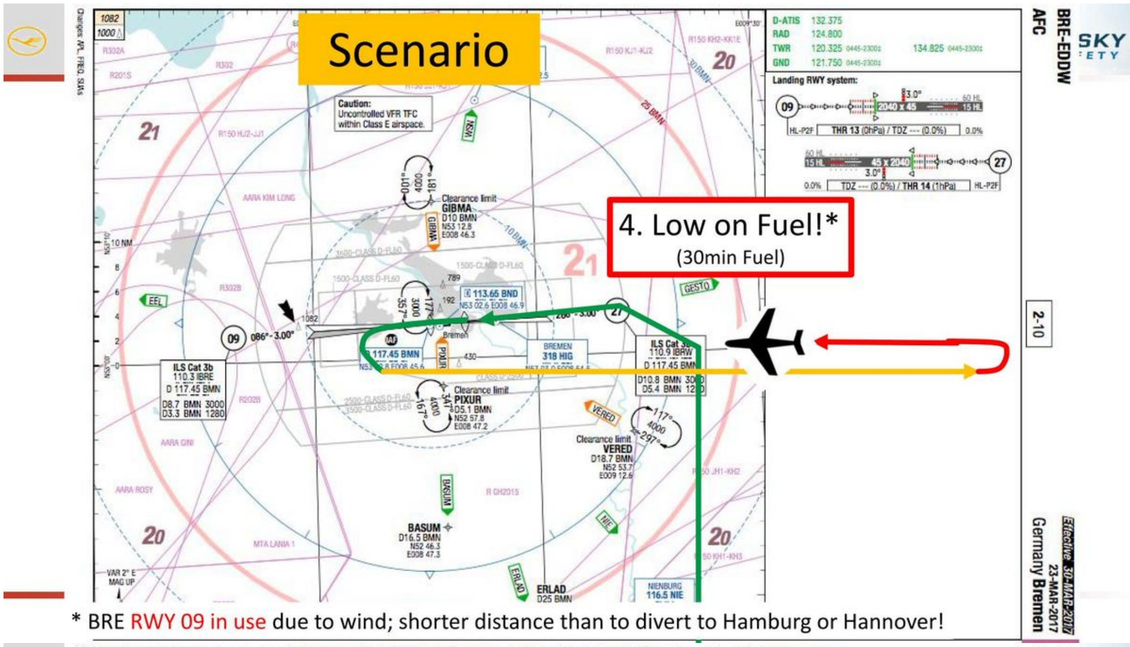
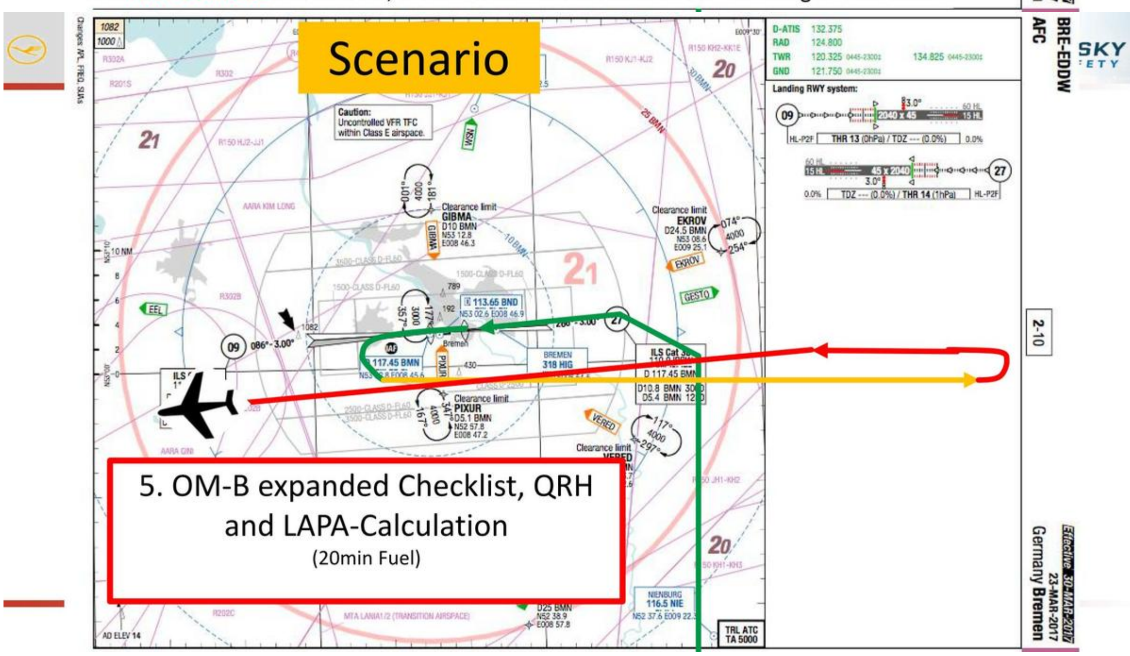
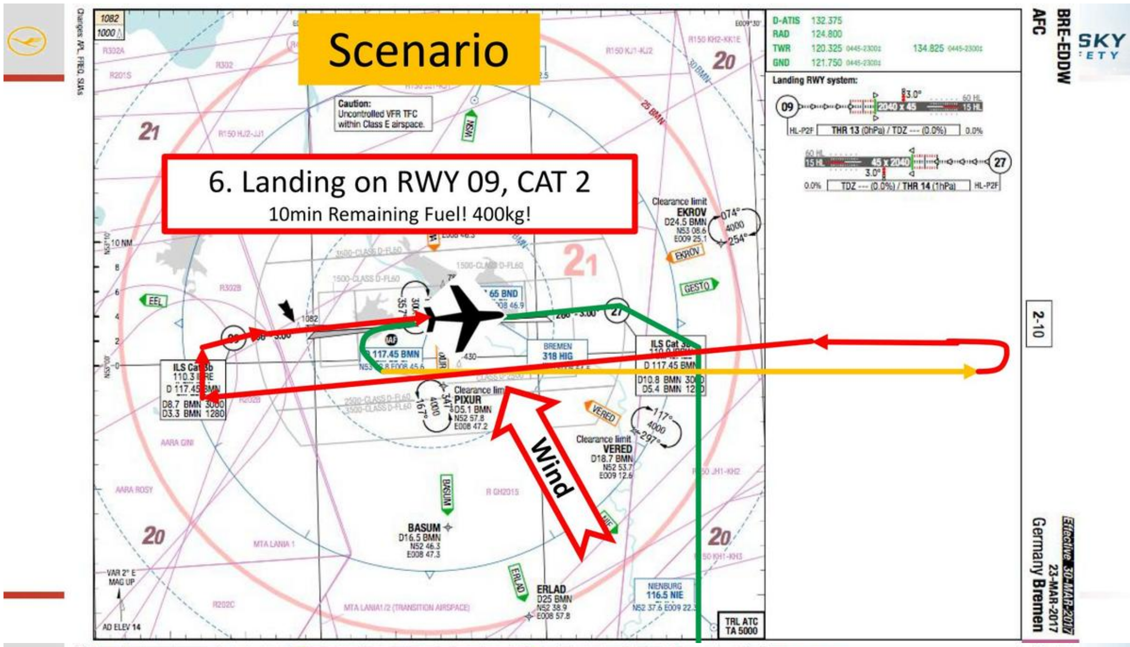


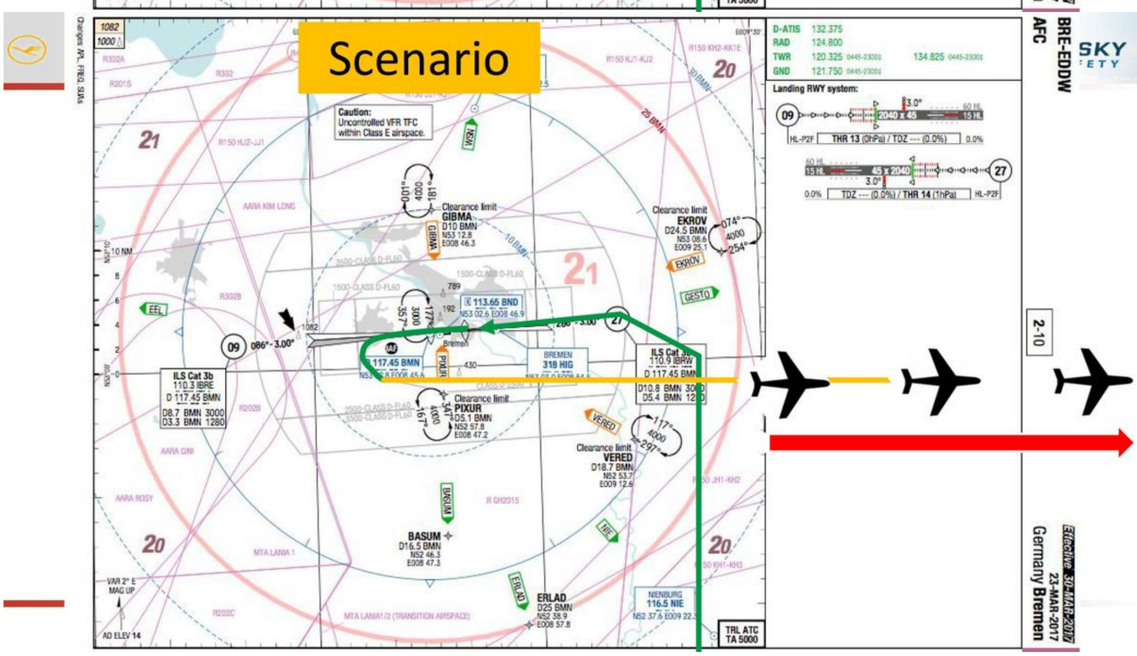


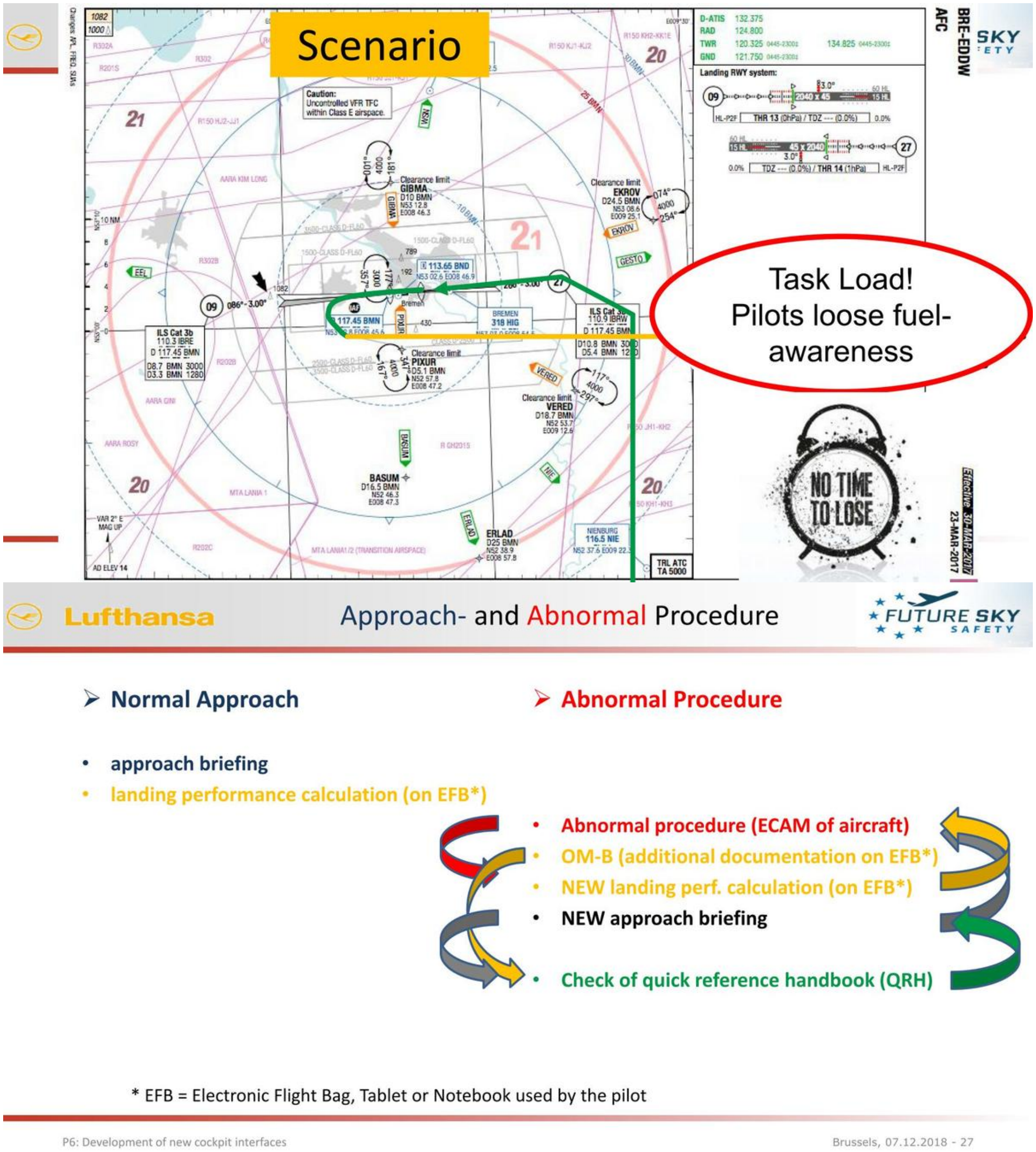
* **New Weather** AITS K: EDDW 16018KT RVR 0500 BKN002 OVC004, Temp 1/0 1013 RWY 4mm slush -SN

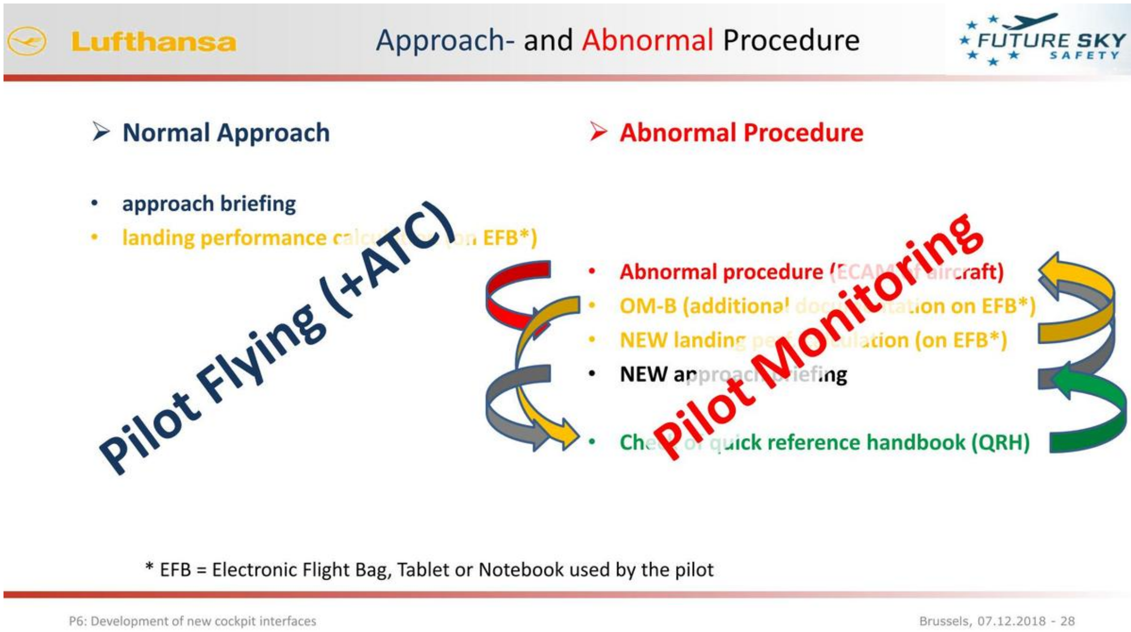

Scenario
4. Low on Fuel!*
(30min Fuel)
* BRE RWY 09 in use due to wind; shorter distance than to divert to Hamburg or Hannover!
BRE-EDDW
AFC
Germany Bremen

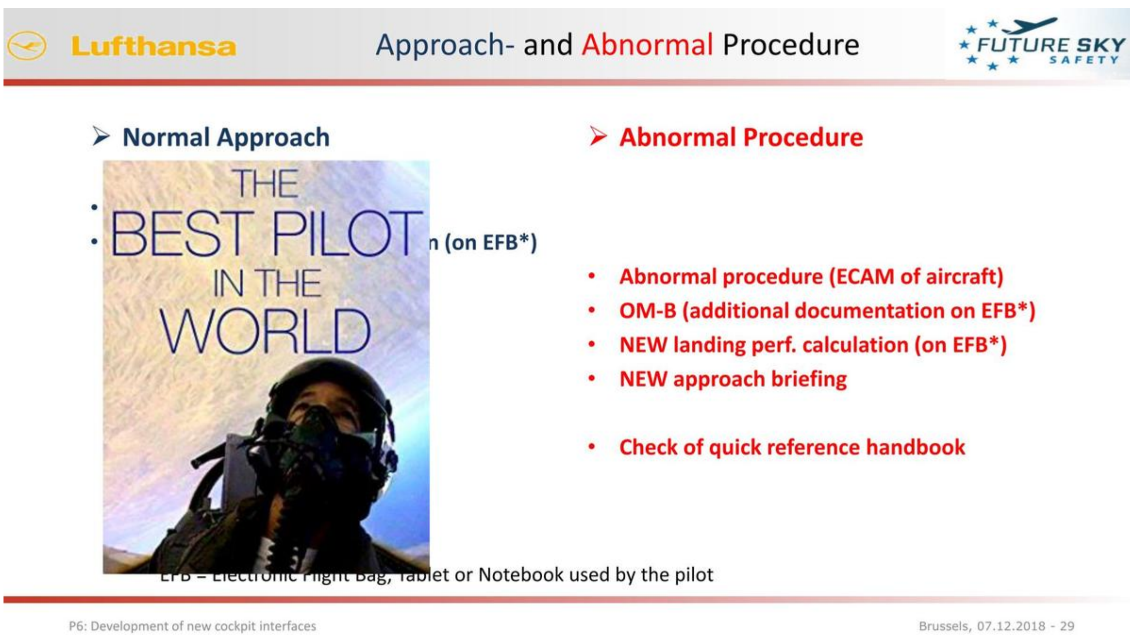

Scenario
5. OM-B expanded Checklist, QRH and LAPA-Calculation
(20min Fuel)
BRE-EDDW
AFC
Germany Bremen


Scenario
6. Landing on RWY 09, CAT 2
10min Remaining Fuel! 400kg!
Wind
BRE-EDDW
AFC
Germany Bremen


Scenario
BRE-EDDW
AFC
Germany Bremen


Scenario
Task Load!
Pilots loose fuel-awareness
NO TIME TO LOSE
Lufthansa
Approach- and Abnormal Procedure
FUTURE SKY SAFETY
Normal Approach
Abnormal Procedure
approach briefing
landing performance calculation (on EFB*)
Abnormal procedure (ECAM of aircraft)
OM-B (additional documentation on EFB*)
NEW landing perf. calculation (on EFB*)
NEW approach briefing
Check of quick reference handbook (QRH)
* EFB = Electronic Flight Bag, Tablet or Notebook used by the pilot
P6: Development of new cockpit interfaces
Brussels, 07.12.2018 - 27





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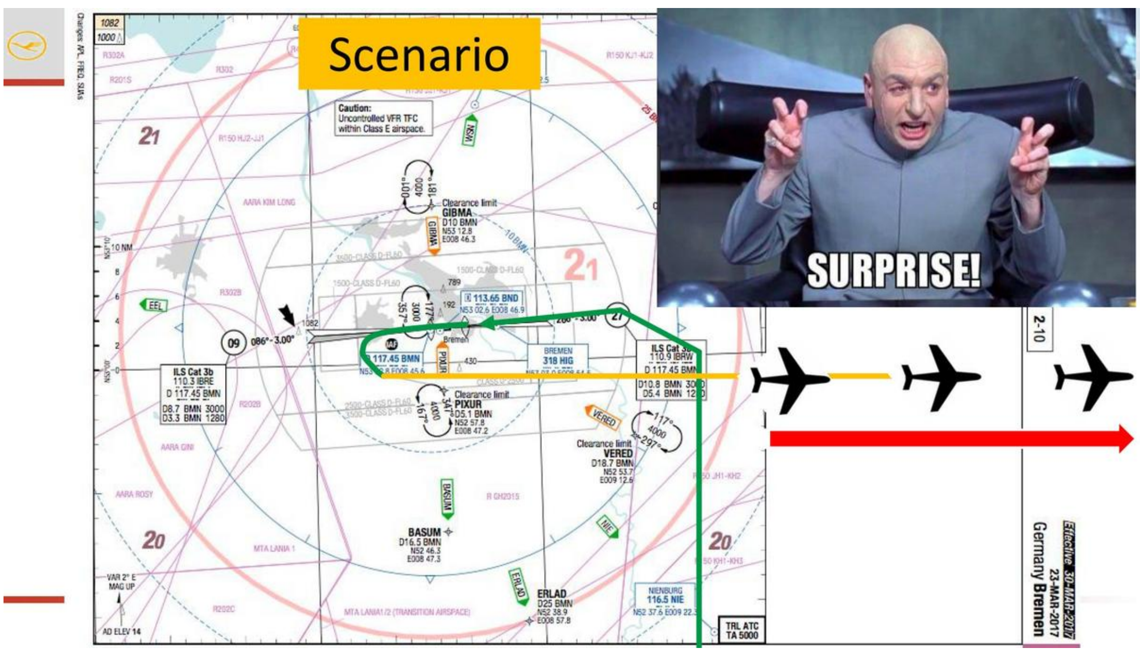

