Automation and Safety Forum
02, 03 June 2015
Brussels:

Findings and Conclusions

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CONTENTS

Executive Summary

An Automation and Safety Forum initiated by the Flight Safety Foundation, The European Regions Airline Association and EUROCONTROL, took place on 02 and 03 of June 2015 at EUROCONTROL Brussels. The report is an event summary, similar to minutes of a meeting, and reflects what was presented during the Forum.

The Forum targeted operational and safety professionals, and had a clear focus on the safety aspects of automation in both flight operations and air traffic management domains. The aim of the Forum was to identify considerations for regulators, aircraft operators, air navigation service providers, aircraft manufacturers, training providers and equipment manufacturers and to develop awareness material that would be of relevance for future regulation, aircraft design, ATM system design, and which could be incorporated into training regimes and daily operational practices.

The Forum results were summarised in a series of findings and conclusions, grouped according to their predominant relevance to flight operations or ATM. The Forum agreed on 19 flight operations findings and conclusions, 24 ATM findings and 19 ATM conclusions.

Key findings and conclusions from the Forum included:

- ❑ Pilots must be competent and confident in the management of the operational safety of their aeroplane throughout the various levels and combinations of availability of automated systems during both automation-assisted and manual flight path management.
- ❑ Advanced technology designed to reduce workload and improve situation awareness has created new challenges, notably complacency, automation dependency and lack of understanding.
- ❑ Expertise in the use of automated systems requires practicing ‘soft’ skills like task/workload management, situation awareness, problem solving and decision making.
- ❑ Experience measured in flying hours does not equal expertise and it is believed that the nature of long haul flying and the reserve system at many airlines reduces pilots' exposure to flight path management in general and manual flying in particular.
- ❑ Systems knowledge and procedures can be trained relatively inexpensively by effective use of CBT and maximising the use of CBT and FBS for learning so that more FFS time can be used for manual flight operations may lead to improved performance and reduced cost.
- ❑ Many opportunities for 'quick wins' in the enhancement of pilot competency are not accessible to small operators because of either or both their scale and their fluctuating and marginal financial state.
- ❑ The potential benefits of Automation in ATM are many and can include: a) increased safety, b) increased consistency and reliability of service, c) increased interconnectivity between sectors, units, service providers, controllers / pilots, d) increased resilience of operation, e) reduced environmental impact and f) reduced cost.
- ❑ There are a number of potential pitfalls associated with automation in ATM that need careful consideration to ensure that it is implemented and used safely: a) system considerations, b) the role of the Controller and Engineer, c) design, d) in-service operations, e) learning, f) safety accountability / safety assurance and g) degradation / fallbacks / contingency.
- ❑ There is room for improvement in the way the automated systems’ aspects of safety events are captured at all levels of occurrence severity.

Chapter 1 Introduction

1.1 What is the purpose of this report?

Documenting and communicating.

This report describes the background, objectives, and outcomes of the Automation and Safety Forum, initiated by the Flight Safety Foundation, The European Regions Airline Association and EUROCONTROL. The report is an event summary, similar to minutes of a meeting, and reflects what was presented during the Forum.

The Forum took place on 02 and 03 of June 2015 in EUROCONTROL Brussels and was held thanks to the partnership, briefings and proceedings support from Airbus, Boeing, Bombardier, DFS, Emirates Airline, FAA, IATA, NATS, NAV Portugal, NLR, LVNL, UKFSC, UK AAIB, UK CAA, Thomas Cook Airlines.

1.2 How to use this report?

Reviewing and integrating in local or regional activity.

The report is not an overall risk management process but a small element to be considered and taken on board by others. This report is intended to be reviewed by the aviation actors to inform their related safety ongoing or new initiatives. Some actions are already been taken in some regions and by some organisations whereas others are less developed.

