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WORKING PAPER

TWELFTH AIR NAVIGATION CONFERENCE

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Agenda Item 6: Future direction
6.1: Implementation plans and methodologies

ADDRESSING HUMAN-IN-THE-SYSTEM ISSUES IN EMERGING SYSTEMS, TECHNOLOGIES AND OPERATIONS

(Presented by the Civil Air Navigation Services Organisation)

SUMMARY

The Conference is invited to note the expectations of the global ANSP community primarily in the areas of human performance, human interface design and human-system interaction factors in coping with new technology and increased automation.

The community urges all industry partners to collaborate on a human-in-the-system approach:

a) automate the parts of the system to help the human, but keep the human engaged and in the control; and
b) automate only to improve overall system and human performance, not just because the technology is available.

Action: The Conference is invited to agree the recommendations in paragraph 3.

1. INTRODUCTION

1.1 Assembly Resolution A37-15 Appendix V identified that human factors contributed to 70% of accidents and recognized "the increased use of automation and the introduction of new technology with its associated complexity in both flight and ground operations may further exacerbate the human factors issues unless appropriate and timely measures are taken". To this end, the 37th Session of the ICAO Assembly resolved that:

a) Contracting States should take into account relevant human factors aspects when designing or certifying equipment and operating procedures and when training and/or licensing personnel;

b) Contracting States should be encouraged to engage in far-reaching cooperation and mutual exchange of information on problems related to the influence of human factors on the safety of civil aviation operations; and

c) the Council should collect and analyse the experience of States and develop and introduce appropriate ICAO material regarding the various aspects of human factors.

[1]Arabic, Chinese, English, French, Spanish and Russian versions provided by CANSO.

1.2 This Civil Air Navigation Services Organisation (CANSO) paper builds on the ICAO working paper entitled “Human Performance” and focuses on a strategy for the early engagement of operational personnel not only in the use of the advances in concepts, systems and technologies that the modules bring but also in their design and testing.

2. BACKGROUND

2.1 CANSO supports the ICAO concept of the human-in-the-system which has a broader definition than human performance or human factors. We recognize that we should learn from and avoid the mistake of automating simply because automation is possible. Rather, we should automate the parts of the system to support the human and keep the human engaged and in control.

2.2 Air traffic management requires the interoperability of ground and airborne systems to deliver a safe and efficient network. As the automation and interoperability of these systems increases, the role of the human will alter. This paper examines the human-in-the-system issues from an air navigation services perspective.

2.3 Automation

2.3.1 Human failures are a contributory factor to a large percentage of incidents both in the air as control failures, and from the ground as losses of separation. It is also evident that these failures are often a result of degradation or failures in the design, redundancy and function of the equipment and often compounded by inadequate training. When complex and inter-dependent systems fail. The role of the human in assuming control in high pressure events and often in situations of cascading failures is highly subjective to given environment and can rapidly deteriorate. While humans may play a contributory role in incidents or accidents, in some instances humans can also be the ‘heroes’, e.g. the Qantas A380 flight crew who landed the aircraft safely despite significant failures of automated systems. In these cases, it is evident that those involved relied on past knowledge and experience to determine how to assume control and recover the situation.

2.3.2 The design of future automated systems needs to accommodate the strengths and frailties of the human and assure that as new systems and automation are introduced, role clarity is maintained, and the ability of the human to intervene in the event of a system failure is recognized and enhanced. This particularly relates to the ATM environment where simulator training, for example, has not evolved to a level that has been attained in other flight-critical domains. Our position, consistent with the ICAO strategy is:

a) automate only to improve overall system and human performance, not just because the technology is available;

b) examine the overall impact of automation before implementation to avoid additional complexity, loss of appropriate situation awareness or increase of errors;

c) achieve a balance between the efficiency created by automation and the human capability to intervene and recover from non-nominal and/or degraded modes of operations (automation failure strategy);

d) place the human in command. The human will be the automation manager and not the automation monitor. Automation will assist humans to manage their tasks safely, efficiently and effectively. Furthermore, the delegation of authority to machine should be clearly defined and understood in all operational situations;

e) minimize the potential for errors. This can be achieved by regulating workload , providing tools to help humans organise their work and make the right decisions, emphasising teamwork and collaborative decision making between users;

f) automation will be both error resistant and error tolerant;

g) involve users in all phases of system design to ensure benefits for overall system performance and to foster trust and confidence in the automation functions; and

h) consider the respective typical strengths and weaknesses of humans and of technology when deciding what to automate.