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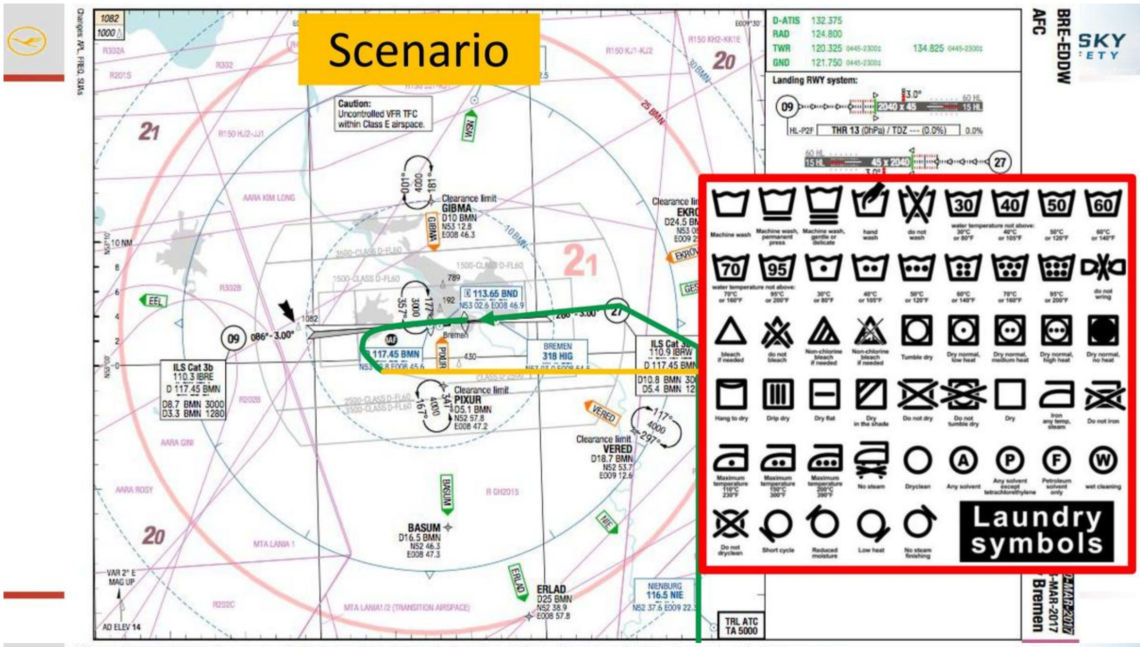
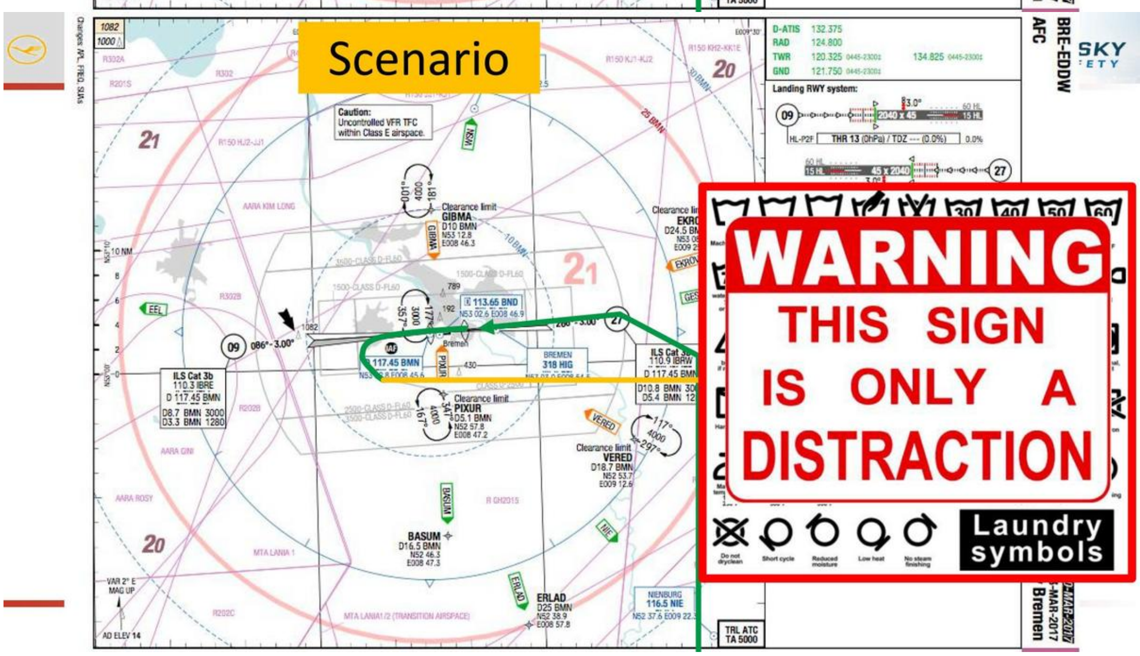

Scenario
Laundry symbols


Scenario
WARNING
THIS SIGN
IS ONLY A
DISTRACTION
Laundry symbols


Lufthansa
Challenge of staying focussed
FUTURE SKY SAFETY
P6: Development of new cockpit interfaces
Brussels, 07.12.2018 - 35


Lufthansa
Challenge of staying focussed
FUTURE SKY SAFETY
WEAPONS OF
You Tube
MASS DISTRACTION
P6: Development of new cockpit interfaces
Brussels, 07.12.2018 - 36

Lufthansa New Cockpit Interfaces

Simulator research: Technical abnormal

1. HMI: What kind of information?
2. HMI: How to get that information?
3. HMI: When to get the info and how long it takes (timing)?

P6: Development of new cockpit interfaces Brussels, 07.12.2018 - 39

Lufthansa New Cockpit Interfaces

Simulator research: Technical abnormal

1. HMI: What kind of information?
2. HMI: How to get that information?
3. HMI: When to get the info and how long it takes (timing)?

Priorities !

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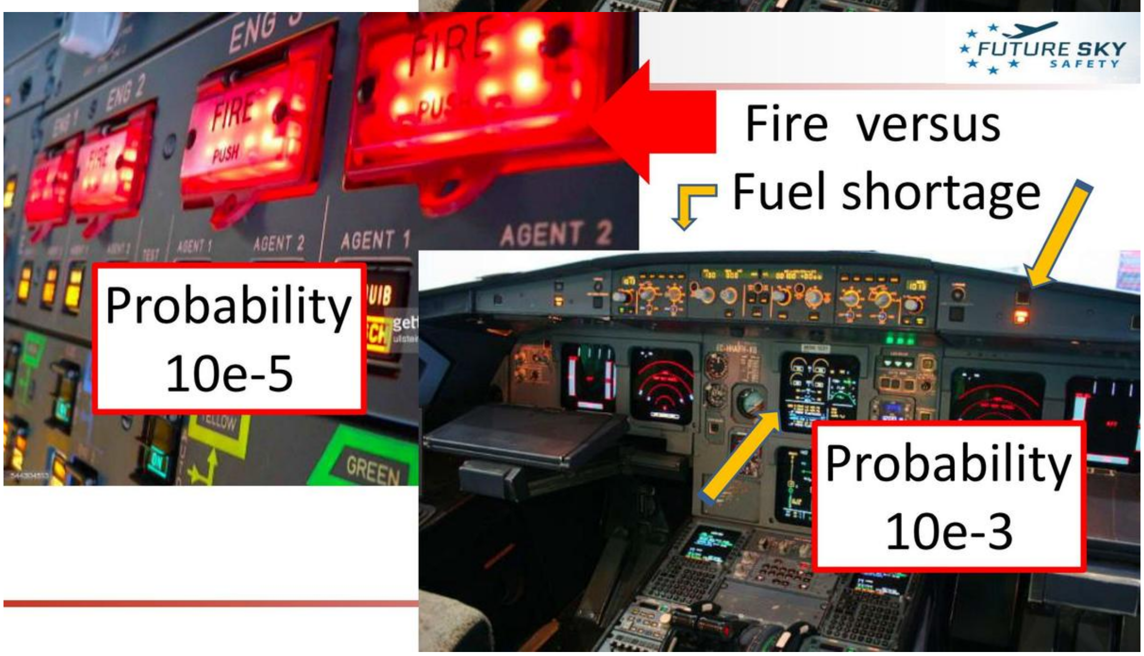
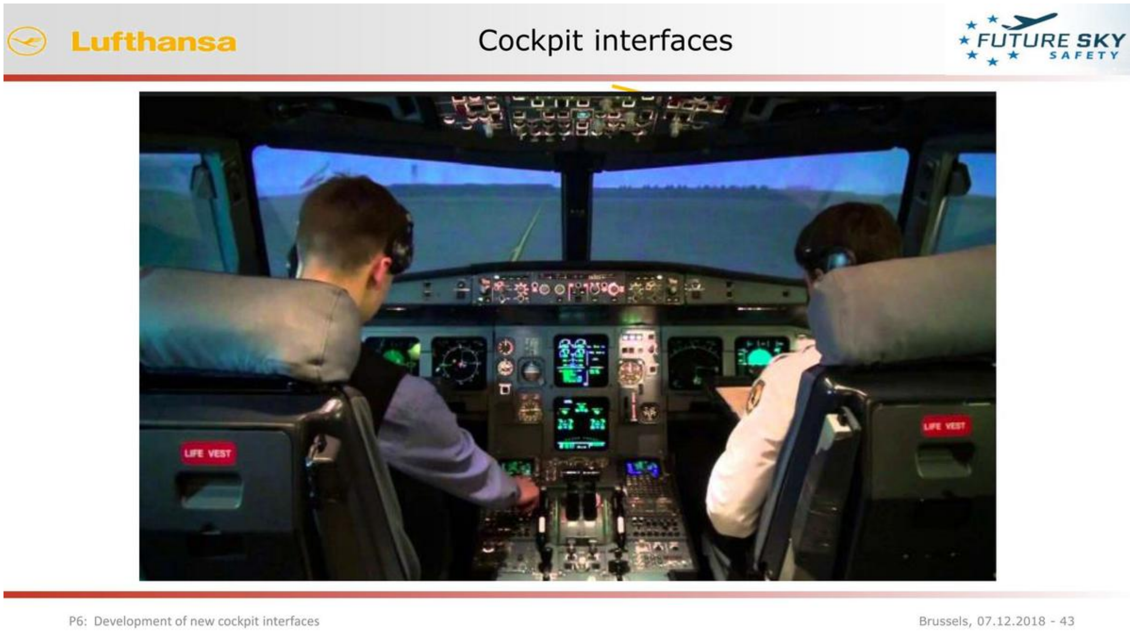
Fire versus
Fuel shortage


Fire versus
Fuel shortage
Probability
10e-5
Probability
10e-3


Lufthansa
Cockpit interfaces
FUTURE SKY SAFETY
LIFE VEST
LIFE VEST
P6: Development of new cockpit interfaces
Brussels, 07.12.2018 - 43


Lufthansa
FUTURE SKY SAFETY
LIFE VEST
LIFE VEST
P6: Development of new cockpit interfaces
Brussels, 07.12.2018 - 44

Lufthansa

- Fuel Awareness does **NOT** correlate with:

  age, amount of flight hours, amount of aircraft types or with the number of airline companies worked for

- There is no multitasking: The more interruptions, the more mistakes and the lower the fuel awareness

P6: Development of new cockpit interfaces Brussels, 07.12.2018 - 45

Lufthansa

Cockpit Interface

Simulator research: Technical abnormal

1. HMI: What kind of information?
2. HMI: How to get that information?
3. HMI: When to get the info and how long it takes (timing)?

Format !

P6: Development of new cockpit interfaces Brussels, 07.12.2018 - 46


Lufthansa
Right place - right format
FUTURE SKY SAFETY
1. Fuel must be in Primary Flight Display (PFD)
2. Remaining fuel given in kg
(must recalculated from **kg** in **minutes**)
P6: Development of new cockpit interfaces
Brussels, 07.12.2018 - 47


Lufthansa
Time needed for a hike
FUTURE SKY SAFETY
ZUCKBICHL 30'
SCHLANDERS 2h 20'
14
14 ST. MARTIN IM KOFEL 50'
VINSCHGER HÖHENWEG ALTA VIA VAL VENOSTA
VINSCHGER HÖHENWEG ALTA VIA VAL VENOSTA
P6: Development of new cockpit interfaces
Brussels, 07.12.2018 - 48

Lufthansa

Time vs. calories

P6: Development of new cockpit interfaces

Brussels, 07.12.2018 - 49

Lufthansa

Cockpit Interface

Simulator research: Technical abnormal

1. HMI: What kind of information?
2. HMI: How to get that information?
3. HMI: When to get the info and how long it takes (timing)?

Timing !

P6: Development of new cockpit interfaces

Brussels, 07.12.2018 - 50

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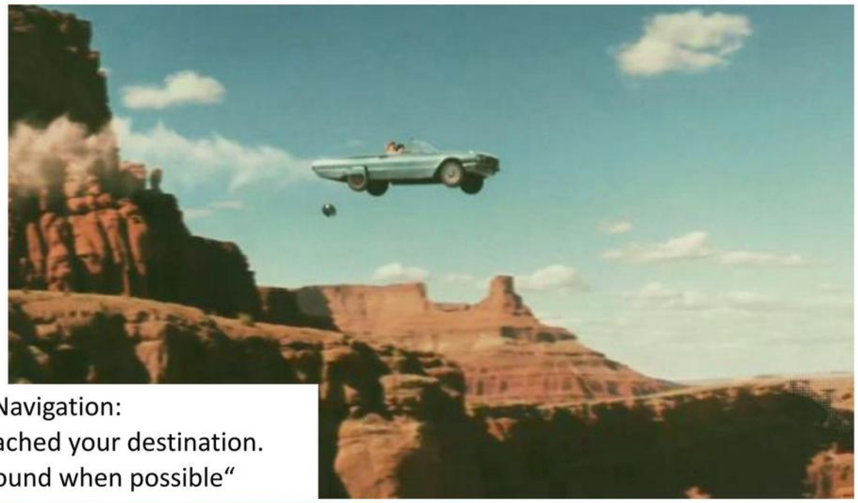
Lufthansa

Timing



Car Navigation:
„You have not reached your destination.
Please turn around when possible“

P6: Development of new cockpit interfaces

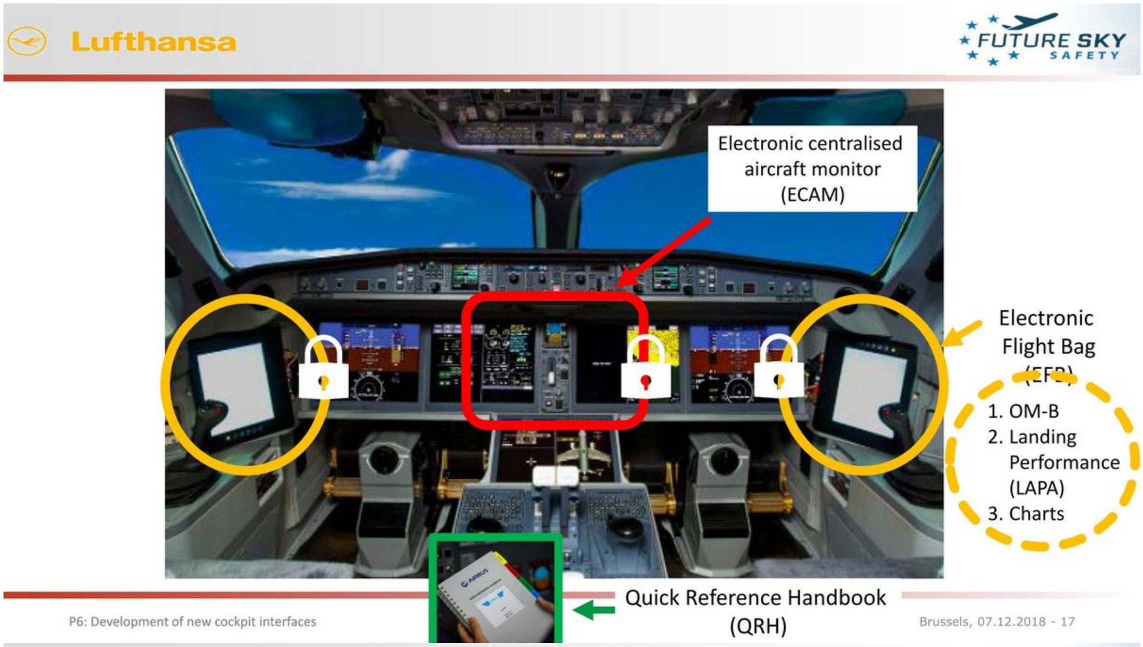
Brussels, 07.12.2018 - 51

Lufthansa

Timing

P6: Development of new cockpit interfaces

Brussels, 07.12.2018 - 52



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Lufthansa EFB – new cockpit interface

P6: Development of new cockpit interfaces Brussels, 07.12.2018 - 55

Lufthansa Time needed for the calculation

1. The fastest way to calculate <u>landing performance</u>

- Start of computer „Performance Landing" 0:12 min
- Entry of data with abnormal failure 1:30 min
- Calculation of the program 0:14 min
- (Warning sign with indication „mind crosswind")

2. The fastest way to look up the <u>OM-B expended checklist</u>

- Start of library „documentation " 0:10 min
- OM-B search: Limitation -> general limitiation -> wind limits –> max wind condition for CAT II or CAT III -> crosswind -> plus entry of a/c registration <u>2:30 min</u>

Gesamt **<u>4:26 min</u>**

P6: Development of new cockpit interfaces Brussels, 07.12.2018 - 56

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Lufthansa — The Electronic Flight Bag (EFB) today

- library: over 30 (!) different operational manuals
- company news, duty roster, safety bulletin
- performance calculation tool
- electronic communication (email, all reports)
- route manual with maps and charts
- complete briefing tool (weather, NOTAMS, etc.)
- over 70 (!) computer based training programs
- different tools (dictionary, converter, etc.)
- flight and fuel efficiency program
- etc. etc. etc.

P6: Development of new cockpit interfaces — Brussels, 07.12.2018 - 57

Lufthansa — The Electronic Flight Bag (EFB)

- library: over 30(!) different operational manuals
- comp ... ty bulletin
- perfo
- electr ... , all reports)
- route ... arts
- ... tc.)
- ... ns

P6: Development of new cockpit interfaces — Brussels, 07.12.2018 - 58

Lufthansa — Resumee: new cockpit interfaces

Simulator research has shown:

1. Correct priorities: **What** is important?
2. Better format: **How** to get that information?
3. Right timing: **When** to get the info and how long does it take

P6: Development of new cockpit interfaces — Brussels, 07.12.2018 - 59

Lufthansa — Thank you for your attention

P6: Development of new cockpit interfaces — Brussels, 07.12.2018 - 66

Appendix B.20 "P6: Development of a smart vest for real-time measurement of physiological data" – Josias Wacker, CSEM

European Commission

csem

FUTURE SKY SAFETY

Development of a smart vest for real-time measurement of physiological data

Josias Wacker, CSEM

SAFETY | FUTURE SKY 7 November, 2018

Project #6 HUMAN PERFORMANCE ENVELOPE

FUTURE SKY SAFETY

Outline

Background
Wearables
CSEM's smart vest
Live demonstration
Conclusion

SAFETY | FUTURE SKY 7 November, 2018 | 2

Background

- Many safety critical domains rely on human operators (**Air traffic control**, **Aviation**, Maritime, Rail, Military, Medical, etc.)
- Need to know when human operators are approaching the **edges of acceptable performance**, e.g. when should automation take over?
- One way to track human operators' performance is to **monitor significant physiological signals.**
- Equip operators with **wearables containing sensors.**
- **Evaluate** measured signals **and alarm in critical situations.**

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7 November, 2018 | 3

Wearables

- Sensor-equipped «clothing»
- **Glasses** which monitor the eyes
- **Chest belt** which records heart activity
- **Bracelet** which measures body activity, heart rate
- **Shoes** which record running efficiency
- **Comfortable, inconspicuous**

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Future Sky Safety has received funding from the EU's Horizon 2020 Research and Innovation Programme, under Grant Agreement No. 640597.

CSEM's smart vest

- **1-lead electrocardiogram (ECG):**
  - Heart rate
  - Heart rate variability
  - …
- Trans-thoracic **bio-impedance**
  - Breathing rate
- **Skin temperature**
- **Activity**
  - Posture: Sitting/Lying/Standing
  - Walking/Running/Rest
  - Steps/Cadence
  - Energy Expenditure
- **Photoplethysmography (PPG)**
  - SpO2
  - BP
  - …

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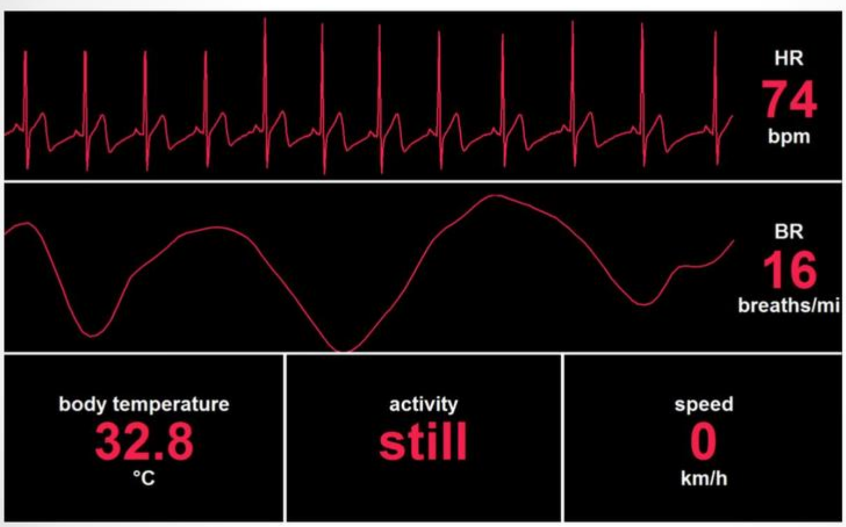
Live Demonstration



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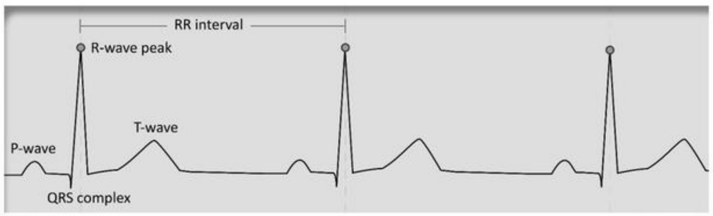
Live Demonstration

Project #6 HUMAN PERFORMANCE ENVELOPE

- Parameters to watch:
  - Heart rate
  - Heart rate variability
  - Breathing rate



SAFETY | FUTURE SKY 7 November, 2018 | 7

Conclusion

Project #6 HUMAN PERFORMANCE ENVELOPE

- In FSS, monitoring relied mainly on **cardiovascular signals** such as heart rate and heart rate variability (both **extracted from ECG**).
- CSEM's sensor vests measure **more physiological signals**:
  - Breathing rate
  - Skin temperature
  - Activity
  - PPG (SpO2, blood pressure, …)