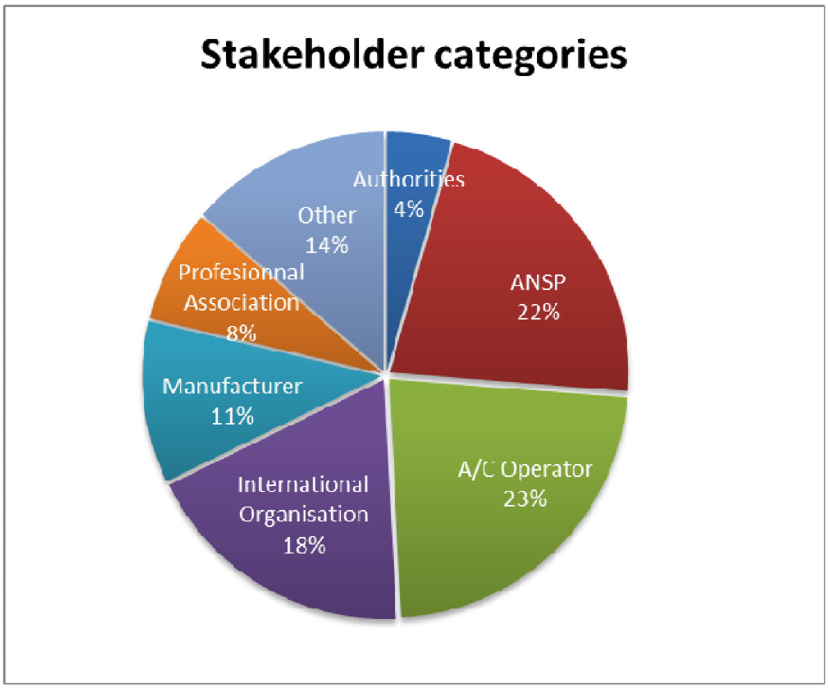
1.3 The objectives of the Automation and Safety Forum

One Day, One Issue, One Co-ordinated Outcome Event.

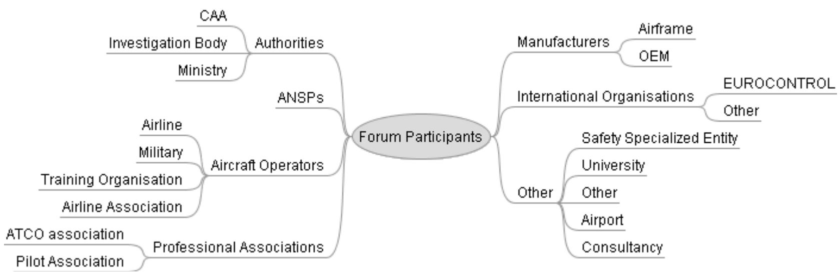
The Automation and Safety Forum targeted operational and safety professionals with the intention to hold a one-day event (spread over two half days), with a clear focus on automation safety aspects and to result in the creation of an event report and supporting awareness material.

1.4 Participants

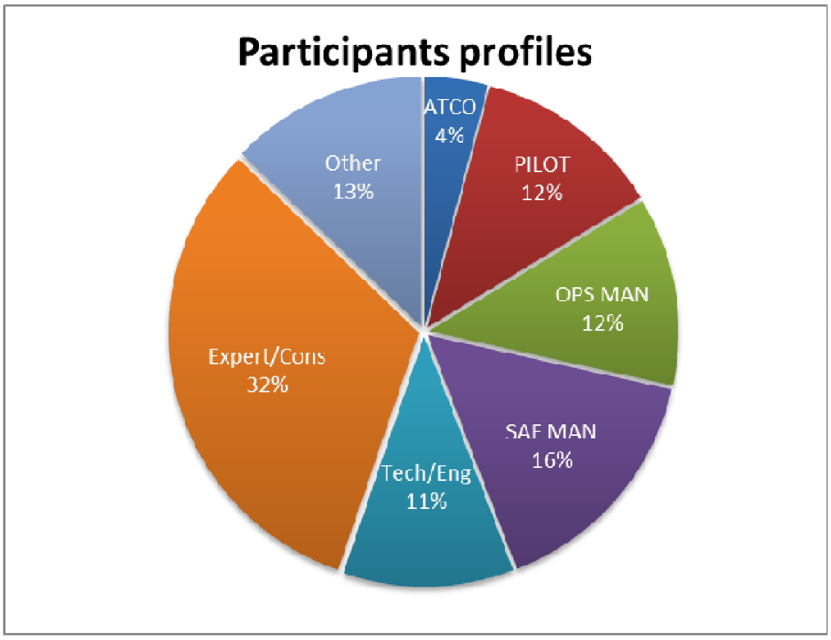
The Automation and Safety Forum attracted attention of 251 aviation professionals representing various stakeholders.