2.4 Multi-disciplinary, collaborative approach

2.4.1 Traditionally, our industry has focussed on the individual human performance issues faced by each sector in individual roles. No longer can the flight deck, the air traffic control console and vehicles operating on aprons or taxi-ways be considered in isolation. The integrated nature of the systems and procedures which are used must be developed and implemented with specific performance outcomes in mind. Collaboration between stakeholders is therefore the key to future success.

2.4.2 Challenges will arise from having to balance competing demands for safety, security, efficiency, flexibility and enhanced environmental outcomes and will require all industry players to view the system as a single entity. This “total systems” and multi-disciplinary approach will require all stakeholders to work in a collaborative manner, all working to assure that each component maximises safety in the system.

2.5 Scope of safety management systems

2.5.1 Safety management systems (SMS) have for the most part focused on embedding organisational processes such as accident/incident investigation and risk assessment, and on the management of a number of explicit behavioural risks associated with human performance, e.g. fatigue, drugs and alcohol.

2.5.2 As automation of the air traffic management system increases, and the role of the air traffic controller changes, SMS need to evolve. The evolution should address a wider range of automation and Human-in-the-System risks in operations and embed processes that demand the human be considered in all phases, i.e. from design, planning, implementation to operation. CANSO is already working to develop processes and principles that it can promote to ANSPs, which not only assure a safe design, but also ensure that opportunities that change systems and procedures are used to maximise safety outcomes, i.e. proactive design for safe systems in addition to design of resilient and reliable systems.

2.5.3 Managing fatigue is an important issue in maintaining network safety. CANSO strongly supports the development of fatigue risk management systems (FRMS), but is cautious of the requirement to mandate them a part of a SMS. Organizations should be allowed the freedom to implement an FRMS in a way that best fits with their business processes.

2.6 Recruitment, selection and training

2.6.1 It is clear that the role of the air traffic controller will change as automation and interoperability between airborne and ground based systems increases. ANSPs will take primary carriage of how the roles of the air traffic controllers and ATSEPs evolve in their organizations. However, cross-industry coordination (given the changing roles of pilots) and transfer of learning between individual ANSPs must occur to assure a consistent approach to the evolution of air traffic management concepts and application at both a strategic and tactical level. There will be a marked increase in the reliance on data and replacing voice for managing both routine and

non-routine situations. Though voice will remain as a back-up for the foreseeable future, critical tasks (and task-sharing) in ensuring Conformance, recognition of loss of separation and intervention may all required by use of data systems.

2.6.2 Recruitment, selection and training in ATM domains will need to change significantly to ensure they have the right blend of skill and knowledge to manage their future tasks. Training must also provide controllers with both the competence and confidence to recognize and recover from non-standard and abnormal situations. It is also essential that on-going continuous professional development (CPD) is carried out for controllers to maintain their level of competency.

2.7 Change management

2.7.1 Automation of tasks currently fulfilled by air traffic controllers must recognize the risk of deskilling them to the point where reversion to a manual operation is effectively impossible. ANSPs, regulators and industry partners must agree a change management philosophy that places the human at the centre of the system supported by automation, and also examine emerging techniques and put strategies in place to support those personnel who potentially may experience difficulty in adapting to the change role/tasking.

2.7.2 This philosophy will facilitate the transition from a “manual” operation to one where increasing levels of automation are provided to support the controller’s role. It will also ensure that the controller maintains the spatial awareness required to intervene where necessary to enable an effective fall back and recovery strategy following automation failure or outage.