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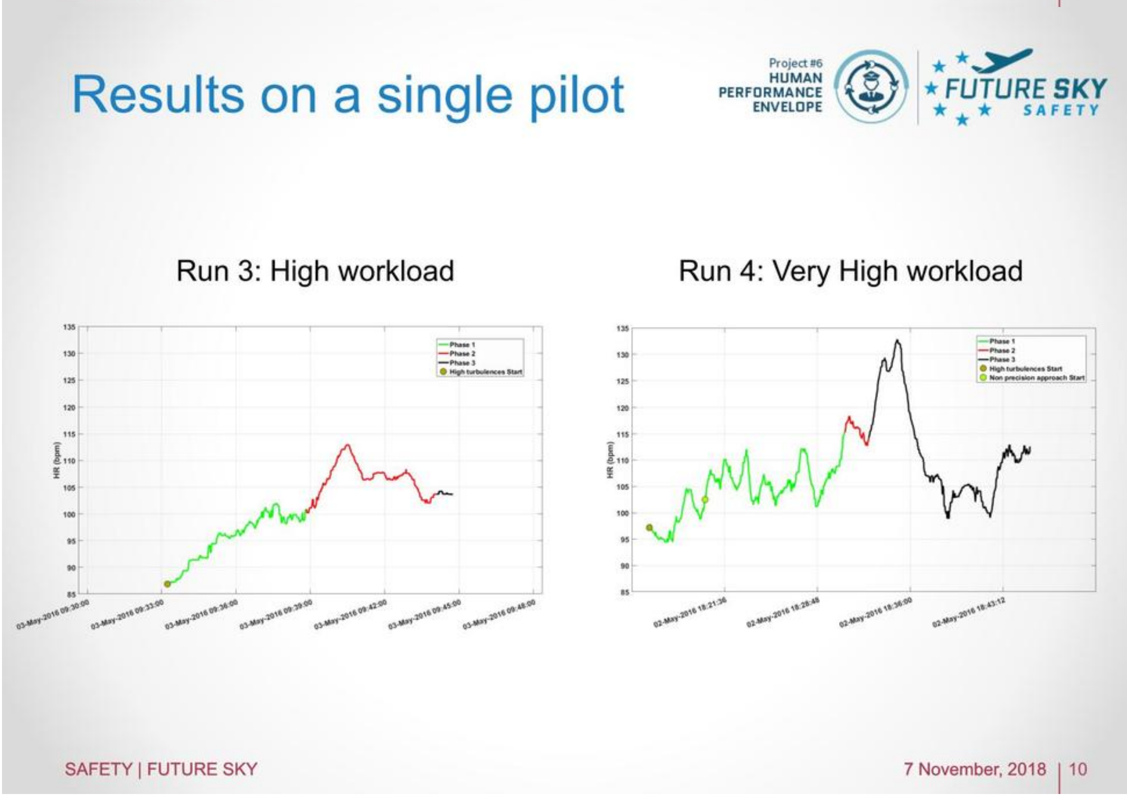
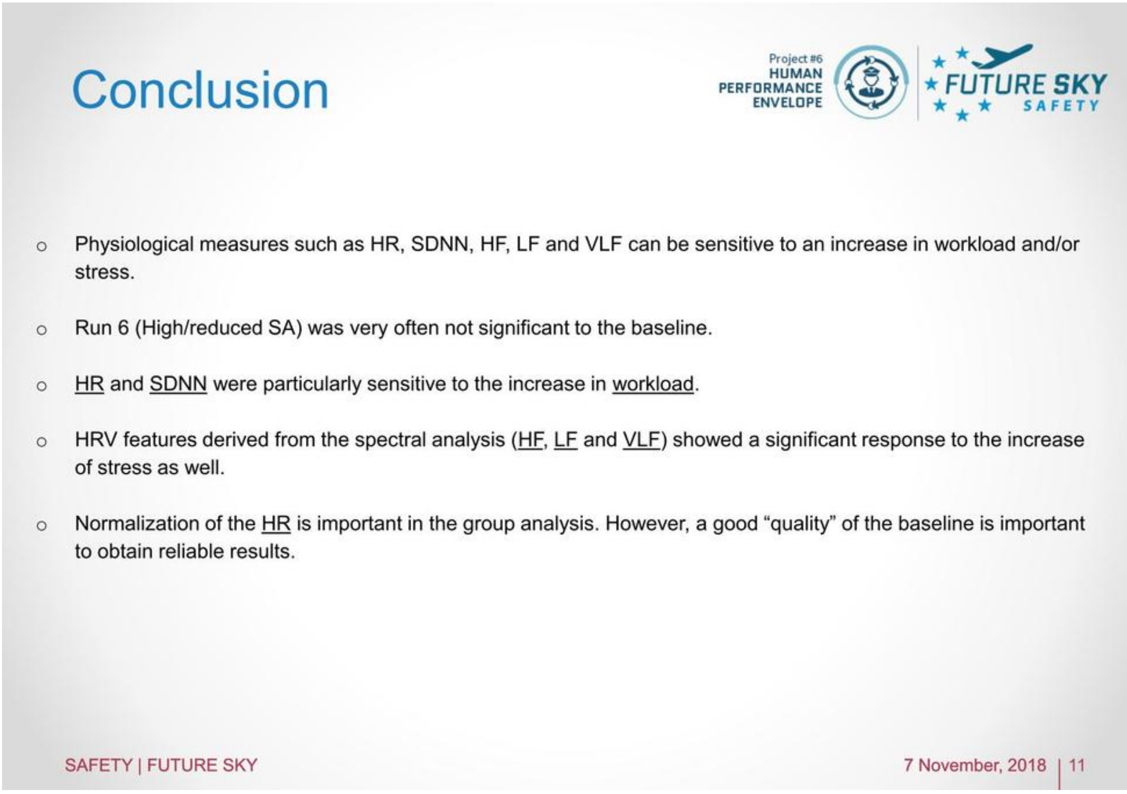
Project #6
HUMAN PERFORMANCE ENVELOPE
FUTURE SKY SAFETY
Thank you
SAFETY | FUTURE SKY


Results on a single pilot
Project #6
HUMAN PERFORMANCE ENVELOPE
FUTURE SKY SAFETY
Run 3: High workload
Run 4: Very High workload
Phase 1
Phase 2
Phase 3
High turbulences Start
Non precision approach Start
HR (bpm)
SAFETY | FUTURE SKY
7 November, 2018
10



Appendix B.21 “P7: Mitigating risks of fire, smoke & fumes” – Eric Deletombe, ONERA


European Commission
FUTURE SKY SAFETY
FSS - 2nd Public Workshop – 07/11/2018
P7 Mitigating Risks of FS&F
Eric Deletombe / ONERA – The French Aerospace Lab
eric.deletombe@onera.fr
+33 (0)3 20 49 69 36
EMBRAER
AIRBUS
LEONARDO
NLR
DLR
Civil Aviation Authority
ONERA
Cranfield University
CEiiA
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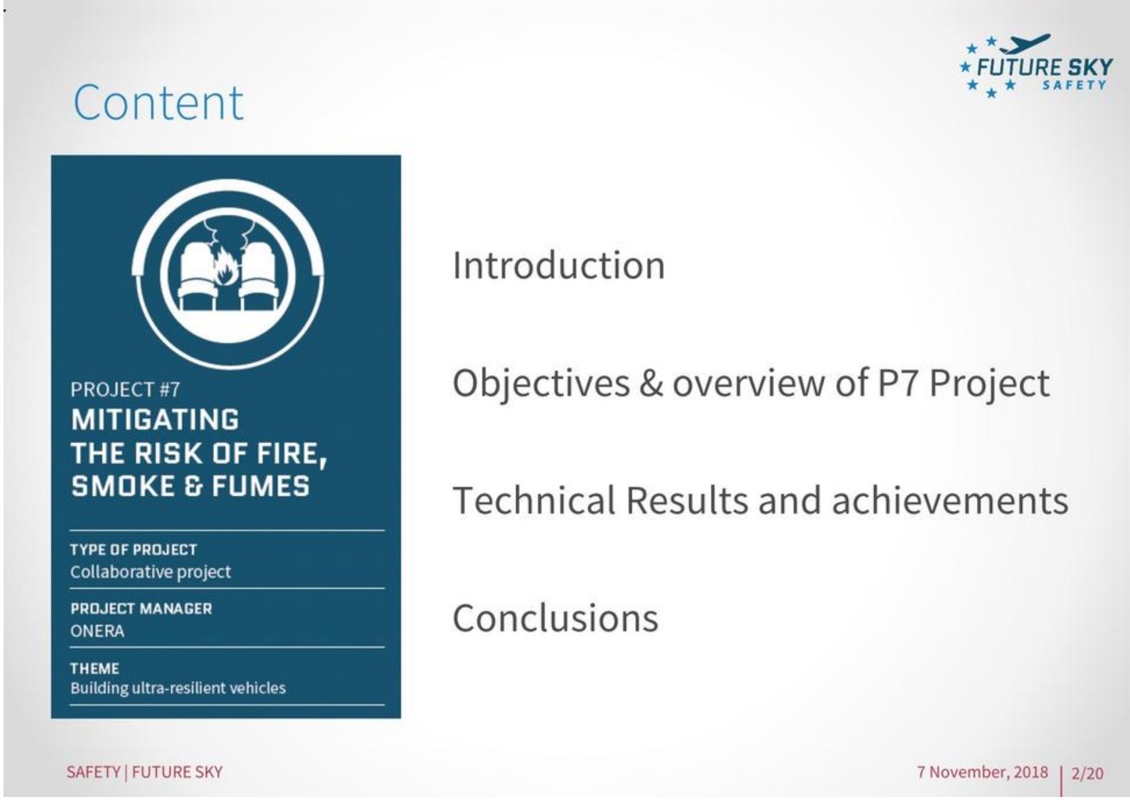
7 November, 2018


FUTURE SKY SAFETY
Content
PROJECT #7
MITIGATING THE RISK OF FIRE, SMOKE & FUMES
TYPE OF PROJECT
Collaborative project
PROJECT MANAGER
ONERA
THEME
Building ultra-resilient vehicles
Introduction
Objectives & overview of P7 Project
Technical Results and achievements
Conclusions
SAFETY | FUTURE SKY
7 November, 2018 | 2/20

Introduction

Many fatalities in case of accidents are still fire caused/ related.

Emerging - New trends / new risks :

- More electric aircraft maybe increases risks of in-flight fires
- More organic composites in A/C design with very different behavior compared to metalic materials
- Limited knowledge wrt fire & heat behavior of composites materials

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Objectives of P7 Project

To increase safety by …

O1 : **Improving knowledge** concerning OMC materials and structures behaviours vs fire

O2 : **Assessing mechanical properties** of heating/burning/degraded materials

O3 : **Evaluating the fire consequences** (incl. toxicity, smoke), proposing solutions to mitigate them

O4 : **Sharing database** for future modelling purposes (expensive tests)

O5 : **Establishing**/giving **recommendations**

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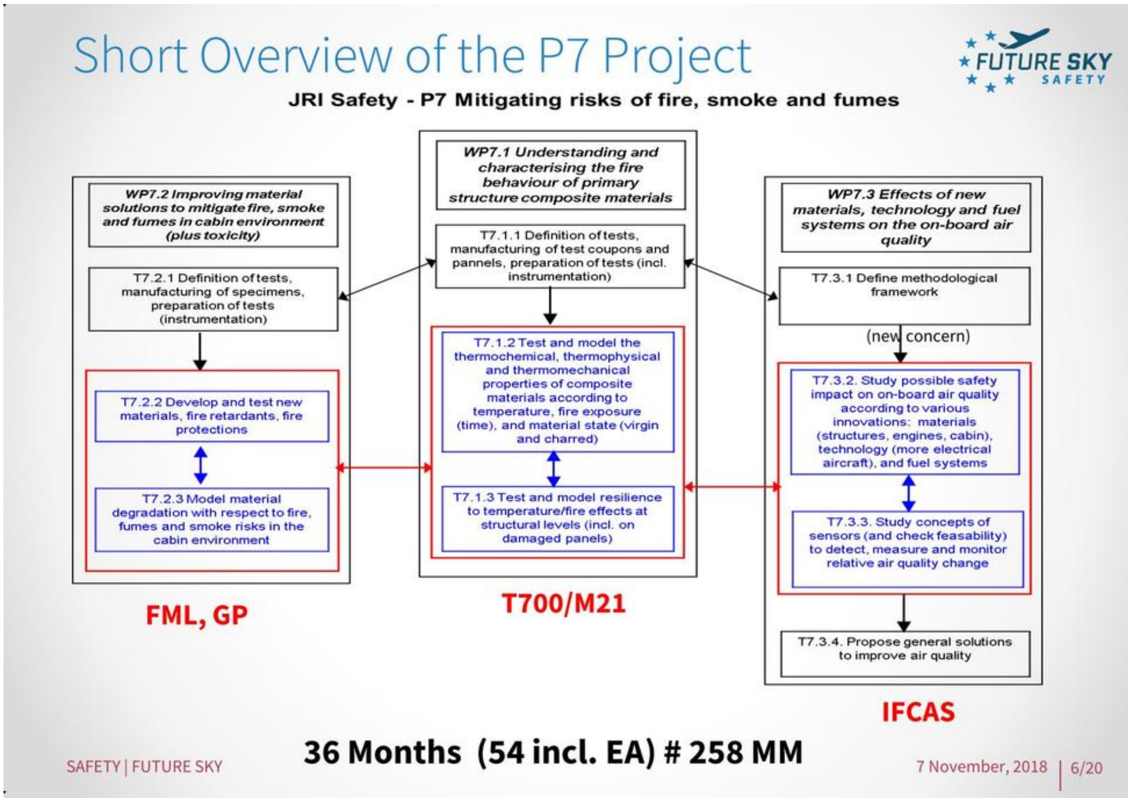
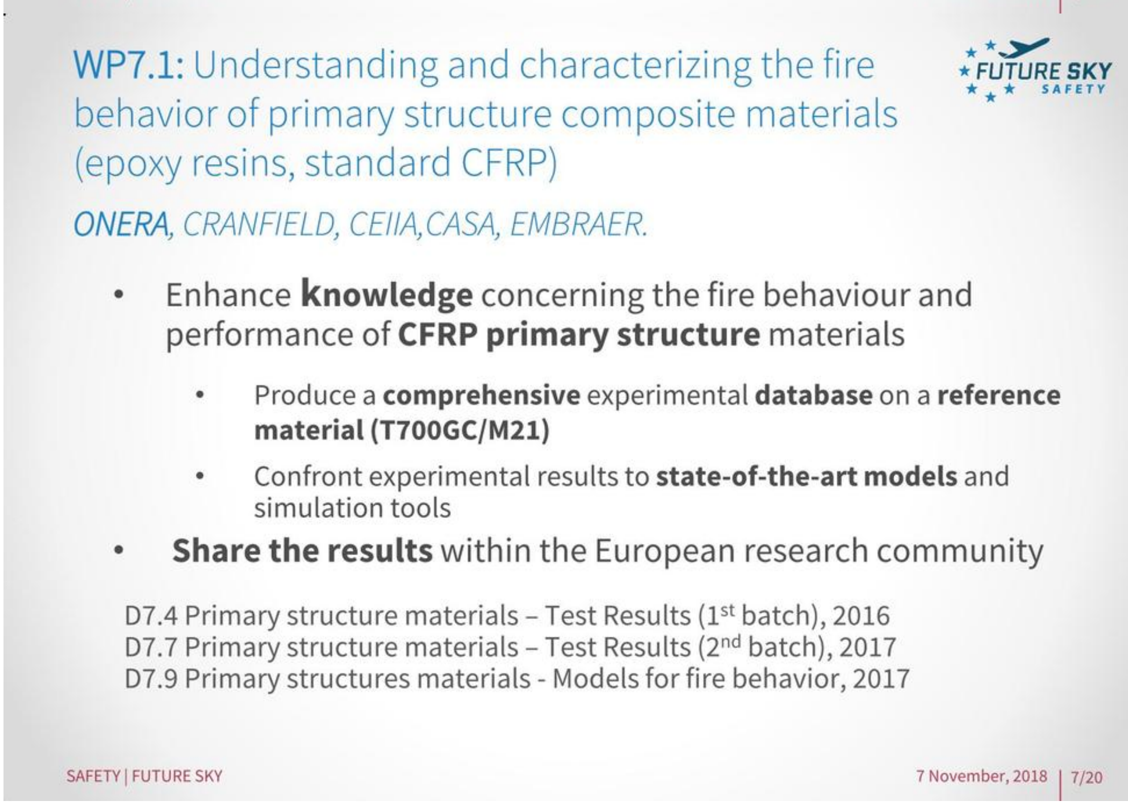
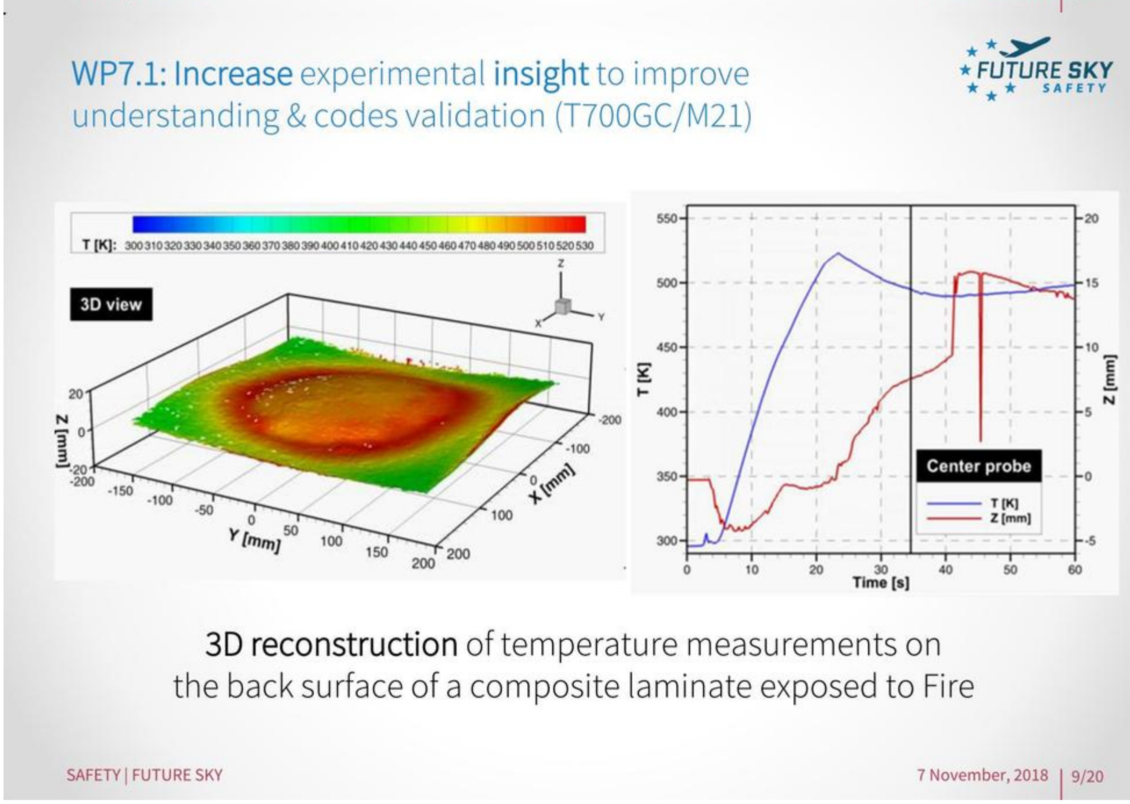
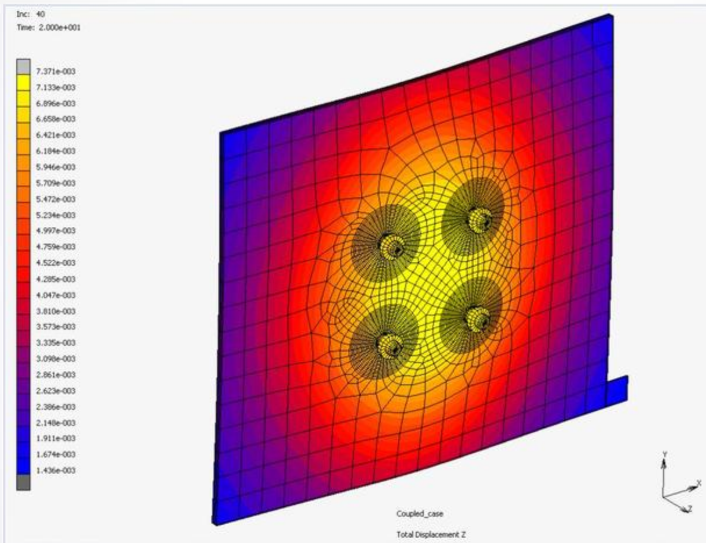

Short Overview of the P7 Project
FUTURE SKY SAFETY
JRI Safety - P7 Mitigating risks of fire, smoke and fumes
WP7.1 Understanding and characterising the fire behaviour of primary structure composite materials
T7.1.1 Definition of tests, manufacturing of test coupons and pannels, preparation of tests (incl. instrumentation)
T7.1.2 Test and model the thermochemical, thermophysical and thermomechanical properties of composite materials according to temperature, fire exposure (time), and material state (virgin and charred)
T7.1.3 Test and model resilience to temperature/fire effects at structural levels (incl. on damaged panels)
WP7.2 Improving material solutions to mitigate fire, smoke and fumes in cabin environment (plus toxicity)
T7.2.1 Definition of tests, manufacturing of specimens, preparation of tests (instrumentation)
T7.2.2 Develop and test new materials, fire retardants, fire protections
T7.2.3 Model material degradation with respect to fire, fumes and smoke risks in the cabin environment
WP7.3 Effects of new materials, technology and fuel systems on the on-board air quality
T7.3.1 Define methodological framework
(new concern)
T7.3.2. Study possible safety impact on on-board air quality according to various innovations: materials (structures, engines, cabin), technology (more electrical aircraft), and fuel systems
T7.3.3. Study concepts of sensors (and check feasability) to detect, measure and monitor relative air quality change
T7.3.4. Propose general solutions to improve air quality
FML, GP
T700/M21
IFCAS
36 Months (54 incl. EA) # 258 MM
SAFETY | FUTURE SKY
7 November, 2018 | 6/20


WP7.1: Understanding and characterizing the fire behavior of primary structure composite materials (epoxy resins, standard CFRP)
FUTURE SKY SAFETY
ONERA, CRANFIELD, CEIIA,CASA, EMBRAER.
• Enhance knowledge concerning the fire behaviour and performance of CFRP primary structure materials
• Produce a comprehensive experimental database on a reference material (T700GC/M21)
• Confront experimental results to state-of-the-art models and simulation tools
• Share the results within the European research community
D7.4 Primary structure materials – Test Results (1st batch), 2016
D7.7 Primary structure materials – Test Results (2nd batch), 2017
D7.9 Primary structures materials - Models for fire behavior, 2017
SAFETY | FUTURE SKY
7 November, 2018 | 7/20


WP7.1: Produce a comprehensive experimental database on a reference material (T700GC/M21)
FUTURE SKY SAFETY
ONERA
THE FRENCH AEROSPACE LAB
Fire
Use of ONERA research facilities to study fire exposure of composite plates
SAFETY | FUTURE SKY
7 November, 2018 | 8/20


WP7.1: Increase experimental insight to improve understanding & codes validation (T700GC/M21)
FUTURE SKY SAFETY
T [K]: 300 310 320 330 340 350 360 370 380 390 400 410 420 430 440 450 460 470 480 490 500 510 520 530
3D view
Z [mm]
Y [mm]
X [mm]
T [K]
Z [mm]
Time [s]
Center probe
T [K]
Z [mm]
3D reconstruction of temperature measurements on the back surface of a composite laminate exposed to Fire
SAFETY | FUTURE SKY
7 November, 2018 | 9/20

WP7.1: Simulate thermomechanical structural response with state-of-the-art simulation tools (T700/M21)



Use of numerical simulation to **reduce ISO 2685** structural **test loops** (AIRBUS DS)

SAFETY | FUTURE SKY 7 November, 2018 | 10/20

WP7.2 : Improving material solutions to mitigate fire, smoke and fumes in cabin environment (plus toxicity)

DLR, *VZLU, LEONARDO, CAA*

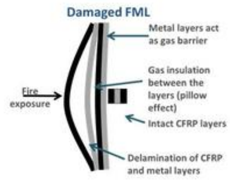
- Enhance **passengers safety** through the development and assessment of **new material solutions**
  - **Develop** and characterize new materials and **combinations** of them for improved fire behaviour of **cabin** (and structural) **environment**
  - **Model** new materials **degradation** with respect to fire, fumes and smoke risks in the cabin environment
- **Assess solutions** at material and structural levels **wrt current industrial safety requirements** using **standard** experimental methods and state-of-the art simulation tools