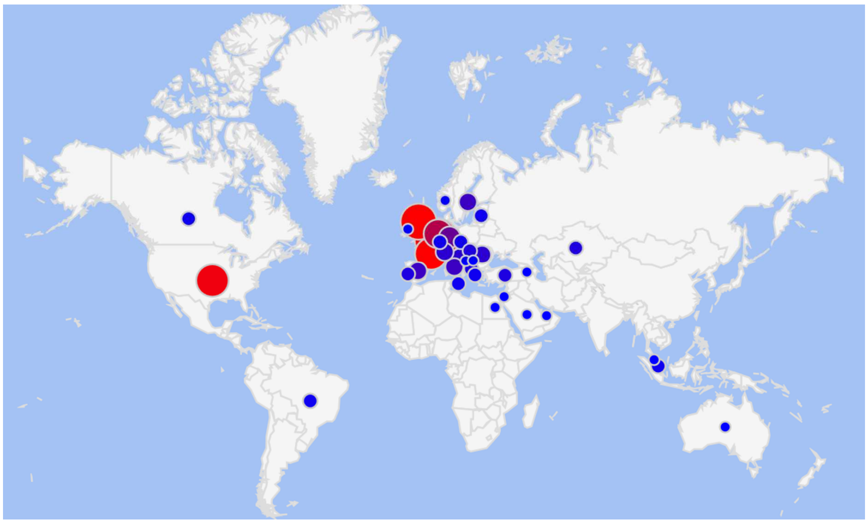
The above categories can be broken down with the following tree.



The profile of the audience is described by the following chart, where "Other" category includes mostly general managers, university lecturers and researchers.



Participants to the Automation and Safety Forum came from all over the world.



1.5 Outline of the Forum results

Findings and Conclusions

The Forum results were summarised in a series of Findings and Conclusion. These Findings and Conclusions were grouped into two groups according to their predominant relevance for a particular audience and referred as Flight Operations or ATM.

Chapter 2
Flight Operations Findings

REF	FINDINGS
FOPS1	***a) Pilots must be competent and confident in the management of the operational safety of their aeroplane throughout the various levels and combinations of availability of automated systems during both automation-assisted and manual flight path management.*** ***b) Advanced technology designed to reduce workload and improve situation awareness has created new challenges, notably complacency, automation dependency and lack of understanding.*** ***c) Expertise in the use of automated systems requires practicing 'soft' skills like task/workload management, situation awareness, problem solving and decision making.*** ***d) Experience measured in flying hours does not equal expertise and it is believed that the nature of long haul flying and the reserve system at many airlines reduces pilots' exposure to flight path management in general and manual flying in particular.***
FOPS2	***a) There has been a change in pilot tasks, roles and cognitive demand.*** ***b) Lack of practice leads to strong degradation in the ability to recall procedures, remember completed steps, visualise aircraft position or recognise abnormal situations, whereas instrument scanning and aircraft control skills may be less affected.*** ***c) The ability of pilots to effectively respond to unexpected circumstances, however***

