TWELFTH AIR NAVIGATION CONFERENCE

Montréal, 19 to 30 November 2012

Agenda Item 6: Future direction
6.1: Standardization – approach to SARPs development in support of One Sky

DEVELOPMENT OF AN AVIATION AUTOMATION POLICY

(Presented by the Presidency of the European Union on behalf of the European Union and its Member States[1]; by the other Member States of the European Civil Aviation Conference[2]; and by the Member States of EUROCONTROL)

SUMMARY

An aviation system automation policy is needed, in order to create a common framework for the performance of requirement engineering, standardization, system deployment and continuous safety monitoring activities.

Action: The Conference is invited to agree to the recommendation in paragraph 6.

1. INTRODUCTION

1.1 This paper calls for the development of an aviation automation policy. This will create a common framework for the performance of requirement engineering, safety and human factors assessment, standardization, system deployment and continuous safety monitoring activities.

1.2 Modern aircraft operations, whether commercially operated or not, and air traffic management (ATM), are increasingly reliant on automation for safe, regular and efficient operations. Automation will become even more important in tomorrow's aviation system, for instance under the SESAR and NextGen programmes in Europe and the United States.

1.3 A new collaboration model for aviation and ATM stakeholders is to be introduced in order to efficiently "navigate the skies". It will inevitably involve the exchange of large amounts of information, for which "automation" is a pre-requisite and may imply the full delegation of certain tasks to the automated system.

[1] Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxemburg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and United Kingdom. All these 27 States are also Members of ECAC.

[2] Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Croatia, Georgia, Iceland, Moldova, Monaco, Montenegro, Norway, San Marino, Serbia, Switzerland, The former Yugoslav Republic of Macedonia, Turkey and Ukraine.

1.4 Automation has contributed to the safety improvements that aviation has enjoyed over the past decades, making it the safest means of transportation. Other advantages include technical reliability: computer technology is more reliable than mechanical technology, is light and less expensive.

1.5 Analysis of accidents and serious incidents, however, often points to incorrect interaction with automation as a contributing factor. Interacting with automated systems presents certain complexities that need to be accommodated in the design, and complemented by appropriate training and procedures.

1.6 The new risks arising from the changes in ATM working processes and supporting technologies being designed to respond to the challenges for air transport capacity, efficiency and safety performances have to be addressed by appropriate policies and regulatory developments.

1.7 Experience has already been gained in the extensive use of automation in modern aircraft. However, the highly collaborative "system of systems" in aviation as a whole implies combinatory complexity. In order to maximize its benefits while minimizing its risks, it is suggested that an aviation automation policy be developed. The following sections summarize the experience gained with modern aircraft and ATM, to illustrate the challenges needing to be met.

1.8 EASA highlighted the importance of the need for an Automation Policy at its "Staying in Control – Loss of Control (LoC) – Prevention and Recovery" Conference, held on 4 and 5 October 2011 in Cologne, Germany.

2. ADVANTAGES OF AUTOMATION

2.1 Aircraft automation has contributed substantially to the sustained improvement of aviation safety around the world. Automation increases the regularity, timeliness and precision of routine procedures, and greatly reduces operational risks and threats to flight regimes.

2.2 Advances in engine control technology and improved vertical and lateral navigation accuracy has allowed fuel savings and increased passenger comfort. Automation has improved flight path control, reduced weather minima and, in some instances, allowed for the decommissioning of land-based navigation aids.

2.3 Family concepts based on the repeatability of automation, similarity of cockpit design and flight dynamics facilitate aircraft type transition by flight crews.

2.4 Automation also integrates safeguards, such as providing flight envelope protection.

2.5 Electronic flight instrument systems and navigation displays enable the provision of enriched representation of the airspace environment and increase pilots' situational awareness. Systems monitoring displays coupled with diagnostic assistance systems have enhanced pilots' and maintenance staff's representation of aircraft system states.

2.6 On the ground automation has been introduced to support air traffic controllers in routine tasks, such as the identification of individual flights on traffic situation pictures and the transfer of control responsibility over sectors boundaries. Developments were made subsequently to support air traffic controller decision-making processes for separation assurance and traffic metering in capacity-constrained airspace.

2.7 Automation has relieved flight crews and the air traffic controllers from repetitive or unrewarding tasks, and from actions where human performance is less effective. Globally, the aim now is to refocus the workload of these highly-specialized operators on the key decision-making processes for the performance of aircraft operations and ATS. As a result, automation may also reinforce the more gratifying parts of pilots' and air traffic controllers' jobs.

2.8 In addition the higher levels of integration between aircraft operators, ATM and flight crews for common decision-making processes require reconsideration of the traditional boundaries of communications, navigation, and surveillance/air traffic management (CNS/ATM), aircraft and airlines systems, and existing automation policies.