D7.5 New materials for fire protection in cabin environment – Test results 1st batch, 2016
D7.8 New materials for fire protection in cabin environment – Test results 2nd batch, 2018
D7.10 Materials for cabin environment protection - Models for material degradation, 2018

SAFETY | FUTURE SKY 7 November, 2018 | 11/20

WP7.2 : Screen new materials for cabin environment wrt their fire, smoke & fumes properties

- Fiber metal laminates)



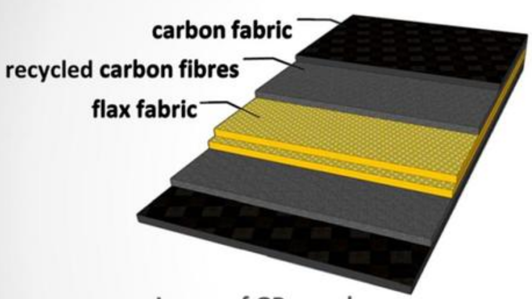
- Geopolymers (resin, foam)

- Natural fibers (cellulosic, linen)

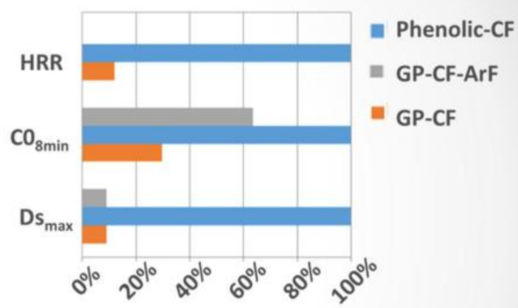
- Recycled carbon fibers (rCF)

SAFETY | FUTURE SKY 7 November, 2018 | 12/20

WP7.2 : Combine new material solutions e.g. into laminated composites



Layup of GP panel demonstrator - natural fibres and recycled carbon fibres applied



Improved FST behavior of GP laminates compared to common phenolic laminates

Design and **assess** new solutions for cabin environment

SAFETY | FUTURE SKY 7 November, 2018 | 13/20

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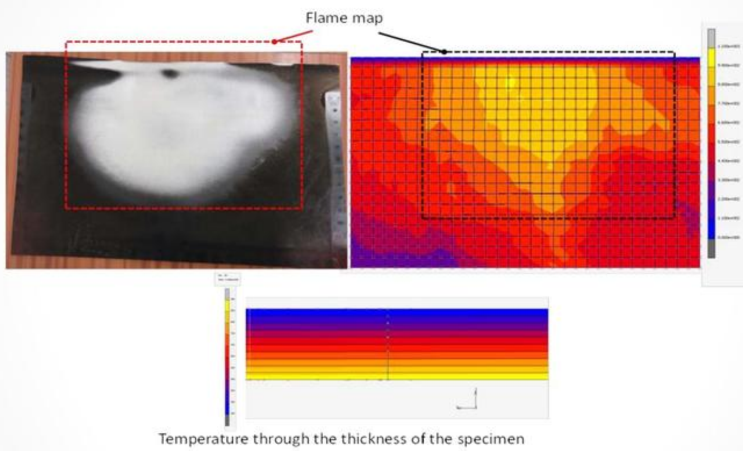
WP7.2 : Model new material solutions and assess state-of-the-art simulation tools



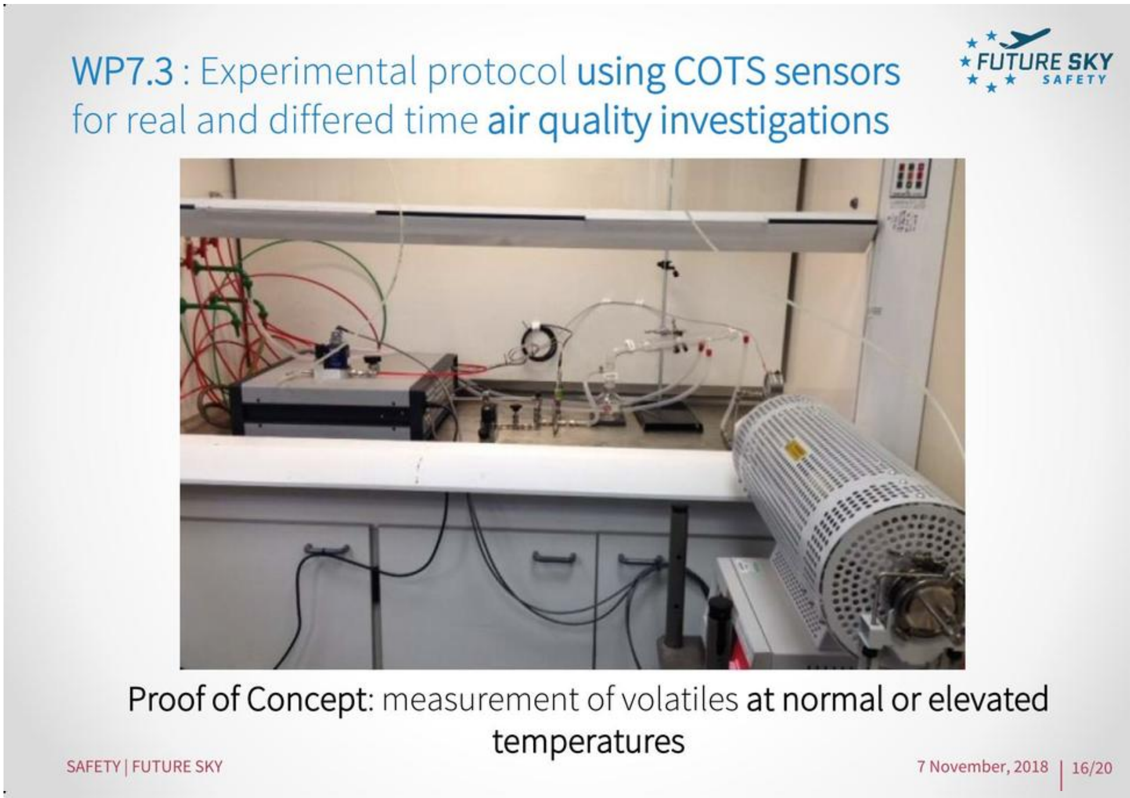
Comparison of GP / CFGP flame penetration tests with FlamePTM simulation (Leonardo)

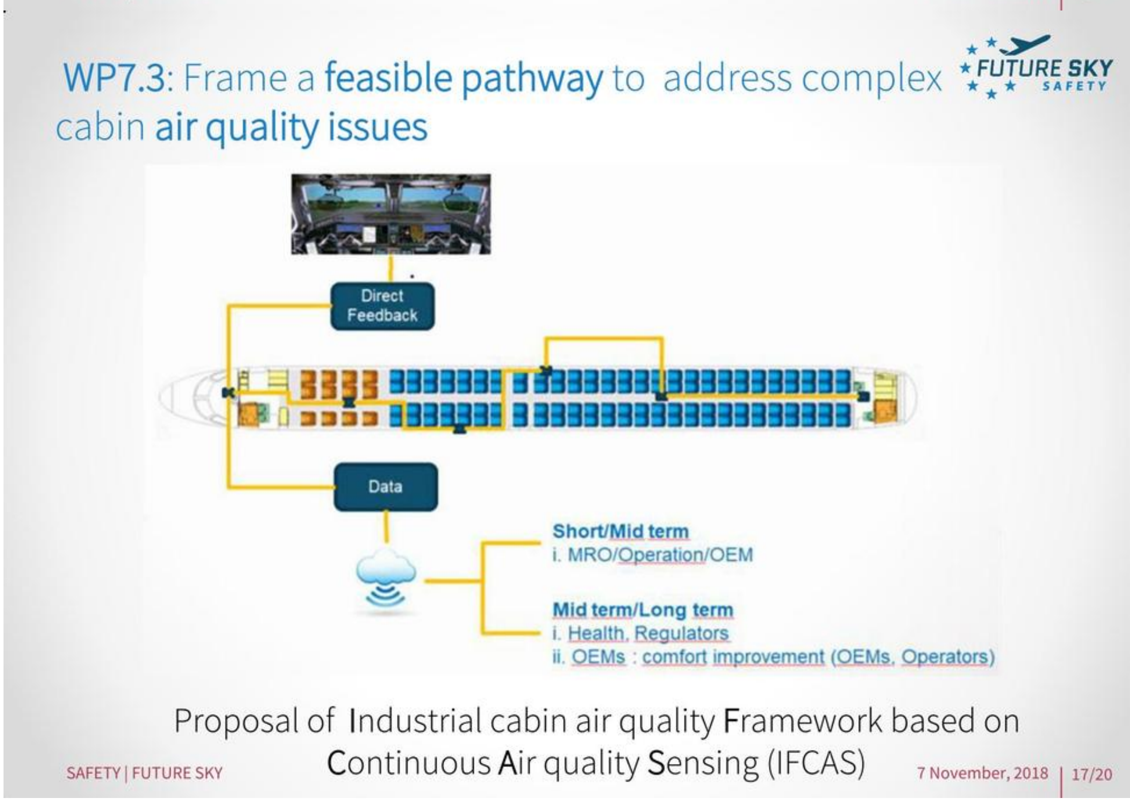
WP7.3 : Effects of new materials, technology and fuel systems on the on-board air quality

NLR, CEIIA, CRANFIELD, EMBRAER, CAA

- Investigate **opportunities** offered by technical developments **to study air quality**
  - Focussing on comfort/**health/**safety considerations
  - **Better understanding of emission sources** as basis for integrated solutions
  - Investigating **sensing technologies** (incl. COTS)
- Propose **Industrial framework** for monitoring of air quality

D7.6 On-board air quality: Literature review and methodological survey, 2016
D7.14 On-board air quality – Final report on the effect of new materials, 2018


WP7.3 : Experimental protocol using COTS sensors for real and differed time air quality investigations
FUTURE SKY SAFETY
Proof of Concept: measurement of volatiles at normal or elevated temperatures
SAFETY | FUTURE SKY
7 November, 2018
16/20


WP7.3: Frame a feasible pathway to address complex cabin air quality issues
FUTURE SKY SAFETY
Direct Feedback
Data
Short/Mid term
i. MRO/Operation/OEM
Mid term/Long term
i. Health, Regulators
ii. OEMs : comfort improvement (OEMs, Operators)
Proposal of Industrial cabin air quality Framework based on Continuous Air quality Sensing (IFCAS)
SAFETY | FUTURE SKY
7 November, 2018
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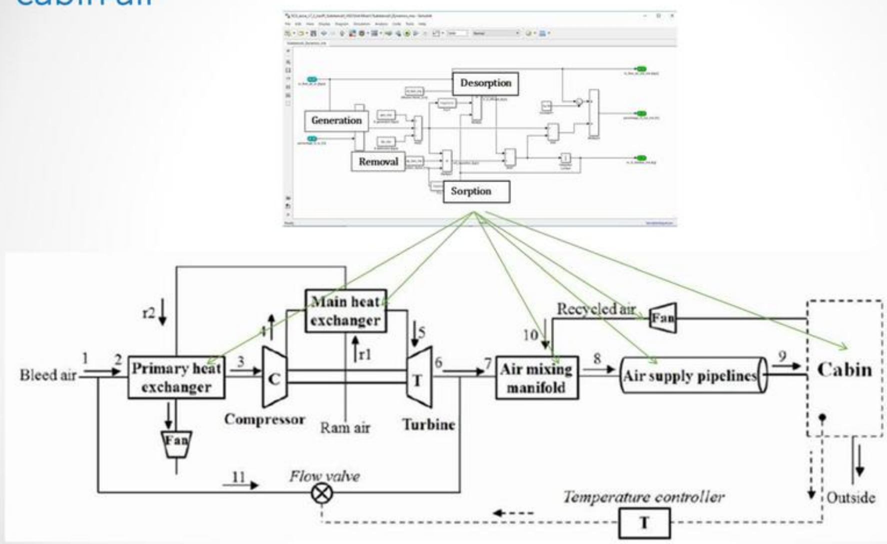
WP7.3 : Modelling the composition & behaviour of cabin air



Verification of building blocks integration for ECS (environmental control systems) models

SAFETY | FUTURE SKY 7 November, 2018 | 18/20

FSS P7 - CONCLUSIONS

Understanding and characterization of the fire behaviour of primary structures composite materials

- Production of a comprehensive experimental database on a reference composite material (T700GC/M21)
- Confrontation of experimental results to state-of-the-art models and simulation tools

Development and assessment of new material solutions that mitigate risk of fire, smoke and fumes in the cabin environment

- Development and characterization of new materials and their combinations for improved fire behaviour of interior and structural materials
- Modelling of material degradation with respect to fire, fumes and smoke risks in the cabin environment

Cabin air quality: using new technological opportunities to address the growing interest in complex issues (comfort, health, safety)

- Industrial cabin air quality Framework based on Continuous Air quality Sensing (IFCAS): feasible pathway to novel applications
- Real-time experimental methodology of air quality at normal or elevated temperatures, for new material investigation and COTS sensor testing

SAFETY | FUTURE SKY 7 November, 2018 | 19/20

Future Sky Safety has received funding from the EU's Horizon 2020 Research and Innovation Programme, under Grant Agreement No. 640597.

FSS P7 - PERSPECTIVES

Understanding and characterization of the fire behaviour of primary structures composite materials

Use models to predict primary structure fire response (stiffened curved panels), validate by structural tests ...

Development and assessment of new material solutions that mitigate risk of fire, smoke and fumes in the cabin environment

Increase TRL level of most promising hybrid solutions ...

Cabin air quality: using new technological opportunities to address the growing interest in complex issues (comfort, health, safety)

Further develop IFCAS, relate to Data4Safety project ...

SAFETY | FUTURE SKY 7 November, 2018 | 20/20

Acknowledgments to EU and P7 team ...

LEONARDO AIRCRAFT EMBRAER AIRBUS
DLR NLR ONERA THE FRENCH AEROSPACE LAB CEiiA
Cranfield University Civil Aviation Authority

Thank you for your attention !

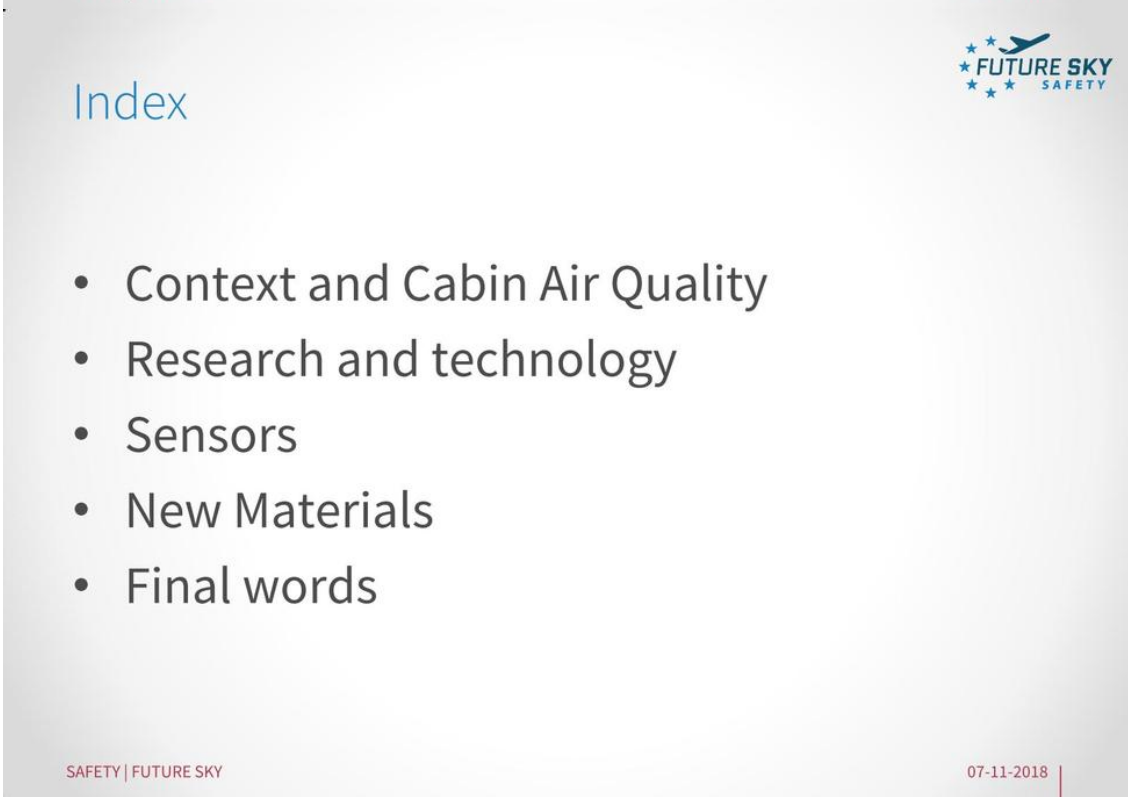
Any Question *(to the WP leaders ;-))* ?

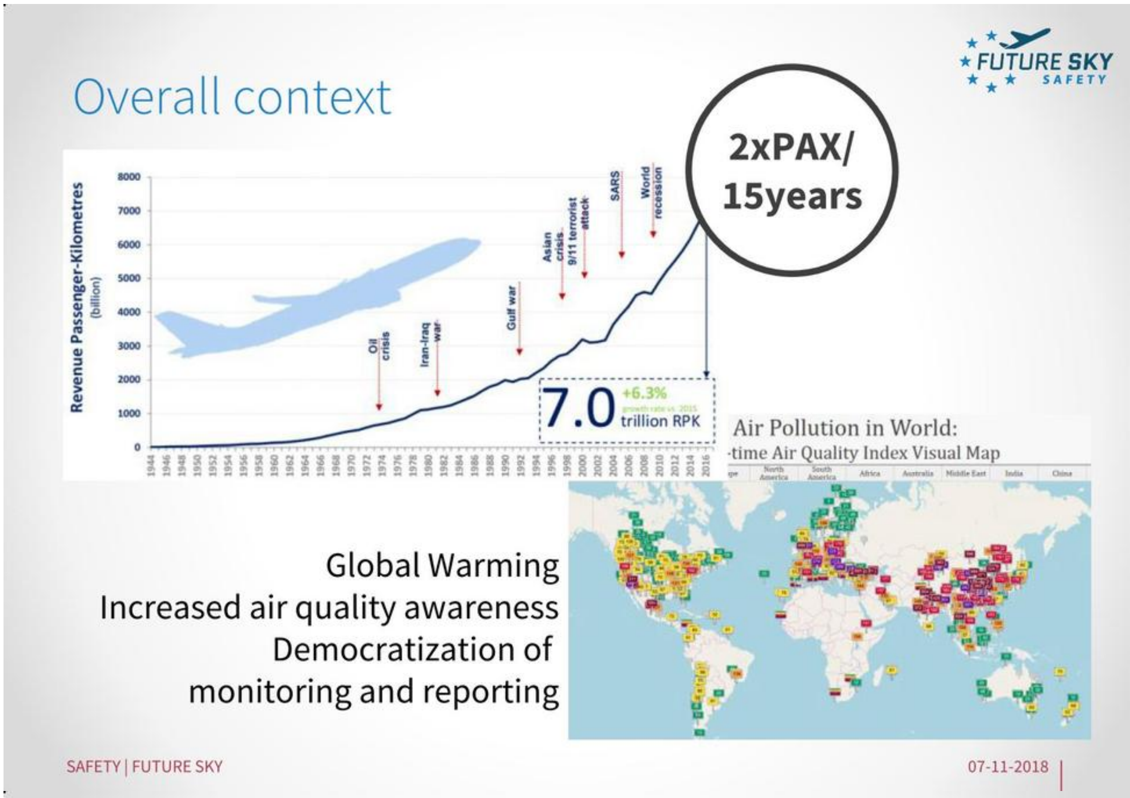
SAFETY | FUTURE SKY 7 November, 2018

Appendix B.22 "P7: Cabin Air Quality" – Ricardo Reis, Embraer Portugal

Future Sky Safety has received funding from the EU's Horizon 2020 Research and Innovation Programme, under Grant Agreement No. 640597.