	they arise, is reduced by both the increasingly wide scope and the increasingly reliable nature of automated systems, coupled with training requirements which have not been adapted to today's operational reality. ***d) Pilot training has not paralleled technological advancement and training programs are continually under pressure to reduce cost.*** ***e) Training must shift the focus from learning procedural steps to understanding aircraft performance in different configurations and improved mental models of systems.*** ***f) Pilot training effectiveness may also be enhanced by accommodating how individuals learn and fully taking into account the operational complexity of aeroplane systems.***
FOPS3	***a) The recovery of an aeroplane from unusual or unexpected situations does not appear to be predicated on the minimum regulatory assessment of a pilot's fitness to fly but rather on their relevant training and sufficient recent experience of flying with less than normal levels of automation especially in un-briefed circumstances.*** ***b) Training helps - exposure to challenging scenarios improves flight crew knowledge and skills.*** ***c) Experience of managing an automated aeroplane in normal operations not necessarily increase knowledge of the aeroplane nor improve performance when the unexpected occurs.*** ***d) Whilst there may be opportunities to practice manual flight within the constraints of airline automation policy, the benefit of this has not been subject to any general evaluation.***
FOPS4	***a) The current format and content of the skill test for initial issue or renewal of an aeroplane type rating does not require a sufficient demonstration of the knowledge, skills and attitudes necessary to safely operate highly automated aircraft. It also includes items which are no longer appropriate.***
FOPS5	***a) The competency approach to training appears to be effective in ensuring that pilots acquire and maintain generic skills and behaviours which will remain effective across all levels of automated system availability including those where manual flight path control is used.*** ***b) Evidence Based Training may be able to positively influence pilots' response to envisaged abnormal situations and there is a need to train competencies rather than manoeuvres.*** ***c) At present, promotion and career prospects generally are commonly linked to experience/seniority rather than to competency.***
FOPS6	***a) Long term use of automated flight path control and inability of pilots to easily revert to a lower level of control sometimes manifests itself in inappropriate initial responses to this and an inability to respond to the resultant increase in cognitive workload.*** ***b) The need for pilot flexibility and resilience to circumstances was recognised.***
FOPS7	***a) Pilot selection on the basis of aptitude and personal motivation to manage both normally high and infrequently low levels and combinations of automated systems is important.*** ***b) Pilots must have the capacity to ask what could go wrong and rehearse for the event in training and they need to be motivated to engage in deliberate practice, to engage in self-learning and to learn from others.***

FOPS8	***a) As older pilots with significant early career experience of manual flying and reduced levels of automation on larger jet types reach retirement and many more new pilots enter automated flight decks immediately they gain their licences and stay there until and after promotion to command, the prospect of operational safety consequences arising indirectly from the increasing prevalence of automated systems may increase.***
FOPS9	***a) The increasingly prescriptive approach to aeroplane operation has resulted in a loss of the necessary ad hoc decision making skills which pilots may need in situations such as loss of full automation or temporary confusion about the status of automated systems***
FOPS10	***a) The relationship between monitoring and the challenges of operating highly automated systems is insufficiently understood and monitoring could be more effective if its capabilities and limitations were taken into account earlier in the development of such systems and their operating procedures. It is recognised that everybody on the flight deck should be monitoring and that monitoring is a competency that must be trained.***
FOPS11	***a) Flight Envelope Protection is less effective at reduced levels of automation than during normal use of automation but remains equally relevant in those circumstances.***
FOPS12	***a) It is likely that the complexity of aeroplanes will continue to increase.*** ***b) The rapid growth in automated systems has led to some flight decks becoming unnecessarily complex with more operational choices being offered than is really necessary and, in some cases, a less-than-optimum design of individual components in terms of their contribution to the automated 'whole'.***
FOPS13	***a) The potential for positive effects, availability and future opportunities to be gained from automated systems can sometimes be constrained by common type ratings which link aircraft of different 'generations'***
FOPS14	***a) There is room for improvement in the way the automated systems' aspects of safety events are captured at all levels of occurrence severity.*** ***b) The identification of relative risk in the utilisation of such data is critical if its value is to be maximised.*** ***c) All feedback on instances of mismanagement, failure or anomalies in automated systems during routine flight is an opportunity for safety improvement provided that there is awareness of their occurrence and the circumstances are known and understood.*** ***d) Safety issues related to automation are often both subtle and difficult to observe and/or understand in real time and so can be difficult to report accurately. The analysis of flight data from events which have involved automated systems management must include the flight crew perspective.*** ***e) Exchanging best practices in the use of flight data monitoring to detect automation issues is beneficial.*** ***f) The relationship between automated systems-related events and their potential contribution to particular accident scenarios is not always clear and data analysis can be usefully structured in terms of the main accident types.***
FOPS15	***a) It is important that automated systems are not considered only in terms of flight path management and that a holistic perspective across all automated systems is necessary in order to achieve the right balance and decisions.***