3. AUTOMATION ISSUES FROM AIRCRAFT AUTOMATION

3.1 In a complex environment such as air transport, the limits of automation have to be carefully assessed all through the lifecycle of the systems. The analysis of accidents and serious incidents often points to incorrect interaction with automation as a contributing factor.

3.2 Basic manual and cognitive flying skills tend to decline because of lack of practice, and the pilot's 'feel' for the aircraft can deteriorate.

3.3 Pilots can lose situational awareness of the automation mode under which the aircraft is operating or may not understand the interaction between a mode of automation and a particular phase of flight or pilot input.

3.4 Pilots interacting with automation can be distracted from flying the aircraft. Selection of modes, annunciation of modes, and Flight Director commands may be given more importance than the value of pitch, power, roll and yaw, and so distract the pilots from flying the aircraft.

3.5 Unexpected automation behaviour can threaten the safety of the flight: engagement or disengagement of automatisms in an inappropriate context or un-commanded transitions, for instance mode reversion, may lead to adverse consequences. Unanticipated situations requiring manual override can be difficult to understand and manage, create a surprise or startle effect, and induce peaks of workload and of stress.

3.6 Flight crews may spend too much time trying to understand the origin, conditions, or causes of an alarm or of multiple alarms, which may distract them from other priority tasks and from flying the aircraft.

3.7 Similarly, air traffic controllers face regularly situations of degraded performance by automated systems, for instance when loss or corruption of traffic data occur. In such circumstances the ability to rapidly detect errors and to initiate mitigation measures is essential to preserve safety.

3.8 In addition the development of automated tools to support air traffic controller decisions has to tackle the imperative need to keep the cases of false or nuisance alerts to very low levels. While conducting high-intensity operations these events create immediate disturbances to air traffic controller situational awareness, and in the long-term decrease the confidence placed in automation support.

3.9 When automation support becomes degraded or suddenly fails, it is difficult for human operators to understand the situation and make appropriate decisions. In such circumstances the high demand put on the flight crews or the air traffic controllers to maintain safety requires effective system design, training and continuous safety monitoring processes.

4. OULINE OF THE PROPOSED POLICY

4.1 In today's ATM environment, automation mainly supports the provision of data to air traffic controllers and flight crews. However, the future aviation "system of systems" will increase the role of automation in providing higher added-value services. An automation policy should set the general principles and determine the issues to be addressed during design, safety assessment and certification, training and deployment and continuous safety monitoring activities. An automation policy is also aimed to provide a common framework to support harmonisation and standardisation efforts.

4.2 Examples of common high-level principles for the development of automation include human-centred approach for design; automation only at the most appropriate level; design systems to be error tolerant; and automation not to reduce overall reliability but should enhance system safety and efficiency.

4.3 Larger systems, with greater degrees of automation, are much more prone to systematic latent failure modes than random ones; because of system complexity inducing combinations of error modes, such failure modes are more difficult to predict by analysis and/or test. Decisions that would have been made by trained and experienced operators (pilot and air traffic controller) are to be made by a machine or an automated system (in the case of the future air ground space system) that has been specified and programmed by system designers lacking the domain knowledge of the operators. Principles must be included in the automation policy to address the avoidance of unwanted outcomes, for example by unambiguous specifications of system architecture and behaviour in a form that can be used by the engineers but that is also meaningful to the domain experts who review and validate the specifications. It is also recommended that assurance arguments be prepared at the same time to give confidence that the specifications are appropriate.

5. PROPOSED ARCHITECTURE DEVELOPMENT PROCESS

5.1 The approach to the development of an aviation automation policy may be composed of the following steps: identification of the generic aviation automation needs and constraints (human-centred approach as opposed to technological focus); identification of the related human factors and human-machine interaction issues; identification of how the complexity of these interactions can be (increasingly) addressed during design, integrated in training schemes and monitored all through the lifecycle of products; assessment of the regulatory provisions for risk management and the need for changes to the regulatory frameworks; prioritization of the automation issues for the different phases of system development; and development of guidelines and recommendations for their analysis and resolution (initiation and continuous process improvement).

5.2 Improvements can also be achieved through safety promotion means. Safety promotion includes the publication of Safety Information Bulletins (SIB) and of safety brochures or leaflets, presentations in conferences, diffusion of best practices through authority and industry channels, safety partnerships such as ECAST and CAST, associations such as the Flight Safety Foundation, encyclopaedic systems such as SKYbrary and Wikipedia, etc.

6. ACTION BY THE CONFERENCE

6.1 The Conference is invited to call for the development of a general policy on aviation system automation, by a multidisciplinary team.

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