FUTURE SKY SAFETY
Cabin Air Quality
Ricardo Reis – Embraer Portugal
SAFETY | FUTURE SKY
07-11-2018


FUTURE SKY SAFETY
Index
• Context and Cabin Air Quality
• Research and technology
• Sensors
• New Materials
• Final words
SAFETY | FUTURE SKY
07-11-2018



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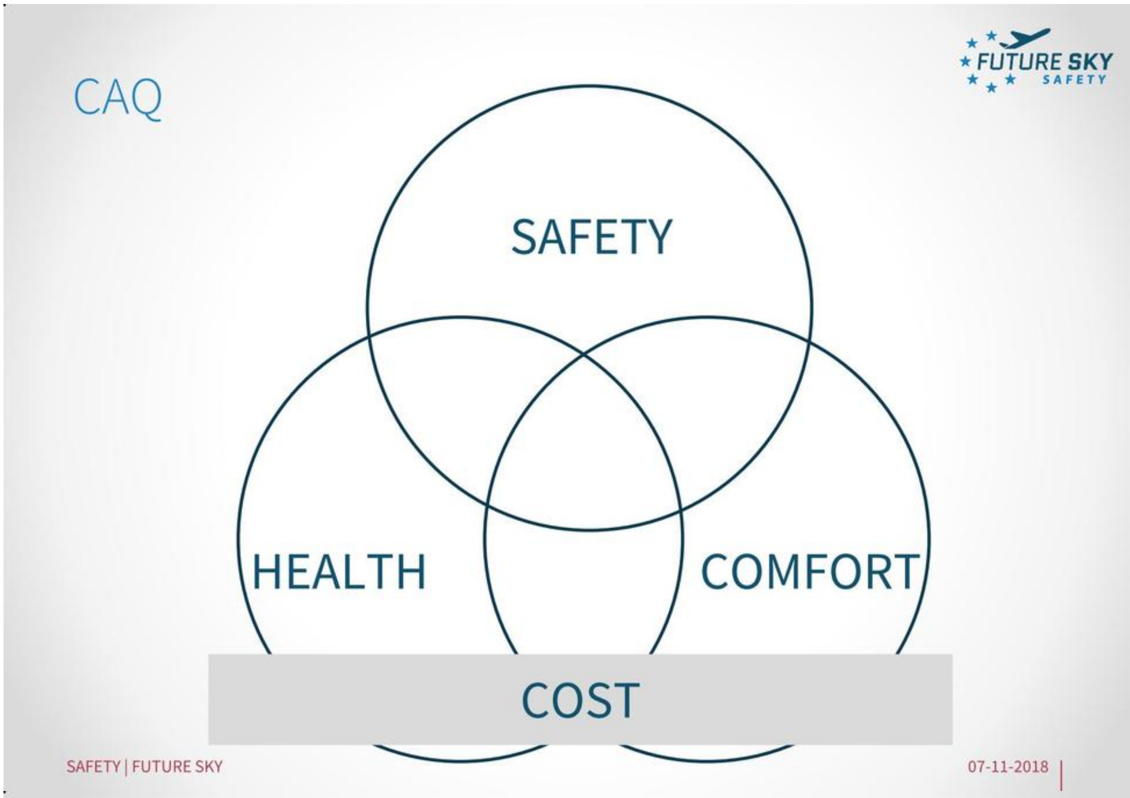

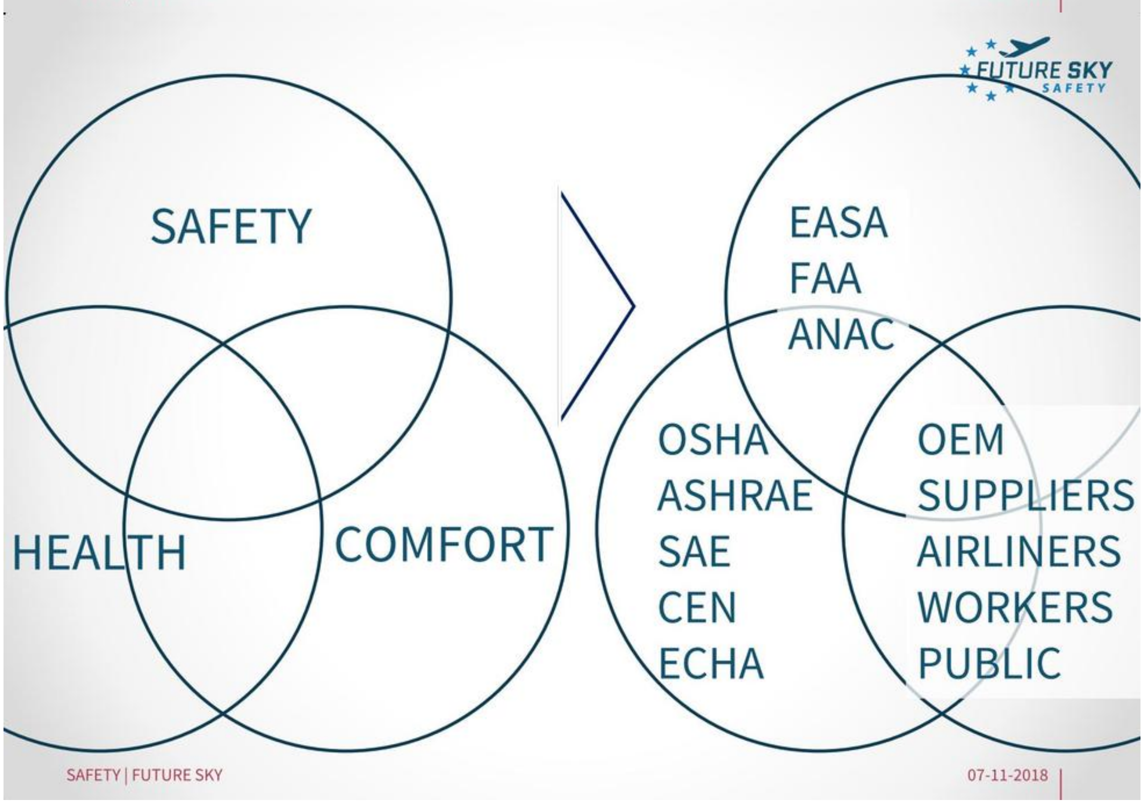

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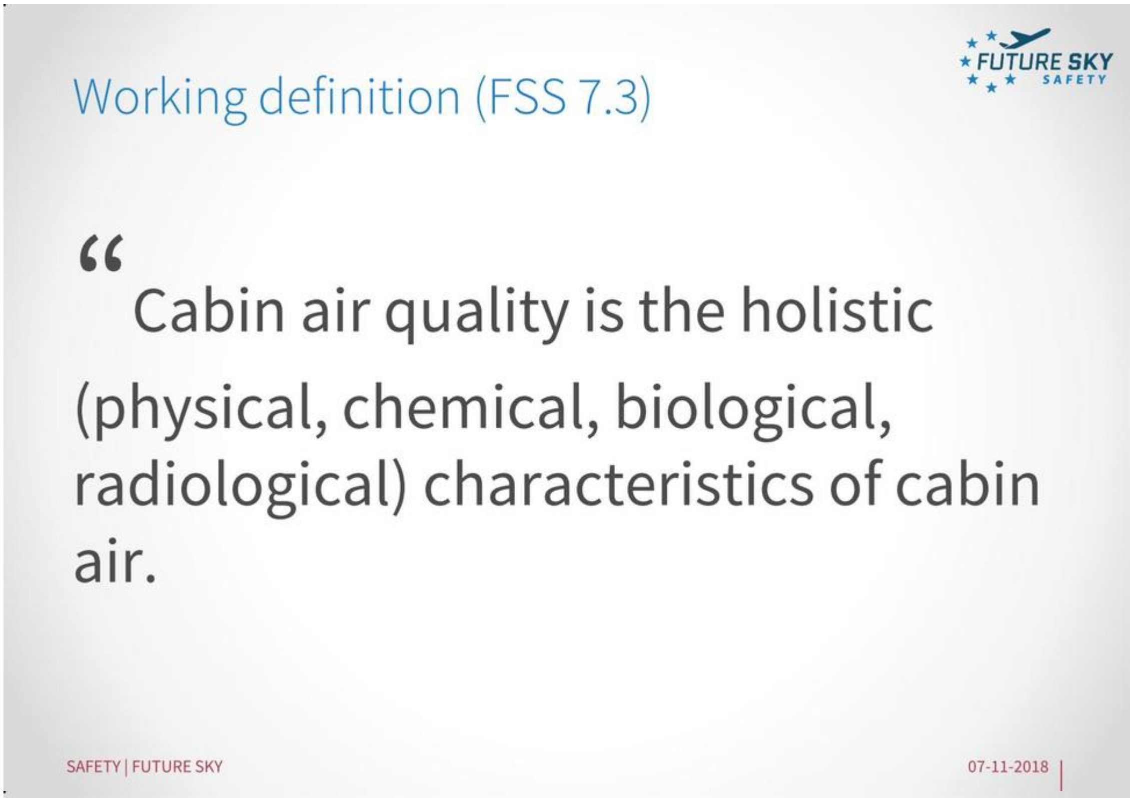

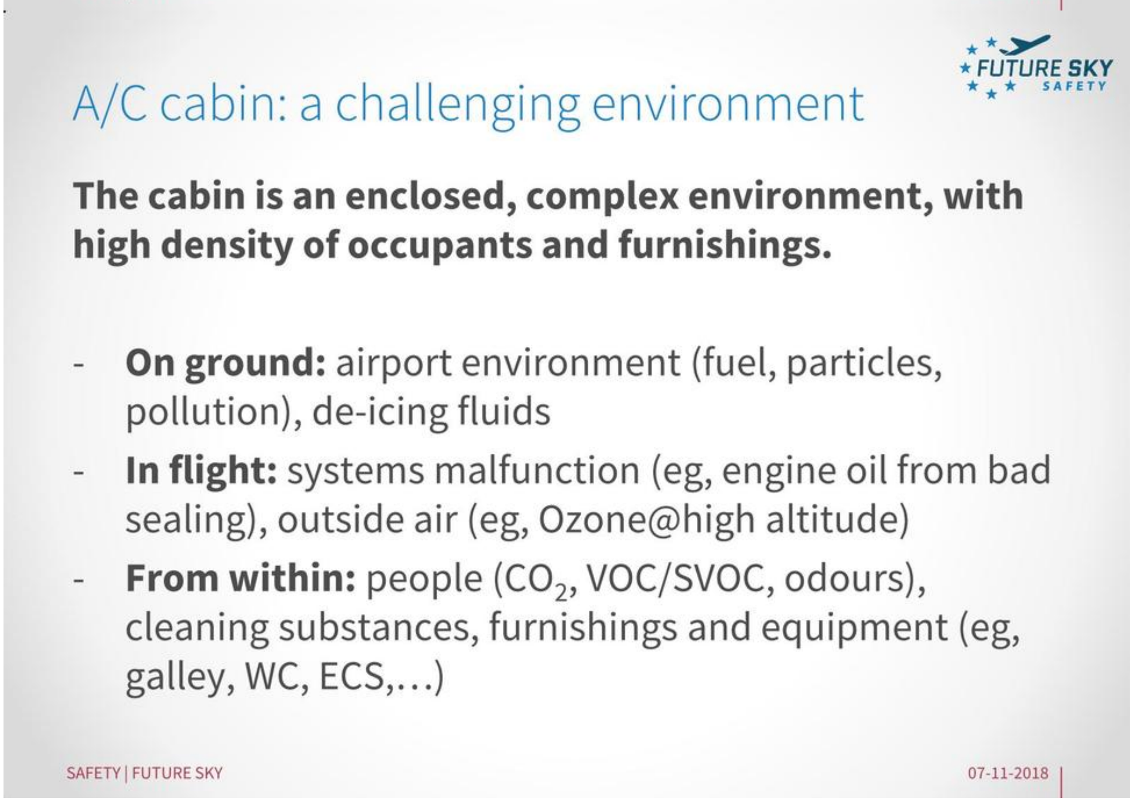

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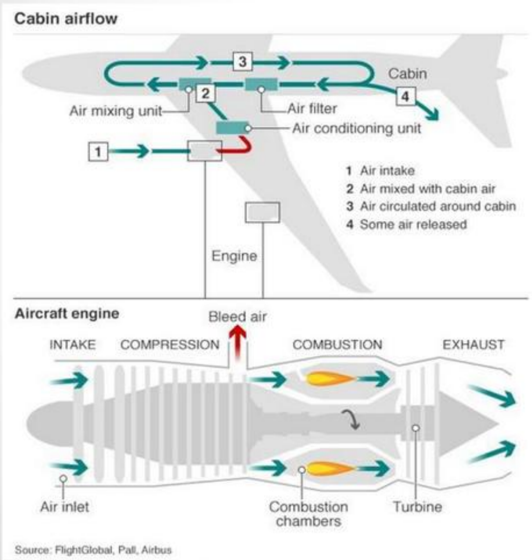
CAQ: managing the A/C environment (I)



OUTSIDE

~[-60 : 50] °C

~[10 : 100] kPa

[0 : 100] %Relative Humidity

Ozone, etc…

INSIDE

22±2 °C

~[75:100] kPa

~[10:20] %Relative Humidity

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CAQ: managing the A/C environment (II)

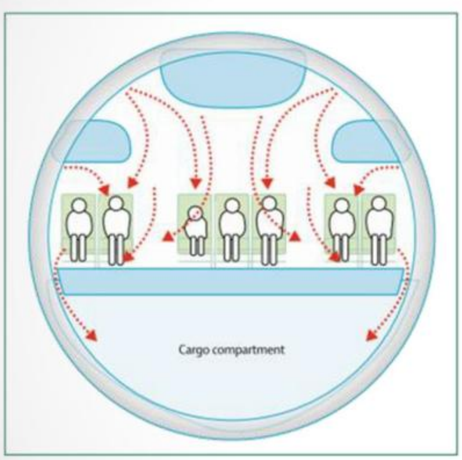

Figure 1: **Air circulation pattern in typical airline passenger cabin**

Air Circulation

50% recirculation of air

recirculation by cross-sections

1 renewal every 2,3 min.

HEPA filters

Ozone catalizers

Sources: "Transmission of infectious diseases during commercial air travel ",Alexandra Mangili, Mark A Gendreau, 2005
"On the 2-Row Rule for Infectious Disease Transmission on Aircraft," V. S. Hertzberg and H. Weiss, 2016

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CAQ: A/C vs buildings

Table 3
Selected environmental and occupational conditions in aircraft cabins and in offices, and exposure impact.

Condition	Aircraft cabin	Offices	Exposure impact
Contamination	Bleed air: tricresyl phosphates, deicing fluids, disinfectants, flame retardants, and plasticizers	Cleaning chemicals, material emissions, traffic pollutants, flame retardants, and plasticizers	Episodic events of temporary elevated exposure Possible thermal degradation Possible ozonolysis
Ozone, $\mu g/m^3$	High concentrations may occur (100–200 $\mu g/m^3$).	Certain regions have high outdoor concentrations, I/O ratios typically 0.2–0.7. Use of air cleaning devices and photocopiers may add substantially to the background level.	Higher concentrations initiate more gas- and surface reactions with unsaturated VOCs producing gas-phase and secondary organic aerosols (ultrafines). Dirty ventilation systems may emit ozone-initiated reaction products, e.g., 4-OPA.
Non-reactive VOCs	Variety of compounds		Likely to be similar patterns
Reactive VOCs (unsaturated)	High concentration of limonene from drink and meal services	High temporary concentration from use of consumer products, e.g., cleaning agents and orange peel; air fresheners may be constant sources.	Temporary high concentrations of oxygenated species may occur including, formaldehyde, 4-AMCH, IPOH, 6-MHO and 4-OPA, and other species can occur.
Reactive surfaces	Large surface area: high density of passengers, clothing, and textiles (seats and textile flooring)	Moderate surface area: moderate density of workers and textile flooring	The larger and the more soiled the surface the more ozone-initiated production of oxygenated species by surface reactions, e.g., 4-OPA.
Relative humidity (RH), %	<10	30–50	The lower the RH the more aqueous loss and decrease of tear production and PTF stability. Less stable PTF may become more susceptible to sensory irritants.
Temperature (T), °C	20–25	20–25	High T decreases tear production from the lacrimal gland, thus altering PFT stability.
Altitude, reduced pressure	Yes	No	Reduced pressure or high altitude enhances aqueous loss from the ocular surface and skin resulting in altered PTF.
Visual display unit (VDU) work Instrumental surveillance	Pilots	Yes, several hours.	VDU or surveillance work alters the PTF stability by a decrease of the eye blink frequency.
Combustion products, e.g., traffic	No	Infiltrated outdoor air, NO_2, particles	Combustion products may alter the PTF.

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Peder Wolkoff, Derrick R. Crump, Paul T.C. Harrison,
Pollutant exposures and health symptoms in aircrew and office workers: Is there a link?,

07-11-2018

Safety/Health : fumes and odours

EASA Study (2017)

- Preliminary results:
  - From flight measurements (limited) : CAQ similar or better than other indoor environments ;
  - Causal link between fumes events and health: addressed in FACTS
- New large scale study: FACTS
- Focus on abnormal events, innovative methodology by simulating fume events.

REACH

- NL requested TCP evaluation (2012)
- Information submission deadline (2018)
  - Neurotoxity
  - Exposure
  - Information questionnaires, medical and clinical investigations
- Evaluation (2019)

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Safety/Health : fumes and odours

SAE

- Cabin Air Quality Measurement Committee
- 2017, after IATA request Nov 2016
- "(..) standards for the measurement of air quality within the cockpit and passenger compartments. (..) developing a standard or standards covering portable and/or fixed installation sensors to quantitatively measure fumes and contaminants that could enter the cabin space."

CEN/TC 436

- Cabin Air Quality on civil aircraft – chemical agents
- develop European standards on "Cabin air quality on civil aircraft - Chemical agents" suitable for all stakeholders including passenger organizations , crew associations, aircraft and engine manufacturers, parts and components manufacturers, airlines and OSH (Occupational Safety and Health) representatives.

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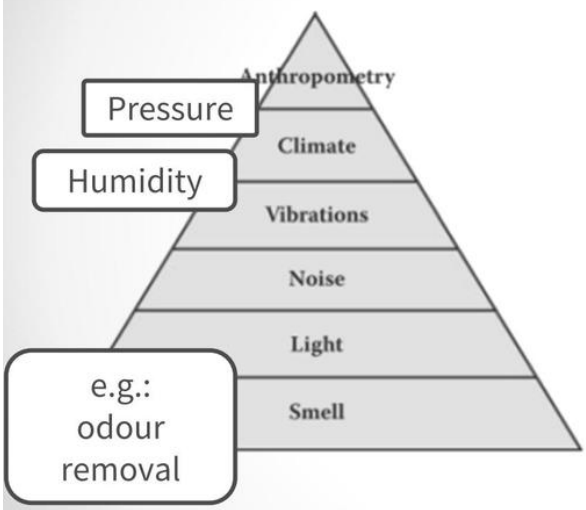
OPPORTUNITIES



- Composites (higher humidity and cabin pressure)
- Improving systems (more electric aircraft, control systems, …)
- Emergence new low cost, weight and energy sensors
- Improved comfort leads to higher productivity

Picutre source: "Aircraft Interior Comfort and Design", Peter Vink and Klaus Brauer 2011

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On board sensors / continuous sensing

Table 2. Cabin environmental quality issues relevant to stakeholders.

Stakeholder	Sensor-Related Issues
Regulatory agencies	Compliance with FARS and ASHRAE Standard
Aircraft manufacturers	Safety, low cost, simplicity, maintenance alerts, aircraft ECS design improvements. 'level playing field'
Airlines[a]	Revenue, passenger comfort, minimal complaints, 'level playing field'
Crew	Documenting exposures to contaminants (hydraulic fluids, pyrolysis products, pesticides); health risks; chemical sensitivity; compliance with standards; discomfort; access to data
Passengers	Health risks, comfort, access to data
Researchers	Exposure data related to health research and aircraft design improvements; access to data

Source: "Aircraft Cabin EnvironmentalQuality Sensors", 2010

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On-board sensing: different approaches

Human Reporting

Industry Sensor Network

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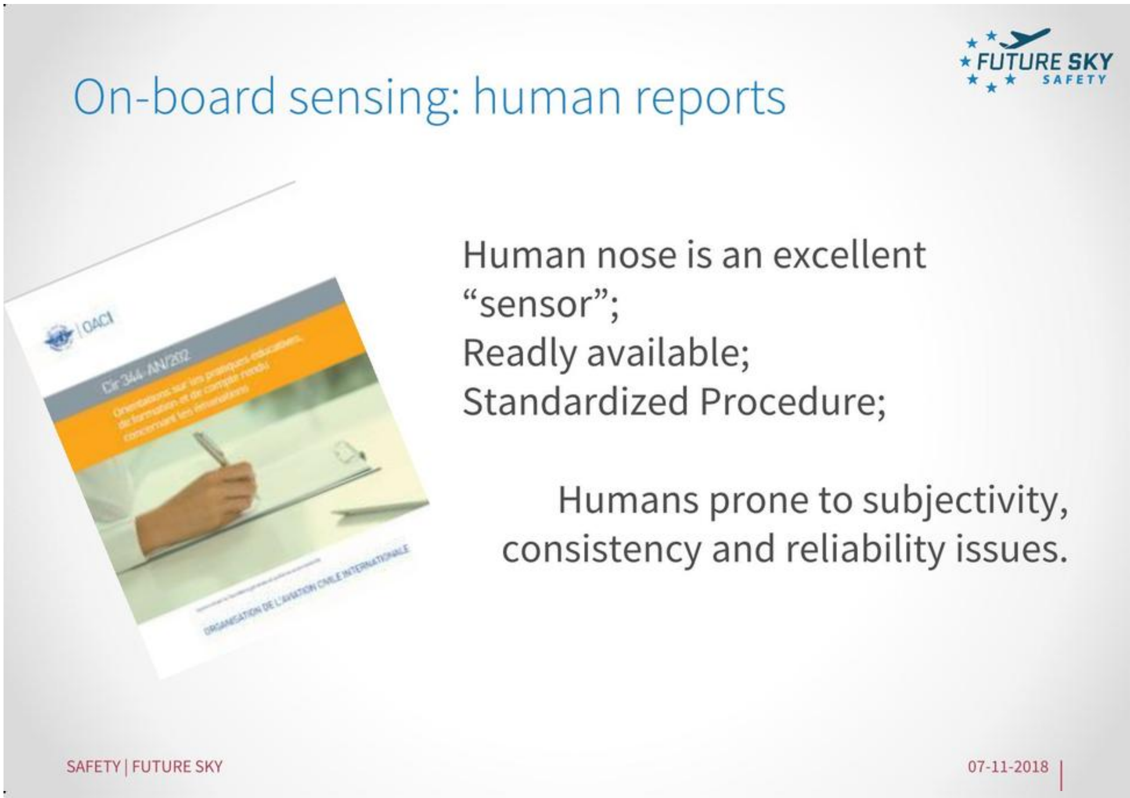

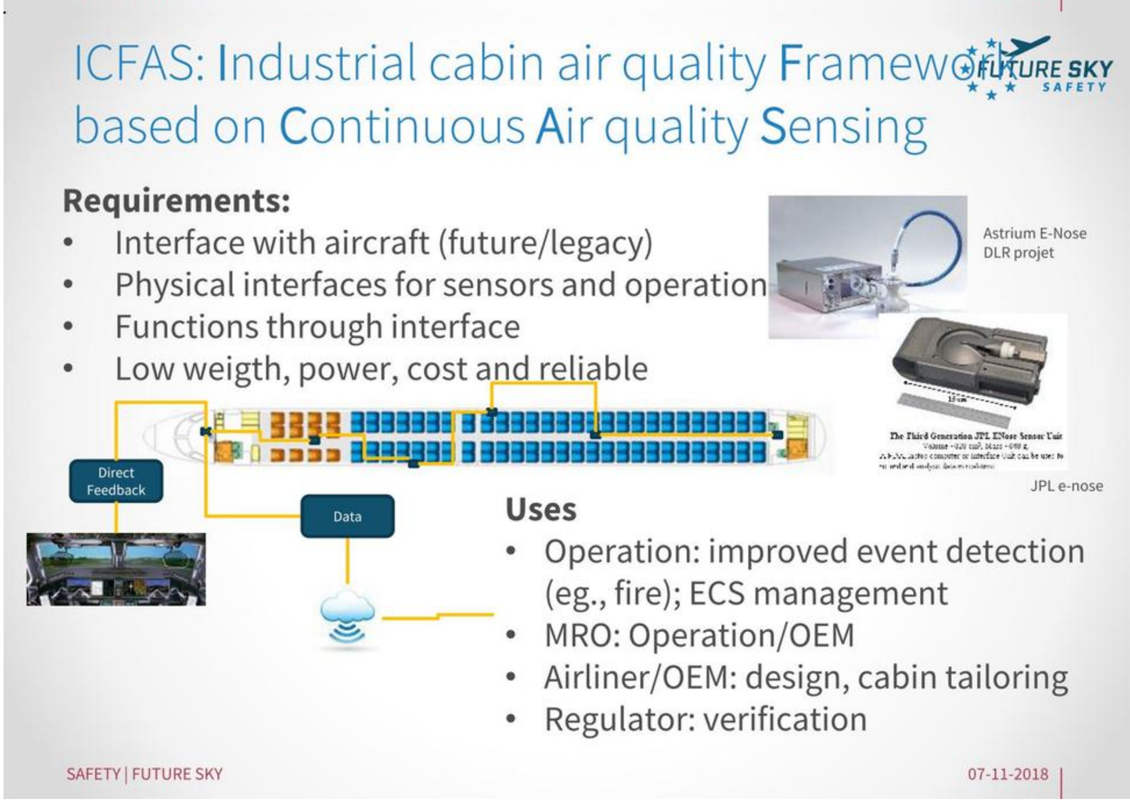

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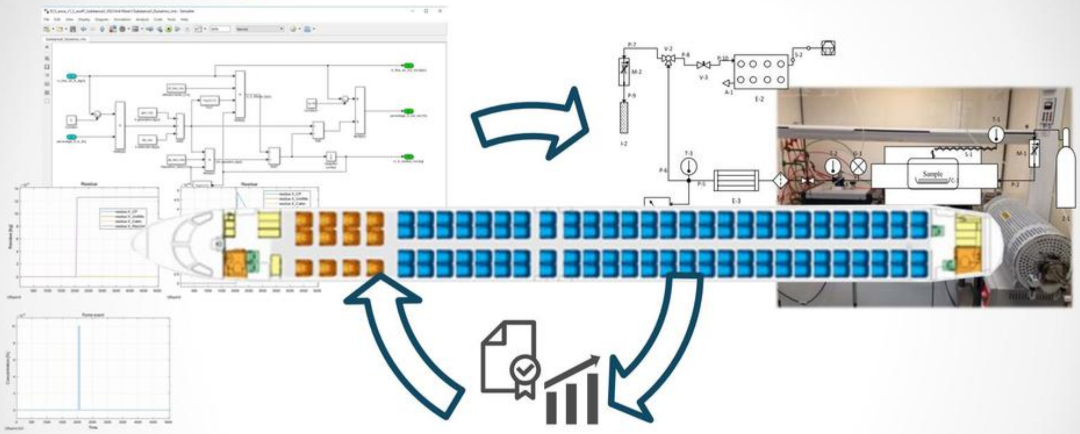
IFCAS: Key enablers