FOPS16	***a)***	***There is a need for the industry to have a common understanding of various terms routinely used when referring to automated systems on aeroplanes. Such terms include Automation, Automated Systems, Manual Flight, Reversion, Automation complexity (as seen by users), Automation design complexity and Operational Complexity.***
FOPS17	***a)***	***Understanding modes, systems and technology is always critical for safe management of complex aeroplanes, especially when the unexpected occurs.***
	b)	***There is a need to change the focus of training programmes and the way training devices are used.***
	c)	***Systems knowledge and procedures can be trained relatively inexpensively by effective use of CBT and maximising the use of CBT and FBS for learning so that more FFS time can be used for manual flight operations may lead to improved performance and reduced cost.***
	d)	***There is also unrealised potential for simple and therefore low cost desktop training solutions to make an important contribution to continued competency.***
FOPS18	***a)***	***Many opportunities for 'quick wins' in the enhancement of pilot competency are not accessible to small operators because of either or both their scale and their fluctuating and marginal financial state.***
FOPS19	***a)***	***There is a benefit in basing operational policy on flight path management rather than focussing on automation management.***

Chapter 3
Air Traffic Management Findings and Conclusions

3.1 ATM General Findings

REF	FINDINGS
ATMF1	a) The controller is in control of the traffic, it is they who hold the ATC licence. b) Automation in ATM is not new. There is already lots of automation being used e.g. radar, electronic flight progress strips, short term conflict alert, code callsign conversion, datalink etc. c) Automation assists the controller in doing their job safely, effectively and efficiently. d) Automation can be thought of as being “assistive technology” or an “electronic team member” that supports the controller. e) Automation is moving beyond provision of information to provision of advice and ultimately of control (if we let it).
ATMF2	a) People create safety. They must be conscious of the safety critical decisions that are being made. b) People use their experience, knowledge, training and intuition to detect cues and subtle changes, to diagnose problems, to adapt, and to create innovative ways to solve problems.

	c) Automation can quickly and consistently process large quantities of data but can cause the system to become "brittle" when faced with novel situations. ***d) Automation must service the needs of the controller, not the other way around.*** ***e) Understanding the current system allows automation to be implemented and used appropriately.***
ATMF3	***The potential benefits of Automation in ATM are many and can include:*** ***a) Increased safety.*** ***b) Increased consistency and reliability of service.*** ***c) Increased interconnectivity between sectors, units, service providers, controllers / pilots.*** ***d) Increased resilience of operation.*** ***e) Reduced environmental impact.*** ***f) Reduced cost.***
ATMF4	***There are a number of potential pitfalls associated with automation in ATM that need careful consideration to ensure that it is implemented and used safely:*** ***a) System Considerations.*** ***b) The Role of the Controller and Engineer.*** ***c) Design.*** ***d) In-service Operations*** ***e) Learning.*** ***f) Safety Accountability / Safety Assurance.*** ***g) Degradation / Fallbacks / Contingency.***

3.2 ATM related findings and conclusions - System Considerations

REF	FINDINGS
ATMF5	❑ ***Automation must fit with the overall ATM architecture; new concepts may be required.***
ATMF6	❑ ***Increased automation is resulting in more integration across the ATM system e.g. sector – sector, unit - unit, ANSP – ANSP etc.***
ATMF7	❑ ***Increased automation is resulting in more integration across the aviation industry e.g. controller – pilot, ATM – aircraft, ATM - airport operator etc.***
ATMF8	❑ ***System performance should be monitored***

REF	CONCLUSIONS
ATMC1	❑ ***There is a need to understand and manage the interdependencies across the total aviation system e.g. the output from one automated function can be the input to a different function.***