2.8 Aviation system block upgrades

2.8.1 Aviation system block upgrades (ASBUs) describe ways to apply the concepts defined in the *Global Air Traffic Management Operational Concept* (Doc 9854) with the goal of achieving regional and ultimately global performance improvements; the definitive objective is to achieve global interoperability to the extent possible in an expeditious manner. Constraints placed on individual States and regions demand a level of interoperability and harmonization that, without degrading safety, must be achieved at a reasonable cost with commensurate benefits.

2.8.2 While changes in the system as described in the ASBU framework will be evolutionary, the design for the future must provide a well-understood, manageable, and cost-effective sequence of improvements that keep pace with human capabilities.

2.8.3 Coping with step change increases in traffic and complexity management arising from reduced separation, and innovative ATM strategies such as self-separation (SSEP) will allow humans to be better informed to carry out their tasks with precision. Increasing automation will re-focus the controller task to increasingly delegate responsibility, yet manage a system that safely reduces separation and addresses demands for increased capacity, efficiency, predictability and environmental considerations.

2.8.4 The future ATM system must accommodate a broad shift from a system that is Flight Information Region (FIR) centric, where controller training and qualification is sector specific, to one that is performance driven and determined by a standardised system of commonality in licensing. Seamless flights crossing multiple FIRs will highlight the need for interoperability of systems, standardised rules of the air, air traffic procedures and methods of operation.

2.8.5 A primary goal in the Global Air Navigation Plan (GANP) is 4D trajectory-based operations (4D-TBO) achieved by leveraging performance-based navigation (PBN), aeronautical information management (AIM), system-wide information management (SWIM), etc. This will require a huge reliance on automation. The

modules should be evaluated against the gaps to identify capabilities that can provide the operational improvements needed to meet the established performance objectives.

2.9 In developing guidelines for transition, it should be acknowledged there will be a significant mixed mode issue as not all ANSPs, aircraft and crew will transition to the new systems and methods of operation at the same time. This will require careful consideration of:

a) mixed-mode operations and workload;

b) sensitivity of solutions to local situations;

c) need for interoperability and new standards;

d) need for training and change management;

e) need to validate and demonstrate new technologies and procedures;

f) need for consistent plans to mutually support individual business cases; and

g) cooperation within/across regions to optimize synchronized deployments of new systems and procedures.

3. CONCLUSION

3.1 System change and automation can provide opportunities to improve human performance by ensuring that current features, which demand workarounds, create distractions or demand that people to work on monotonous tasks are designed out of the systems. The clear message is to ensure that in our quest to improve the efficiency of the system we do not introduce roles or features which will induce error, mistakes or lead workers to operate in environments which are not conducive to working at an optimum level.

Recommendation 6/x – Addressing human-in-the-system issues in emerging systems, technologies and operations

That the Conference:

a) note the Civil Air Navigation Services Organisation position supporting ICAO in the development of human-in-the-system focussed solutions;

b) recognize the paramount importance of collaboration of all industry partners on a human-in-the-system approach, i.e. automate the parts of the system to help the human, but keep the human engaged and in the control; and

c) note that the industry should automate only to improve overall system and human performance, not just because the technology is available;

d) invite ICAO to study the best way to implement and if necessary regulate a “system-of-systems” approach to automation and interoperability;

e) invite ICAO to disseminate the above mentioned study results to all affected stakeholders with the view to share best practices;

f) note that safety management systems need to evolve to address a wider range of automation failures and human-in-the-system risks in operations and also to embed processes which demand that the human is considered in all phases;

g) understand that recruitment, selection and training of air traffic controllers will need to change significantly to ensure they have the right blend of skill and knowledge to manage their future tasks; and

h) urge air navigation service providers, regulators and industry partners to recognize the necessity that places the human at the centre of the system supported by automation to facilitate effective transition, fallback and recovery mechanisms.

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