Business cases (on board sensors, data use)

Standardization

Simulation and modeling coupled with experiment

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Materials and substances: old and new

APPLICATIONS

- Structural
- Isolation: thermal, acoustic
- Furnishing
- IFE
- Cleaning

TYPES

- Composites
- Nano
- Metamaterials
- Flexible electronics
- Multifunctional

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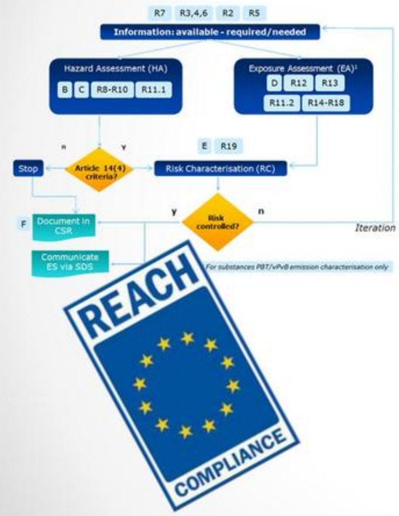
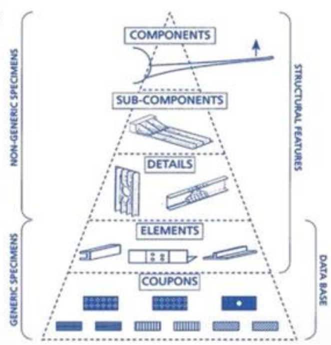
Materials and substances: old and new



NanoSafety Cluster



Modelling
Testing for aging and release (e.g, Cranfield, FSS 7.3)

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Final words

- The aircraft works in a very harsh environment, cabin environment is complex: knowledge is increasing;
- Existing research shows that CAQ is good, improvement still possible (e.g., comfort);
- Different lead initiatives to clear doubts on on-board contaminants: FACTS aims for the definitive answer;
- New technology – eg sensoring, ECS, filtering – enable improvement. Clear value creation ID for adoption;

➢ **IFCAS concept proposed to contribute to CAQ improvement: follow on research needed**

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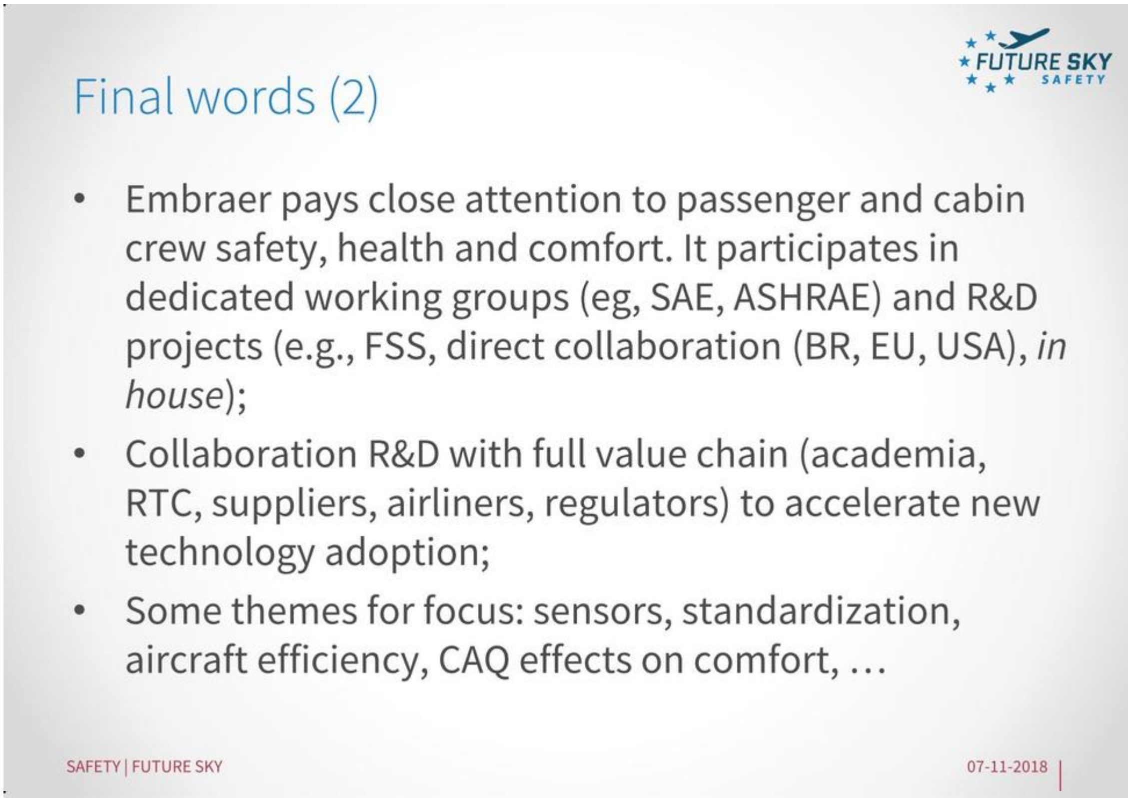

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Appendix B.23 "P7: Material solutions to mitigate fire, smoke and fumes in the cabin environment" – Martin Liebisch, DLR

Aim of WP7.2

Background

- 50% of fatalities are linked to situations where fire is involved
- Inflight or post-crash scenario
- Increase of commercial aircraft traffic and use of composite materials: Contribution to safety with respect to fire related issues needed

Objectives

- Develop and utilize novel and innovative material solutions with high potential for mitigating risks of fire, smoke and fumes in the cabin environment.
- The scope and magnitude of proposed test plan respect industrial safety requirements and usage of state-of-the art simulation tools
- Improve state-of-the art simulation tools to decrease experimental effort and to increase understanding

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Outline

- Simulation of fire testing
- Overview to Material solutions with promising FST behavior
  - Geopolymers
  - Fibre metal laminates
- CuFEx facility
- Test results
- Demonstrator
- Outlook

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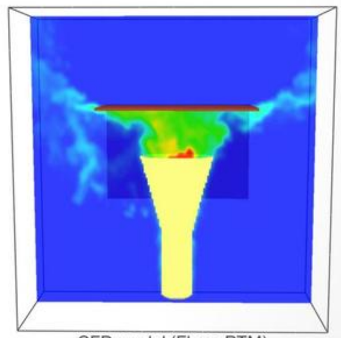
Simulation of fire testing

Numerical simulation to reduce experimental effort

- Simulation of flame penetration tests by coupling of CFD and CSM analyses
- Modelling of pyrolysis to capture the reactions of produced gas

Flame penetration test



CFD model (FlamePTM)

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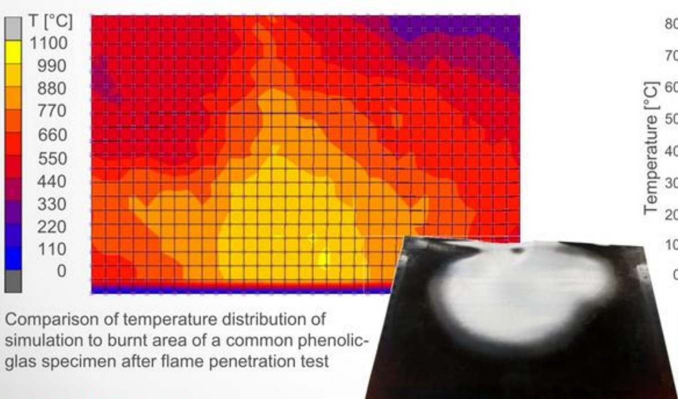
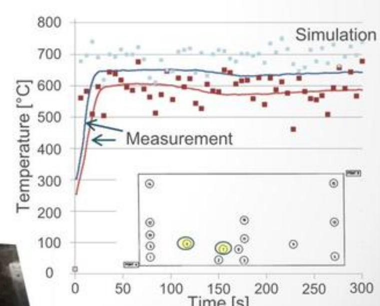
Simulation of fire testing

Numerical simulation to reduce experimental effort

- Simulation of flame penetration tests by coupling of CFD and CSM analyses
- Modelling of pyrolysis to capture the reactions of produced gas
- Validation of the thermo-structural behavior shows good agreement



Comparison of temperature distribution of simulation to burnt area of a common phenolic-glas specimen after flame penetration test



Comparison of temperature history between experiment (lines) and simulation (points) at 2 positions

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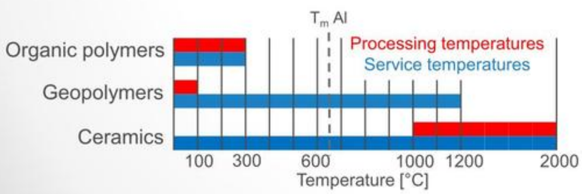
Geopolymers

Low temperature processing

- Ingredients: Metakaolin, silica (SiO2), water and „water glass“ as activator
- Manufacturing:
  - High speed mixing of ingredients at room temperature
  - Wet laminating, Prepreg
- Can be worked up like common resins at low process temperatures




Wetpreg preparation machine


Wetpreg prepared for laminate layup

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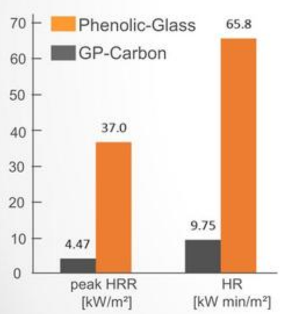
Geopolymers: Test results

Promising FST behavior of GP

- Anorganic polysialate matrix withstands temperatures above 1000°C
- Burn through results: No fire penetration was registered at any of test



Heat release rate


Phenolic-Glass


GP-Carbon

Test of resistance to fire in designated fire zones per ISO 2685

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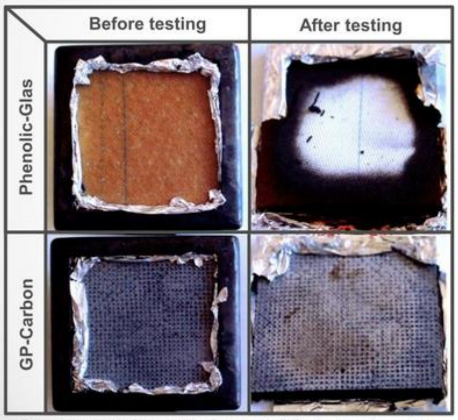
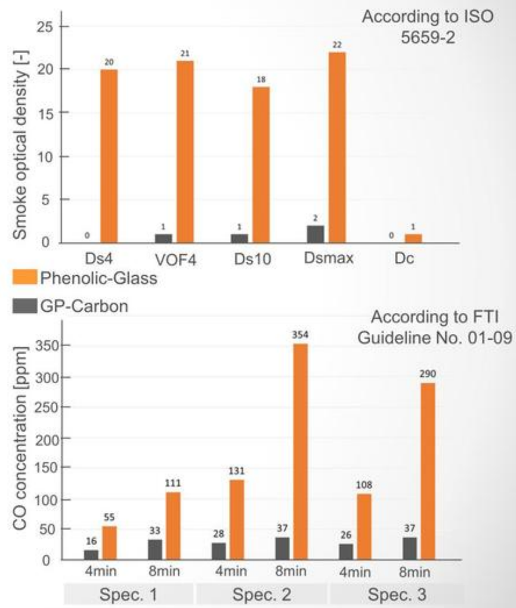
Geopolymers: Test results

Almost zero generation of toxic products or smoke wrt fire exposure



Specimens before and after test: GP shows almost no influence whereas phenolic resin is completely burnt off



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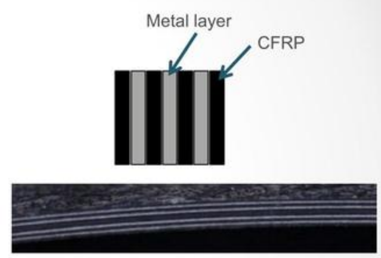
Fibre metal laminates

Manufacturing close to standard processes

- Utilization of common prepreg autoclave curing processes
- Additional preparation of metal sheets
  - Sandblasting
  - Bonding agent
- Variation of metal layer thickness and metal layer positions investigated



Manufactured FML cross section

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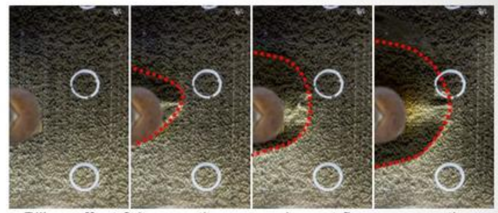
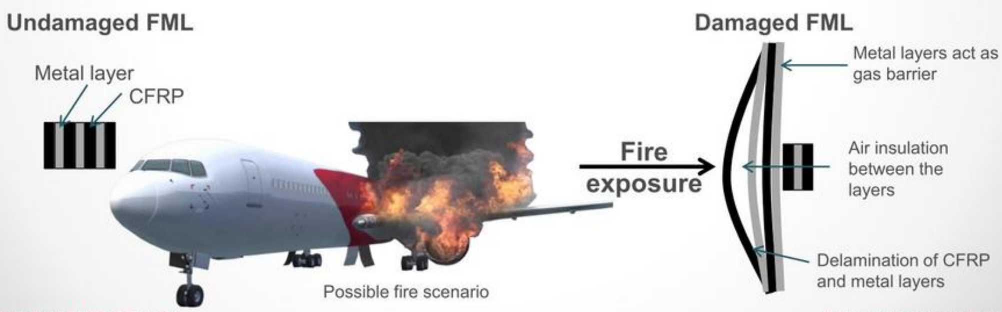
Fibre metal laminates

Developping heat barrier

- Melting temperature of steel > 1200°C
- Decomposition of matrix creates gases
- Metal layers act as gas barrier
- Decomposition gasses are trapped (Pillow effect) and act as insulation
- Rear layers survive within a fire scenario (no decomposition)



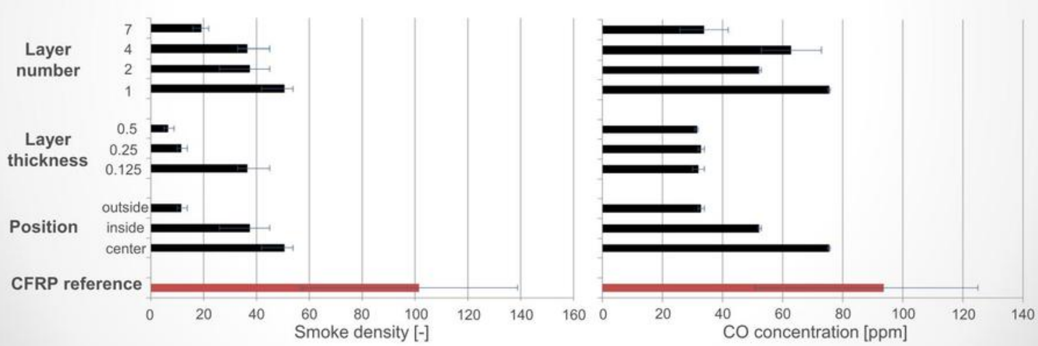
Pillow effect & its growth progression wrt fire exposure time



Fibre metal laminates

Promising FST behavior

- Variation of metal layer numbers (wrt equal metal content)
- Variation of metal layer thickness (wrt to equal number and position)
- Variation of metal layer position (wrt equal metal content and layer number)



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Summary to investigated material solutions

Both, Geopolymers and Fibre Metal Laminates show significant improvement of FST behavior (Smoke density and Smoke Toxicity)

- Geopolymers withstands the high temperatures
- FML create gasses that are trapped between the metal layers. The resulting insulation effect prolongates rear layer life

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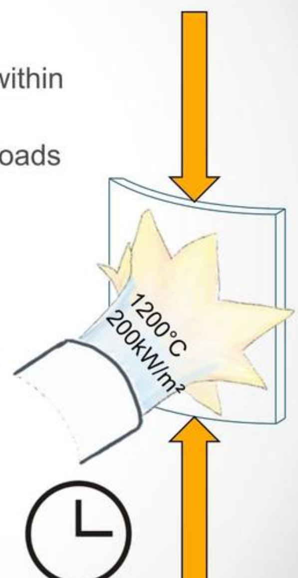
CuFEx facility

Compression under Fire Exposure (CuFEx)

- Aim: Investigate residual mechanical performance within a fire scenario
- New facility that allows combination of mechanical loads and simultaneous fire exposure

Simple test protocol

- Specimen size: 120mm x 200mm
- Curved specimen to guarantee mechanical stability against buckling
- Quasi-static axial compressive preload (50MPa)
- Fire Loading: Aperture may be used to reduce the exposed surface
- Measurement of force and backside temperature



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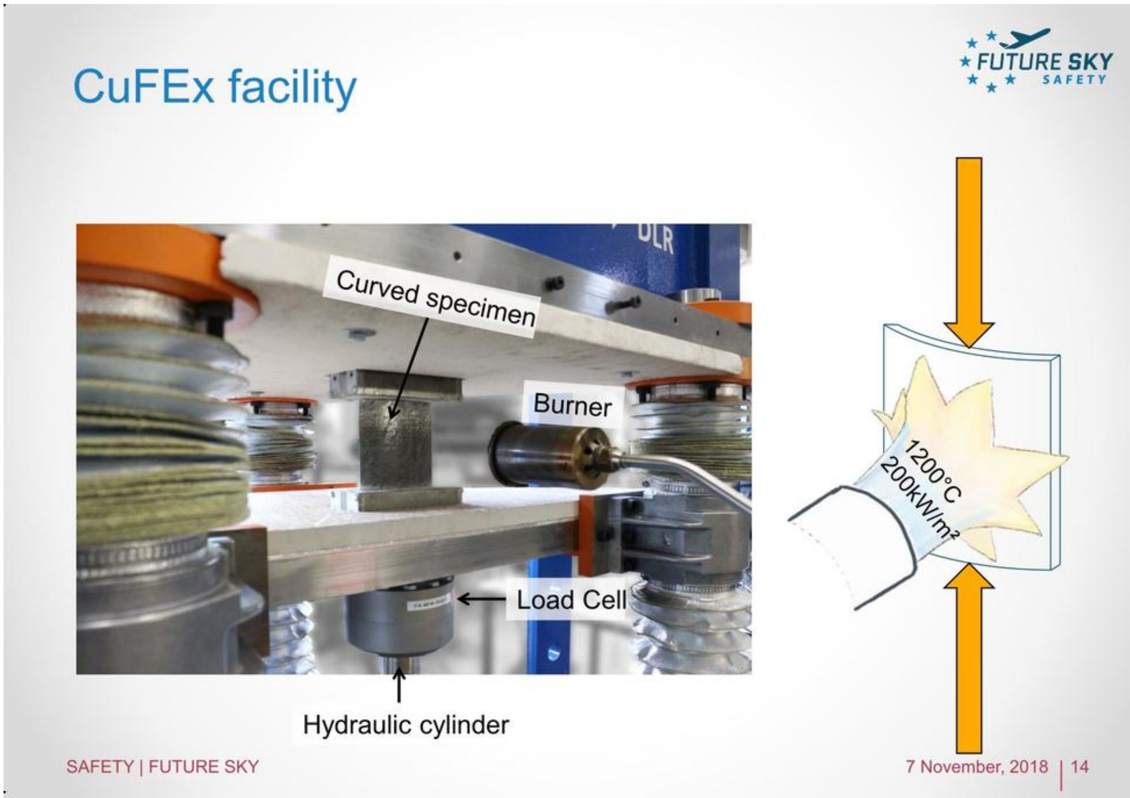
CuFEx facility
Curved specimen
Burner
Load Cell
Hydraulic cylinder
1200°C
200kW/m²
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CuFEx facility
Specimen backside prepared with thermocouples
DLR
Testing
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CuFEx facility

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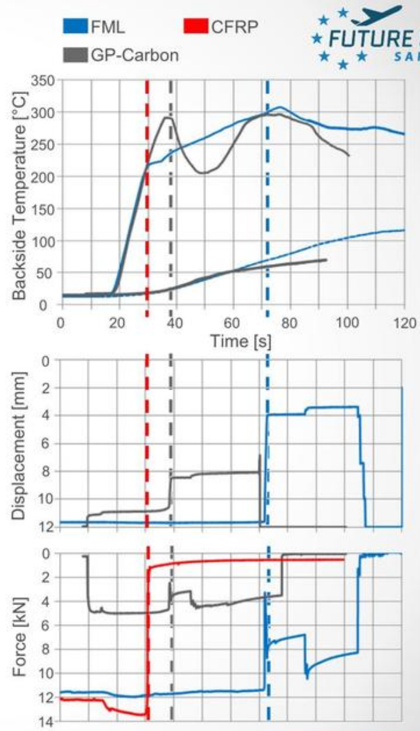
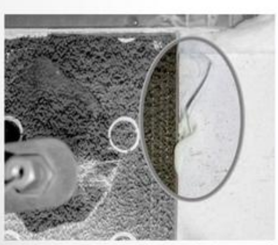
CuFEx test results

- CFRP Reference failing after ≈ 15s
- GP failure after ≈ 25s @ 20MPa due to stability failure
- FML failure after ≈ 55s @ 50MPa introduced by delamination at free edges





Delamination results in leakage of insulating gas

Specimen front after testing, stability failure visible at specimen edges

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Demonstrator

- Fire tests were conducted to demonstrate the improved FST behavior of aircraft structures through materials investigated within FSS compared to common materials
  - Interior structures: Common: Phenolic-glass compared to GP-carbon
  - Primary/ secondary structures: Aluminium compared to FML

Aluminium: Burn-through after approx. 1min

FML: No burn-through or decomposition on the inner side

Phenolic-Glass: Completely decomposed matrix

GP-carbon: Almost no reactions resulting to fire

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Outlook

Geopolymer

- Development of **GP-based honeycomb** for heat resistant sandwich structures
- Development of **GP composites containing ductile layers** to improve toughness

Fibre-metal-laminates

- Further investigations to **derive weight-optimized FML** layups wrt multiple design aspects (FST, fatigue, impact etc.)
- Investigate the promising insulating effect of a FML skin for more representative **stiffened structures** for combined mechanical & fire loading

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Appendix C Posters

Appendix C.1 “P1: Coordination of Institutionally Funded Safety Research”

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Appendix C.2 "P3: Improved operational capabilities on contaminated runways"

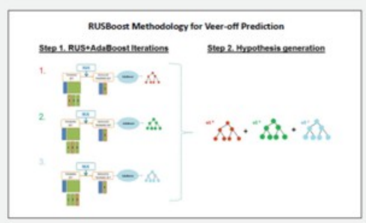
Project #3
SPECIFIC SOLUTIONS FOR RUNWAY EXCURSION ACCIDENTS

AIRBUS D&S IN FSS: SOWING THE SEEDS FOR IMPROVED OPERATIONAL CAPABILITIES ON CONTAMINATED RUNWAYS

Airbus D&S has participated in three Work Packages of Project 3, devoted to safety improvements during the landing phase.