3.3 ATM related findings and conclusions - The Role of the Controller and Engineer

REF	FINDINGS
ATMF9	❑ ***Increased automation could assist the controller and engineer to do their job more safely, effectively and efficiently, but it could also change their role.***
ATMF10	❑ ***There will be more emphasis on planning and less emphasis on conflict detection and tactical resolution.***
ATMF11	❑ ***The satisfaction that the controller will get from their role will be different.***
ATMF12	❑ ***The controller needs to be kept engaged to be able to maintain a sufficient level of situation awareness.***
ATMF13	❑ ***Controllers will not be de-skilled by automation, they will be re-skilled to be able to use it appropriately.***

REF	CONCLUSIONS
ATMC2	❑ ***For the foreseeable future, the controller will remain in control. Automation must be designed, implemented, operated and assured such that it supports the role that the controller and engineer are undertaking.***
ATMC3	❑ ***Recruitment, selection and training need to be appropriate for the new role of the controller and engineer.***
ATMC4	❑ ***Automation design should minimise any reliance on the human as a monitor.***

3.4 ATM related findings and conclusions – Design

REF	FINDINGS
ATMF14	❑ ***Automation should be implemented in support of the objective to be achieved and the role to be undertaken, not based on the availability of technology.***
ATMF15	❑ ***The automation should be designed around the user.***
ATMF16	❑ ***Much of the complexity of automation is hidden from the user and this provides new opportunities for design induced error.***
ATMF17	❑ ***The way in which the automation is actually used can be very different from the way in which it was designed to be used.***

REF	CONCLUSIONS
ATMC5	❑ ***Users should be involved throughout the development lifecycle of design, build and operation.***
ATMC6	❑ ***Failure modes should be considered in the design.***
ATMC7	❑ ***In service monitoring should be used to determine how the automation is actually being used and whether this is in accordance with the safety case***

3.5 ATM related findings and conclusions – In-service Operations

REF	FINDINGS
ATMF18	❑ ***People adapt and find new ways of working with the automation.***

REF	CONCLUSIONS
ATMC8	❑ ***The way in which the automation is actually used can be very different from the way in which it was designed to be used.***
ATMC9	❑ ***There is a need to monitor performance variability.***
ATMC10	❑ ***The design of the automation is unfinished.***

3.6 ATM related findings and conclusions - Learning

REF	FINDINGS
ATMF19	❑ ***Controllers need to understand the strengths and weaknesses of the automaton that they are using.***
ATMF20	❑ ***Controllers need to understand what the automation is doing and why it is doing it.***
ATMF21	❑ ***Automation does not degrade skills – but a lack of practicing those skills does.***

REF	CONCLUSIONS
ATMC11	❑ ***Automation requires more (and different) learning for controllers and engineers.***
ATMC12	❑ ***ATM can learn a lot from the cockpit***

3.7 ATM related findings and conclusions - Safety Accountability / Safety Assurance

REF	FINDINGS
ATMF22	❑ ***People are and will continue to be accountable for safety.***
ATMF23	❑ ***With increased automation, there will be increased responsibilities on designers, software writers, testers, maintainers etc to provide safety assurance.***

REF	CONCLUSIONS
ATMC13	❑ ***Automation must be assured to a level that allows users to rely on it.***
ATMC14	❑ ***Safety assurance must consider not just how the automation will be used, but also how it is designed and developed.***
ATMC15	❑ ***ATM needs to learn from the flight deck.***
ATMC16	❑ ***Safety cases should be revisited to account for actual usage.***
ATMC17	❑ ***All parties should be involved early and throughout.***

3.8 ATM related findings and conclusions - Degradation / Fallbacks / Contingency

REF	FINDINGS
ATMF24	***At some point, the automation will degrade / fail / have a credible corruption:*** ❑ ***There must be operational resilience in terms of redundancy and fallbacks.*** ❑ ***The controller must be aware of the operational status of the automation.*** ❑ ***Procedures must be in place to deal with automation degradation / failure.*** ❑ ***The controller must be able to continue to control safety following a degradation / failure.***

REF	CONCLUSIONS
ATMC18	❑ ***The design and operation of the automation must be resilient to degradation / failure.***
ATMC19	❑ ***There is a need to distinguish between safety risk and business risk.***