Jointly with NLR, Airbus D&S conducted a test campaign with A400M during 2017. The aim was to characterize the **braking friction at tire level,** in contaminated conditions (15 mm standing water).
Results showed strong correlation with previous Cessna tests, carried out by NLR at the same facilities. Additionally, it was possible to characterize the aquaplaning phenomenon, and to estimate aquaplaning speed.
Both constitute **crucial starting points** for potential refinements of AMC 25.1591 braking friction curves and aquaplaning models.

The presence of runway contamination is also one of the leading factors in the development of **veer-offs**, particularly during landing.
Despite their risk, the low frequency of such events (less than 1 % of landings) hinders their modelling and, therefore, the ability to predict them.
Airbus D&S has tested the applicability of an innovative machine learning technique, called **RUSBoost**, in the prediction of rare incidents, such as veer-offs. The results achieved with this technique (success rate beyond 70% and training times below 20 s) demonstrate its potential to predict these events, for eventual use in on-board applications.



Success Rate (Recall) of Veer-off Prediction

Settings	Recall Right	Recall Left	Training time
1000 trees + LR=0.1	76 %	76 %	22 s
10000 trees + LR=0.1	70.6 %	79.9 %	217 s
1000 trees + LR=0.01	73.5 %	84 %	23.7 s
10000 trees + LR=0.01	76.5 %	78.9 %	213 s

FUTURE SKY SAFETY PROGRAMME
has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 640597.
www.futuresky-safety.eu

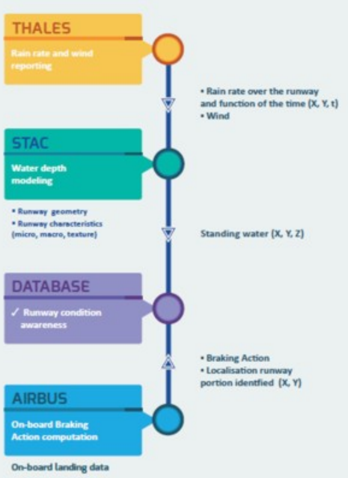
PARTNERS INVOLVED
Airbus Defence and Space, NLR

Appendix C.3 "P3: OPHELIA tool to predict runway water contamination"

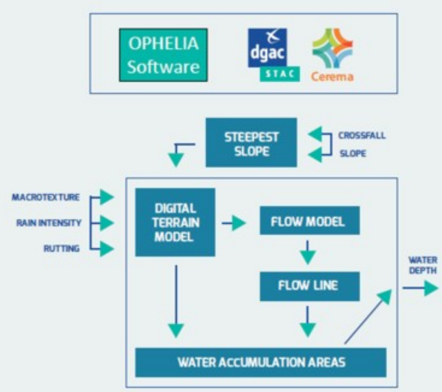
Project #3
SPECIFIC SOLUTIONS FOR RUNWAY EXCURSION ACCIDENTS

OPHELIA: a new tool to predict runway water contamination

Various concepts and initiatives to prevent runway excursions have been studied within Future Sky Safety project P3. Because inaccurate knowledge of the runway contamination status ranks among the main factors contributing to runway overruns, a concept combination for the assessment and prediction of water depth on runway surface has been produced. In this concept, weather (rain, wind...) forecast at the airfield, water flows modelling on the runway surface and aircraft braking action computation are combined, in order to reach better runway condition awareness within the next 30 minutes.



Among these components, OPHELIA has been developed by the French Civil Aviation Technical Center (STAC) and the French Center for Studies and Expertise on Risks, Environment, Mobility and Planning (Cerema) to enable the modelling of water flows and the prediction of water accumulation areas. First, runway surface characteristics (curvature, slopes, texture) are collected by a specific monitoring device called VANI. Then, a numerical mapping of the runway surface is generated for the computation of water paths along steepest slope vectors. Finally, local rain intensity predictions are used to predict water depth over the runway surface. OPHELIA is currently under experimental validation at two French airports. Further improvements could be made by implementing new phenomena, such as drying or wind effects, into the model.



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PARTNERS INVOLVED
Service Technique de l'Aviation Civile, AIRBUS, DLR, THALES

Appendix C.4 "P3: Risk assessment of veer off during landing"

Project #3
SPECIFIC SOLUTIONS FOR RUNWAY EXCURSION ACCIDENTS

RISK ASSESSMENT OF VEER OFF DURING LANDING

The purpose of study and the data considered

The purpose of this work is to evaluate impact of external factors affecting veer off risk and to get knowledge how to reveal the situations leading to sufficiently increased risk under actual conditions of landing.

The basic factors considered are the following:

- RWY surface contamination type (categorical parameter);
- season (categorical parameter);
- crosswind speed (continuous parameter).

There are considered as veer off preconditions the values of some parameters in some checkpoints of landing trajectory.

The subject of processing are the raw data of on-board parametric recorder and METAR data base containing information about the weather and RWY surface conditions.

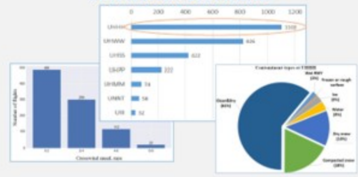
Metrics of landing run

Despite the fact that (generally) frequency of veer off is high enough, it is very difficult in practice to form a representative sample of data suitable for processing based on the methods of applied mathematics.

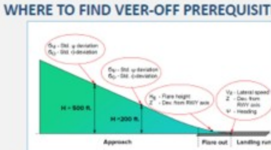
There is proposed some approach of solving the problem, when the risk of veer off is estimated basing on the analysis of successful landings. There is utilized for this purpose new metrics of landing run named as "TrackIndex - TI" which characterizes somehow the deviation of actual landing from its ideal form. It is assumed that the higher value of the metrics corresponds to the greater risk of veer off.

There are taken into consideration a few versions of proposed metrics based on such parameters as: lateral deviation from the runway axis (TI_Z), lateral load factor (TI_{nz}), and rudder pedals position (TI_{Xr}).

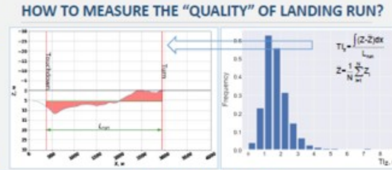
INITIAL DATA FOR ANALYSIS



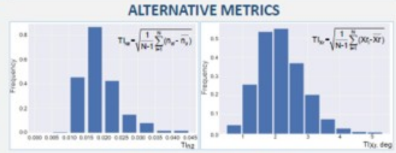
WHERE TO FIND VEER-OFF PREREQUISITES?



HOW TO MEASURE THE "QUALITY" OF LANDING RUN?



ALTERNATIVE METRICS



METRICS INTERCONNECTION

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PARTNERS INVOLVED
Central Aerohydrodynamic Institute (TsAGI)

Project #3
SPECIFIC SOLUTIONS FOR RUNWAY EXCURSION ACCIDENTS

RISK ASSESSMENT OF VEER OFF DURING LANDING

Assessment of risk factors and precursors for veer off events

The degree of influence of the considered parameters on landing run metrics may be evaluated by regression methods. The influence of categorical parameters at the metrics value was assessed by using Mann-Whitney test, and the influence of continuous parameters — by Spearman's correlation coefficient.
There are revealed:

- an increase of TI_z metrics value on a snow-covered runway (compared with dry and purified one);
- an increase of the TI_{nz} and TI_{xr} metrics with an increase in the standard deviations of bank angle or/and yaw angle at the checkpoint on the glide path at a height of 200 feet.

Season influence on the metrics were not found (even in Russian climate).
The results obtained do not contradict data base of observations.

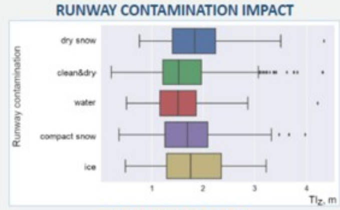
Abnormal landings identification as a way to prevent aircraft veer off events

If to assume for considered set of landings, that in each current vertical plane perpendicular to RWY axis flight parameters are distributed according to normal law, it is proposed the following algorithm of current situation assessment:

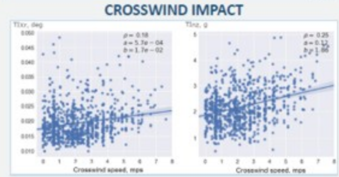
- if the flight parameters belong to multidimensional "tube" of σ width, then the approach may be considered as normal (safe);
- if one of the flight parameters is outside a "tube" of 2σ width, then the approach is considered as "abnormal".

Various machine learning methods may be used to build a multi-dimensional model describing distribution of flight parameters and landing conditions (meteorological and RWY surface conditions) and to detect abnormal landing approaches.
There was used in TsAGI (in particular) the method of describing the multidimensional envelope of flight parameters variations with a mixture of Gaussian distributions (Gaussian Mixture Model - GMM).

RUNWAY CONTAMINATION IMPACT

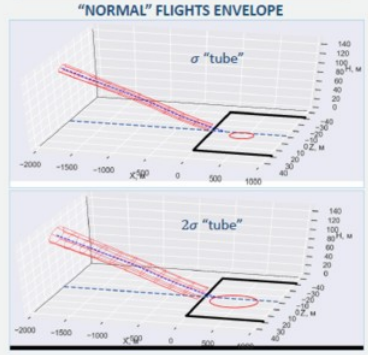


CROSSWIND IMPACT



IMPACT OF STD ϕ AT 200ft

"NORMAL" FLIGHTS ENVELOPE



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Central Aerohydrodynamic Institute (TsAGI)

Appendix C.5 "P4: Enabling improved safety management"

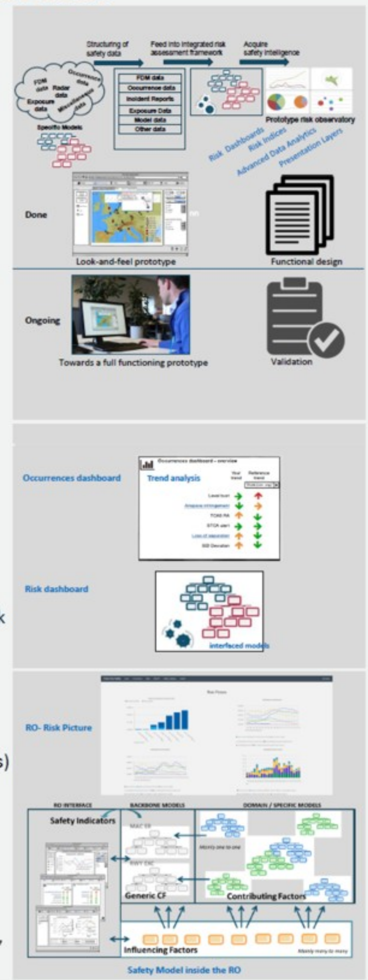
Project #4
TOTAL SYSTEM RISK ASSESSMENT

ENABLING IMPROVED SAFETY MANAGEMENT

Main Objective
- Develop an advanced support tool for Total Safety Management in Aviation

Challenge
- Connecting data and models from different sources and origins

Results
- a prototype **Risk Observatory (RO)**
  - Acquiring, fusing and structuring safety data
  - Translating data into actionable safety intelligence
  - Suiting Safety Management
- an **Integrated Risk Assessment Framework**
  - Occurrence Dashboard
  - Risk Dashboard
  - FDM-data for Safety Performance Indicators
  - What-If-Scenario's
- a **Business Model**
  - How to make RO successful ?



Exploitation Aspects
- **Centralized RO & Framework delivery & maintenance**
  - RO parts like Runway Excursion & Mid-Air Collision back bone models
  - RO complementary to other initiatives like Data4Safety
  - Defined Safety Performance Indicators
  - Enabled Risk Analysis
  - Provided Safety Intelligence
  - Applied different data sources (across different domains) and results of "Big Data" techniques
  - Total (Aviation) System Risk derivation approach
- **Risk Observatory Organisation (ROO)** to be set up
  - Creating a Central Safety Intelligence Organisation
- **Potential Stakeholders:**
  - ANSPs, Airlines, Airports, Regulators and Authorities, Ground Service Providers, MRO, Manufacturers (OEMs), Accident Investigation Boards & many other

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Appendix C.6 "P5: Safety Culture"

Project #5
RESOLVING THE ORGANISATIONAL ACCIDENT

WP3 - SAFETY CULTURE

OBJECTIVE: To develop a method for assessing and reporting on safety culture across the whole aviation system, with areas for improvement being identified and tailored to different operational contexts.

HIGHLIGHTS:
European Cockpit Association (ECA)
>7,000 responses

- Overall, Safety Culture is good
- Pilots are concerned fatigue is affecting their performance and >50% feel their companies do not take the issue seriously
- Pilots on temporary, cargo and low cost airline contracts generally have poorer safety culture
- EC, regulators, airlines and pilot associations need to consider the results and determine ways forward

Surveys with two major European airlines

- A safety culture survey was carried out for easyJet, leading to an internal action plan
- A safety culture survey was carried out for KLM, eliciting more than 11,000 replies.

The Luton safety culture 'stack'
Six parallel safety culture surveys were carried out at Luton Airport in the UK. This has led to ongoing collaboration to improve safety culture at LTN.

- Air Traffic Control (NATS)
- Airlines (easyJet)
- Airport (London Luton Airport)
- Ground-Handling, Fire & De-Icing Services

Outcome: The Stack approach allows organisations to learn from each other, and to overcome safety 'blind-spots' at their interfaces.

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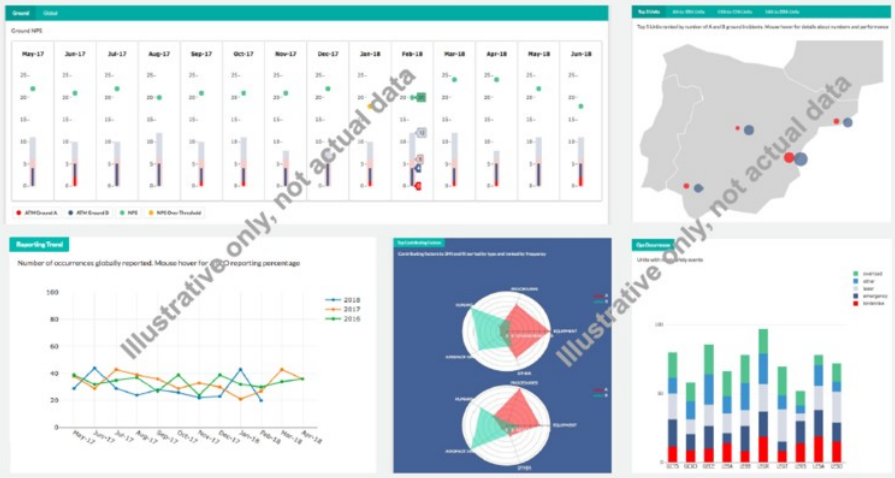
Appendix C.7 "P5: A prototype interactive safety dashboard for ENAIRE"

Project #5
RESOLVING THE ORGANISATIONAL ACCIDENT

A Prototype Interactive Safety Dashboard for ENAIRE

(Data shown are ***illustrative only****, and* ***not actual data****)*



In the context of the Future Sky Safety P5 exploitation action on Safety Intelligence, we further developed the work started in 2016 on Safety Dashboards (SDB) for ANSPs executives.

In January 2018, EUROCONTROL launched a series of workshops to present the first static prototype of SDB designed with the help of a small user group of 6 ANSPs, and continue the discussion about safety data visualisation.

ENAIRE, the largest Spanish ANSP, volunteered for partnering up with EUROCONTROL and Deep Blue to develop a full-scale interactive SDB.

We kicked off the work in May 2018, meeting ENAIRE safety staff to understand their current SDB, collect their needs and produce a first sketch of the future SDB.

Deep Blue worked on the software development of a first prototype and shared it with EUROCONTROL and ENAIRE in August 2018, to receive feedback and steer the functional and visual design accordingly.

In addition to the front-end visualisation aspects, the remaining work will take care of the back-end by automating data feed into the dashboard, thereby streamlining the connection to the multiple data sources in use.

The final goal is the release of a fully functional SDB by the end of December 2018.

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Appendix C.8 "P5: Organisational capability of agile response to crises"

FUTURE SKY SAFETY

Project #5
RESOLVING THE ORGANISATIONAL ACCIDENT

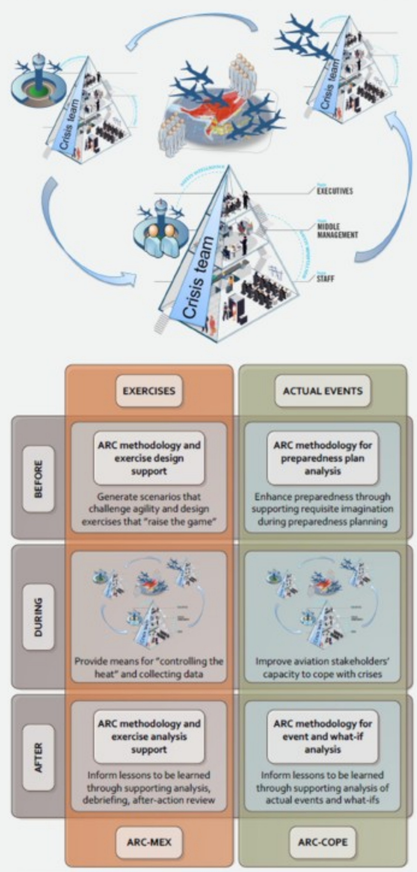
ORGANISATIONAL CAPABILITY OF AGILE RESPONSE TO CRISES

Aviation is a highly inter-connected system of systems. This means that a problem in one area may cause effects in other countries or parts of the Air Transport System (ATS). For example, a fire at a major hub can cause disruption over a large part of Europe. Additionally, there is the potential for massive system-wide events such as occurred during the volcanic ash crisis in 2010. **What is needed in ATS crisis situations is** not only rapid coordination, but an **agile response**.

FSS WP5.4 provides aviation organisations with Agile Response Capability (ARC) guidance material, to help organisations set up, exercise, and evaluate more adaptive and flexible organisational structures for handling disturbances and crises, and pro-actively and retrospectively analyse actual events.

Agility, like **resilience**, refers to the ability to cope with dynamics and complexity in a flexible manner, by adjusting and adapting performance and the organization of work to better fit changing demands, both pro-actively as a way of preventing unwanted outcomes, and re-actively as a way of coping with, and understanding, unwanted events.

The ARC approach consists of the ARC Method for EXercise planning (ARC-MEX) to aid staff responsible for the planning and analysis of crisis exercises, and the ARC Crisis Operations and Plan Enhancement (ARC-COPE) aimed at staff responsible for developing preparedness or crisis plans and analysing past events.



Agile Response Capability approach: ARC-MEX and ARC-COPE using the ARC methodology. FSS WP5.4 © FOI, 2018

Rogier Woltjer (rogier.woltjer@foi.se), Björn J.E. Johansson, Per-Anders Oskarsson, and Peter Svenmarck, FOI, and Barry Kirwan, EUROCONTROL together with WP5.4 partners

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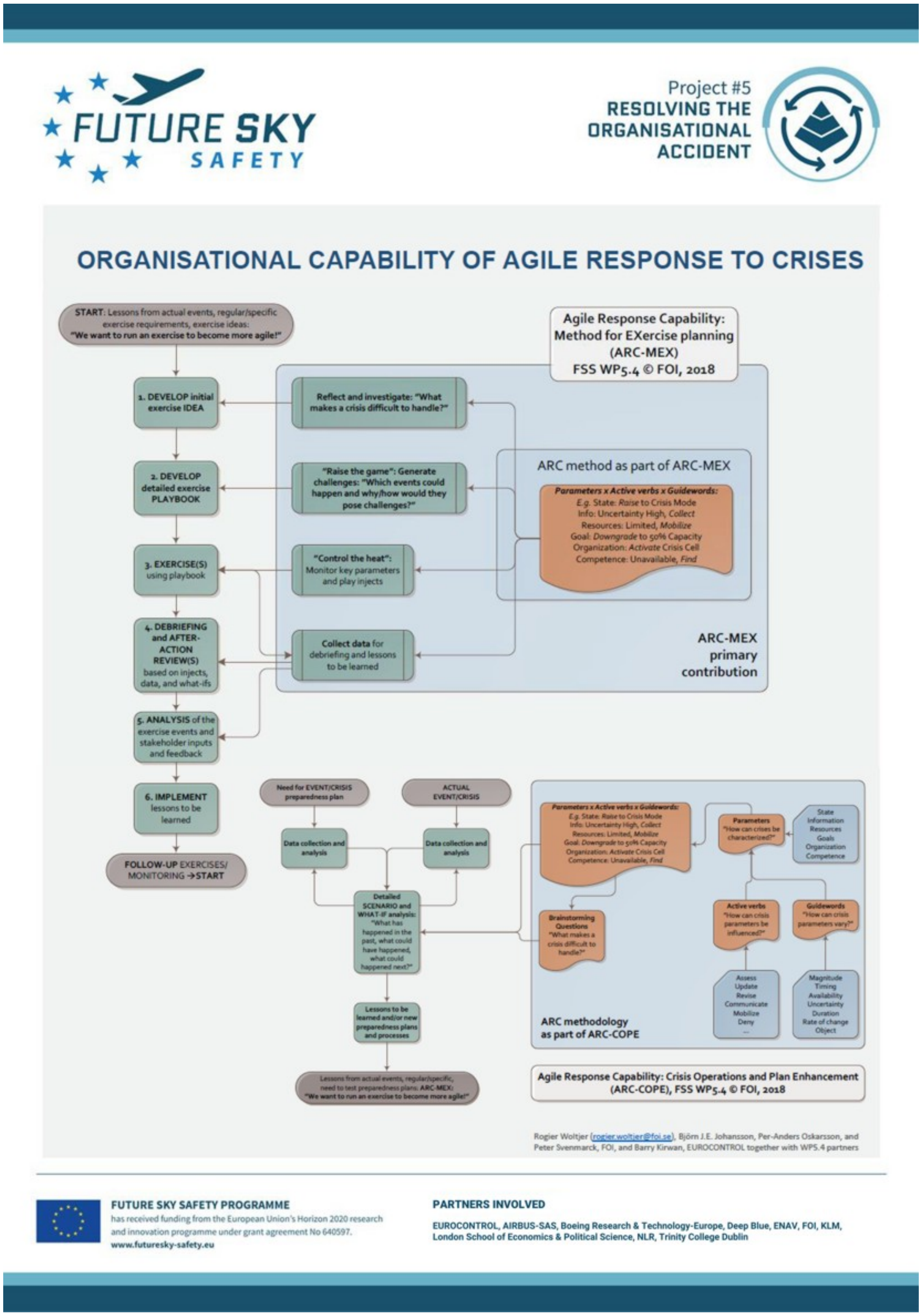
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Project #5
RESOLVING THE ORGANISATIONAL ACCIDENT
ORGANISATIONAL CAPABILITY OF AGILE RESPONSE TO CRISES
START: Lessons from actual events, regular/specific exercise requirements, exercise ideas: "We want to run an exercise to become more agile!"
Agile Response Capability: Method for EXercise planning (ARC-MEX) FSS WP5.4 © FOI, 2018
1. DEVELOP initial exercise IDEA
Reflect and investigate: "What makes a crisis difficult to handle?"
2. DEVELOP detailed exercise PLAYBOOK
"Raise the game": Generate challenges: "Which events could happen and why/how would they pose challenges?"
ARC method as part of ARC-MEX
Parameters x Active verbs x Guidewords:
E.g. State: Raise to Crisis Mode
Info: Uncertainty High, Collect
Resources: Limited, Mobilize
Goal: Downgrade to 50% Capacity
Organization: Activate Crisis Cell
Competence: Unavailable, Find
3. EXERCISE(S) using playbook
"Control the heat": Monitor key parameters and play injects
4. DEBRIEFING and AFTER-ACTION REVIEW(S) based on injects, data, and what-ifs
Collect data for debriefing and lessons to be learned
ARC-MEX primary contribution
5. ANALYSIS of the exercise events and stakeholder inputs and feedback
6. IMPLEMENT lessons to be learned
FOLLOW-UP EXERCISES/ MONITORING →START
Need for EVENT/CRISIS preparedness plan
ACTUAL EVENT/CRISIS
Data collection and analysis
Data collection and analysis
Detailed SCENARIO and WHAT-IF analysis: "What has happened in the past, what could have happened, what could happened next?"
Lessons to be learned and/or new preparedness plans and processes
Lessons from actual events, regular/specific, need to test preparedness plans: ARC-MEX: "We want to run an exercise to become more agile!"
Parameters x Active verbs x Guidewords:
E.g. State: Raise to Crisis Mode
Info: Uncertainty High, Collect
Resources: Limited, Mobilize
Goal: Downgrade to 50% Capacity
Organization: Activate Crisis Cell
Competence: Unavailable, Find
Parameters "How can crises be characterized?"
State Information Resources Goals Organization Competence
Brainstorming Questions "What makes a crisis difficult to handle?"
Active verbs "How can crisis parameters be influenced?"
Guidewords "How can crisis parameters vary?"
Assess Update Revise Communicate Mobilize Deny ...
Magnitude Timing Availability Uncertainty Duration Rate of change Object
ARC methodology as part of ARC-COPE
Agile Response Capability: Crisis Operations and Plan Enhancement (ARC-COPE), FSS WP5.4 © FOI, 2018
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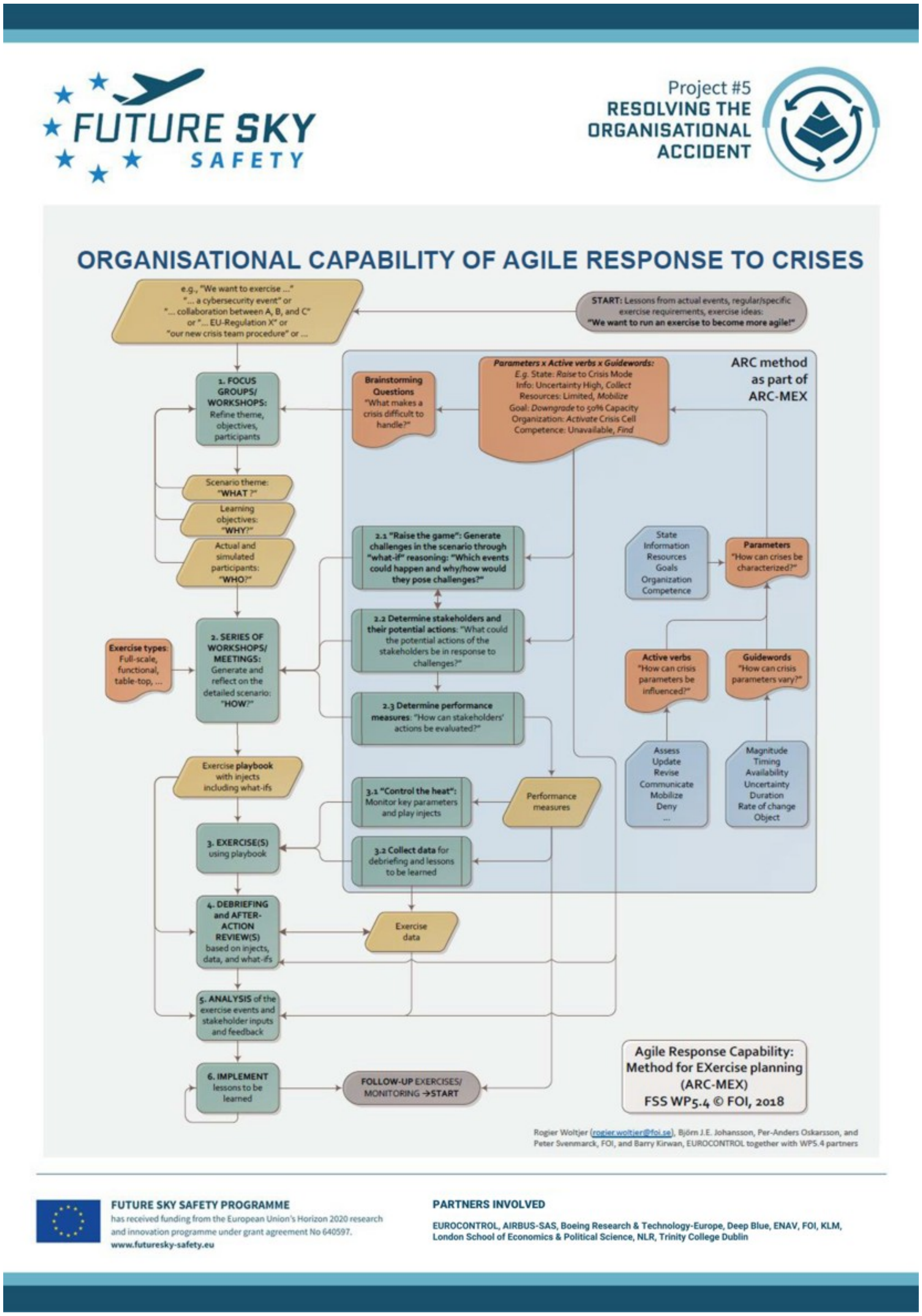
FUTURE SKY SAFETY
Project #5
RESOLVING THE ORGANISATIONAL ACCIDENT
ORGANISATIONAL CAPABILITY OF AGILE RESPONSE TO CRISES
e.g., "We want to exercise ..." "... a cybersecurity event" or "... collaboration between A, B, and C" or "... EU-Regulation X" or "our new crisis team procedure" or ...
START: Lessons from actual events, regular/specific exercise requirements, exercise ideas: "We want to run an exercise to become more agile!"
ARC method as part of ARC-MEX
1. FOCUS GROUPS/ WORKSHOPS: Refine theme, objectives, participants
Brainstorming Questions "What makes a crisis difficult to handle?"
Parameters x Active verbs x Guidewords:
E.g. State: Raise to Crisis Mode
Info: Uncertainty High, Collect
Resources: Limited, Mobilize
Goal: Downgrade to 50% Capacity
Organization: Activate Crisis Cell
Competence: Unavailable, Find
Scenario theme: "WHAT ?"
Learning objectives: "WHY?"
Actual and simulated participants: "WHO?"
2.1 "Raise the game": Generate challenges in the scenario through "what-if" reasoning: "Which events could happen and why/how would they pose challenges?"
State Information Resources Goals Organization Competence
Parameters "How can crises be characterized?"
2.2 Determine stakeholders and their potential actions: "What could the potential actions of the stakeholders be in response to challenges?"
Exercise types: Full-scale, functional, table-top, ...
2. SERIES OF WORKSHOPS/ MEETINGS: Generate and reflect on the detailed scenario: "HOW?"
Active verbs "How can crisis parameters be influenced?"
Guidewords "How can crisis parameters vary?"
2.3 Determine performance measures: "How can stakeholders' actions be evaluated?"
Exercise playbook with injects including what-ifs
Assess Update Revise Communicate Mobilize Deny ...
Magnitude Timing Availability Uncertainty Duration Rate of change Object
3.1 "Control the heat": Monitor key parameters and play injects
Performance measures
3. EXERCISE(S) using playbook
3.2 Collect data for debriefing and lessons to be learned
4. DEBRIEFING and AFTER-ACTION REVIEW(S) based on injects, data, and what-ifs
Exercise data
5. ANALYSIS of the exercise events and stakeholder inputs and feedback
6. IMPLEMENT lessons to be learned
FOLLOW-UP EXERCISES/ MONITORING →START
Agile Response Capability: Method for EXercise planning (ARC-MEX)
FSS WP5.4 © FOI, 2018
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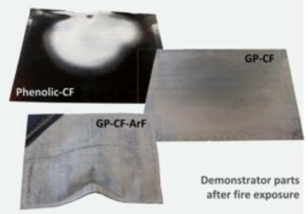
Appendix C.9 "P7: Improved material solutions to mitigate fire, smokes and fumes"

Project #7
MITIGATING THE RISK OF FIRE SMOKE & FUMES

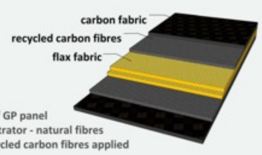
Improved material solutions to mitigate fire, smokes and fumes

Geopolymers (GP) – inorganic aluminosilicate polymers

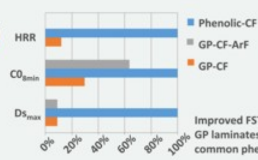
- Low temperature processing
- Very high temperature stability
- Significantly improved FST behavior
- Very good residual integrity of GP fibre composites after fire exposure
- Investigated GP composite systems:
  - Monolithic & sandwich structures incl. GP-foam
  - Carbon fibre reinforcements, recycled carbon fibres (rCF)
  - Natural fibre reinforcements (flax fibres)
  - Hybrid GP/phenol composite systems



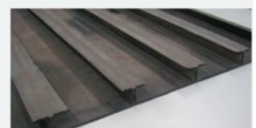
Demonstrator parts after fire exposure



Layup of GP panel demonstrator - natural fibres and recycled carbon fibres applied



Improved FST behavior of GP laminates compared to common phenolic laminates

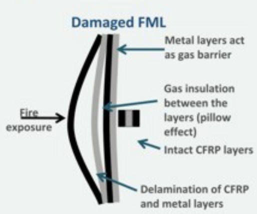


Carbon fibre GP composite structure after fire exposure

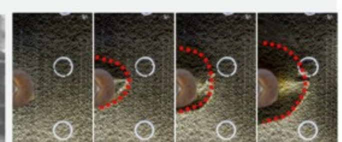
Fibre Metal laminates (FML) – CFRP laminates reinforced by metal layers

- Steel layers do not melt and act as gas barrier
- Trapped decomposition act as thermal insulation (pillow effect)
- Significantly improved FST behavior
- Prolonged mechanical performance within a fire scenario, generated by intact back side layers

Demonstrator parts after fire exposure



FML test in the CuFEx facitlity



Increasing size of insulating gas pillow wrt to fire exposure duration

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PARTNERS INVOLVED

LEONARDO AIRCRAFT · DLR

Appendix C.10 "P7: Mitigating risk of fire, smoke and fumes"

Project #7
MITIGATING
THE RISK OF FIRE
SMOKE & FUMES

MITIGATING RISK OF FIRE SMOKE AND FUMES

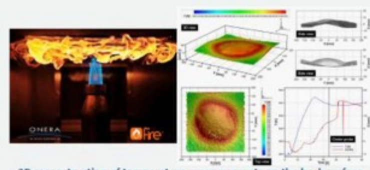
Understanding and characterizing the fire behaviour of primary structures composite materials

Production of a comprehensive experimental database on a reference composite material (T700GC/M21)

- D7.4 Primary structure materials – Test Results (first batch), 2016
- D7.7 Primary structure materials – Test results (2nd batch), 2017

Confrontation of experimental results to state-of-the-art models and simulation tools

- D7.9 Primary structures materials - Models for fire behavior, 2017



3D reconstruction of temperature measurements on the back surface of a composite laminate exposed to fire (FIRE facility @ONERA)

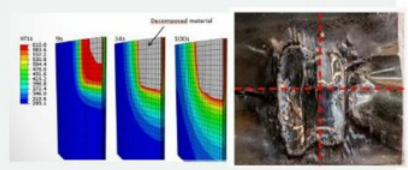
Development and assessment of new material solutions that mitigate risk of fire, smoke and fumes in the cabin environment

Development and characterization of new materials and their combinations for improved fire behaviour of interior and structural materials.

- D7.5 New materials for fire protection in cabin environment – Test results first batch, 2016
- D7.8 New materials for fire protection in cabin environment – Test results second batch, 2018

Modelling of material degradation with respect to fire, fumes and smoke risks in the cabin environment.

- D7.10 Materials for cabin environment protection - Models for material degradation , 2018



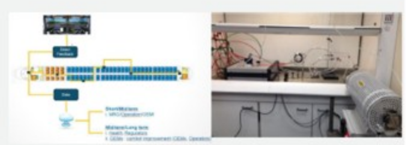
Example of ...

Cabin air quality: using new technological opportunities to address the growing interest in complex issues (comfort, health, safety)

Industrial cabin air quality Framework based on Continuous Air quality Sensing (IFCAS): feasible pathway to novel applications

Real-time experimental methodology of air quality at normal or elevated temperatures, for new material investigation and COTS sensor testing

- D7.6 On-board air quality: Literature review and methodological survey, 2016
- D7.14 On-board air quality – Final report on the effect of new materials, 2018



Left: IFCAS concept architecture (cabin/cockpit pictures Embraer)

Right: Experimental characterisation of gas emissions at elevated temperatures in real-time using commercial gas sensors and thermal desorption tubes

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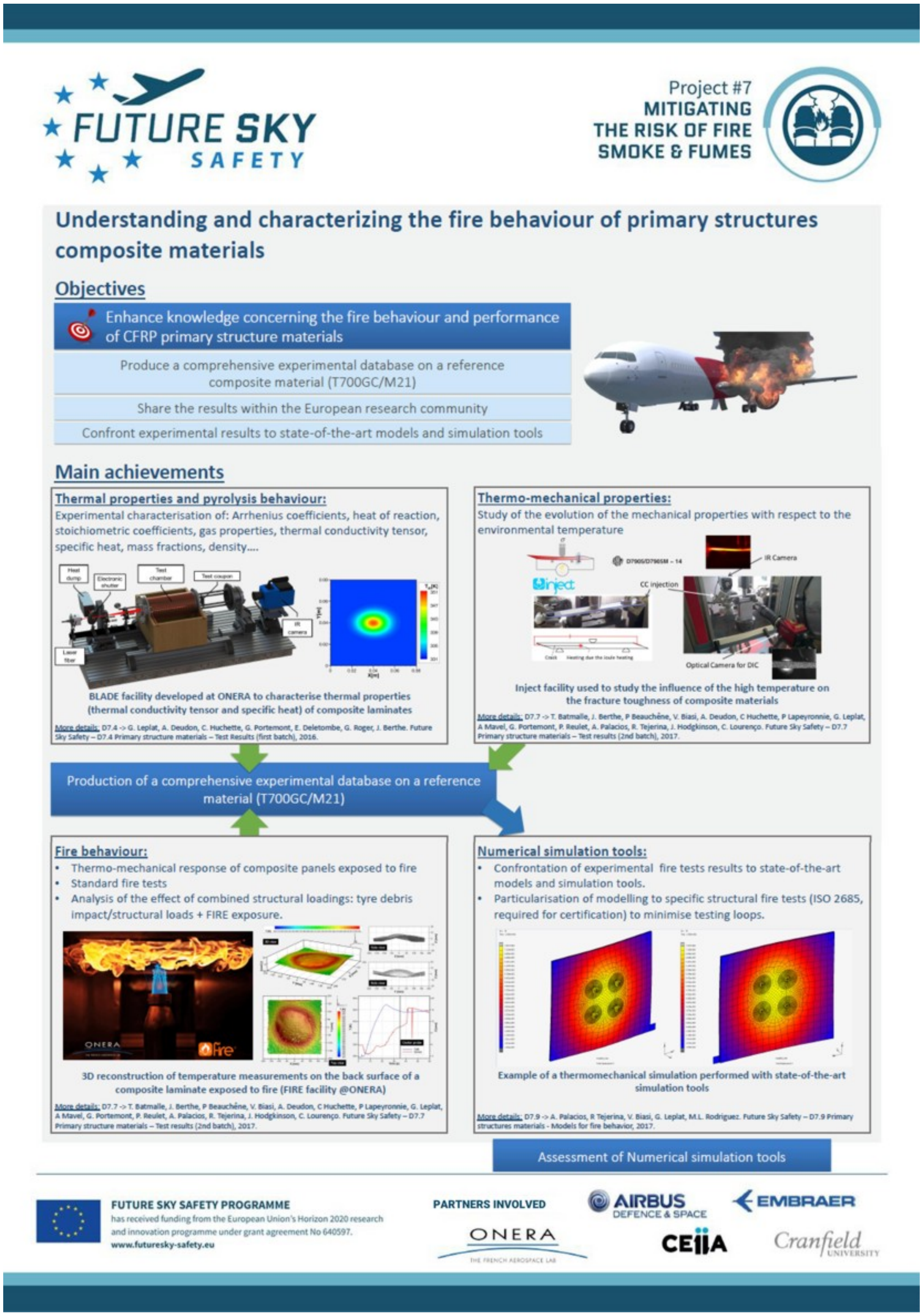
Appendix C.11 "P7: Understanding and characterizing the fire behaviour of primary structures composite materials"



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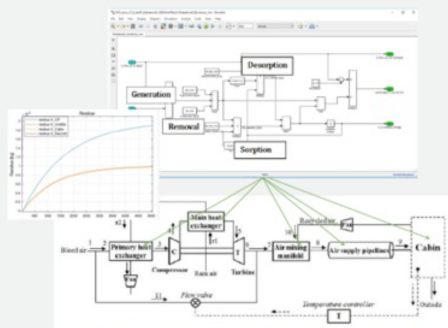
Appendix C.12 "P7: Cabin air quality"

Project #7
MITIGATING THE RISK OF FIRE SMOKE & FUMES

CABIN AIR QUALITY

New aircraft architectures and technology developments - such as new materials, filters and electronics miniaturisation - provide an opportunity for reviewing and enhancing cabin air quality.

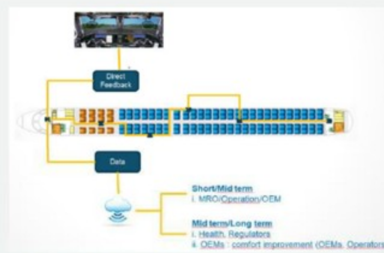
In line with the globally increasing awareness of air quality, there is a growing interest to address complex cabin air quality issues (comfort, health, safety). In this context, the main achievements are:



Cabin air quality building block for aircraft environmental control system (ECS) model. ECS schematic from [1]. Verification of the integration of the building block.

Industrial cabin air quality Framework based on Continuous Air quality Sensing (IFCAS) proposed:

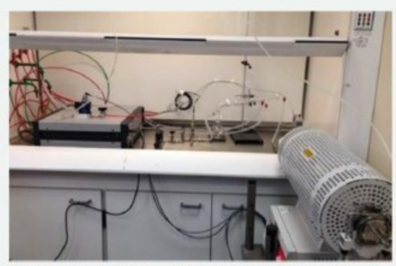
- Feasible pathway to address complex cabin air quality issues
- Well-placed network of distributed low power, low weight sensors across the cabin
- IFCAS data for different time-horizons:
  - Prognostic and condition-based health management
  - Evidence-based answers to concerns
  - Improve comfort and better design the air



IFCAS concept architecture (cabin/cockpit pictures Embraer)

Real-time experimental methodology of air quality at normal or elevated temperatures developed for:

- New materials investigation
- COTS sensors testing



Experimental apparatus for characterisation of gas emissions at elevated temperatures in real-time using commercial gas sensors and thermal desorption tubes

Recommendations for:

- Cabin air quality assessment guidelines
- IFCAS maturation with wider stakeholder involvement

[1] H. Yin et al., "Modeling dynamic responses of aircraft environmental control systems by coupling with cabin thermal environment simulations," Build. Simul., vol. 9, no. 4, pp. 459–468, 2016

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Appendix D Photos

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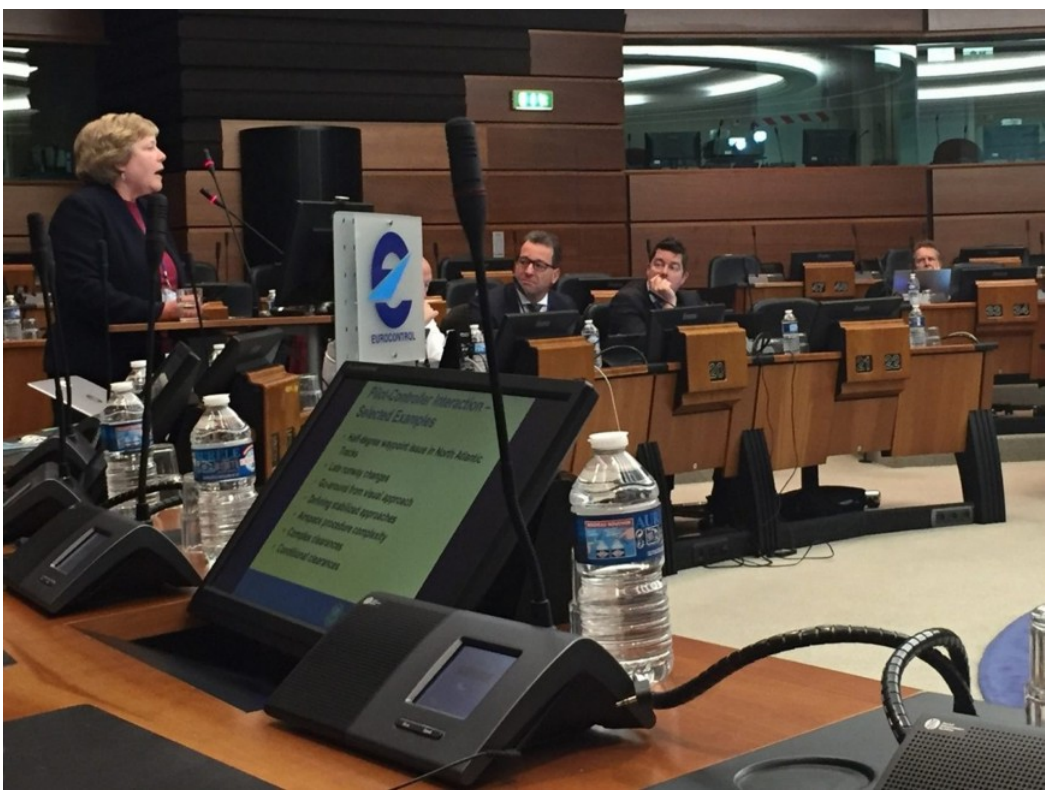

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Factors – Complexity of
light Procedures (IFPs)
Operator Factors
• Independence vs. dependence on Dispatch
• Clarity and consistency of PF/PM roles in reviewing IFPs
Environment Factors
• Terrain
• Traffic
• Weather (Wind or IMC)
• Prohibited airspace