Special Topic Session **Human Factors & Safety**

Session Chairs: Paul Krois, FAA/ATO and Dres Zellweger

Facilitator: Dres Zellweger

Panelists: Tom Sheridan, Volpe; Doris Dehn, EUROCONTROL and Richard Kennedy, Boeing R&T Europe

I – Introduction

A statement "Do We Need People in ATM? For What?" (see section II below) and a brief discussion of associated issues/questions was passed out to all participants. The statement was intended to set the tone for the discussion at the breakout session.

At the beginning of the breakout, each panelist made a short statement (see section III below) to help frame the discussion. Doris was unable to participate, but Paul gave her opening statement. Dres started by asking the audience for comments on the opening remarks and gave the panelists an opportunity to respond.

The rest of the session was broken into three segments. First, we opened the floor to comments on human factors/automation issues, especially those related to the statement that was provided to all of them. The second segment addressed the questions of what kinds of human factors investments should be made in light of the always limited resources. For example, what should be the balance between investment into basic aspects of human factors and in human factors issues related to specific concepts? Another question asked was whether we had the right tools to ensure proper attention to the human element in ATM research? Finally, we explored the issue of human factors and safety. In each of the three segments, a period of open comments (sometimes guided by questions and statements from the facilitator) were followed by responses/comments from the panel. Section IV below contains a summary of major points that were made.

II – Do we need people in ATM ? For what ?

Of course we will still need people for Air Traffic management in the future. While we know that there will be more dependence on automation in the far term (2025+ time frame), the answer to "for what" is not at all clear. In this human factors and safety session we will explore questions to help guide the research into the roles for people and machines and the potential changes in air/ground responsibility. In complex situations, the challenge is to find the proper mix of what people and machines do to complement one another. We know, for example, that people are much more resilient in dealing with failures, but if recovery involves complexity, machines may have to be part of the recovery process. Our discussion will be framed by such questions as:

- Can we shift the controller role from today's tactical nature to a more strategic nature?
  - How will controllers accept not vectoring airplanes, and leaving routine separation assurance to automation or to pilots?
  - Will they resist taking on a new, more strategic role?
  - Will they regard a change in roles and responsibilities as a loss of dignity and job satisfaction?
  - Must we avoid defining new roles that might make controllers subservient to the automation? That is, will automation tell them what to do—OR—does it do things that controllers cannot override?
  - Do we really need different kinds of controllers?
- Who will be responsible for safety? How does authority come into play?
  - If we automate certain functions, what should human responsibility for those functions be? For example, will people have to be responsible for every command and execution, including approving what automation is doing?
  - Under normal conditions? If there are failures?
  - Will people still "feel responsible" even if they no longer are formally responsible?
  - If the automation fails, are there some guiding principles for maintaining safety?
- Do we have the right methods to understand the impact of changes on human performance and help refine operational concepts in relation to the envelope of human performance?

- Do we have the necessary safety methodology to understand the safety of major changes to the ATM system?

III – Introductory statement viewgraphs

A. Tom Sheridan

Simulations suggest that controllers do not want to accept responsibility for separations with less than a 3 minute time window.

Can they be excused from such responsibility?

But automation cannot always make reliable predictions at more than 3 minutes away from collision……

…..so if controllers see a troublesome situation developing, they prefer not to wait for or even trust the automation to make the ideal decision, but to take action just in case….

….and they don't want to be given complex advice or multiple alternatives from which to choose, but just want to get on with the task….

….and they question whether data comm is fast enough when there may be a need for rapid verbal interchange.

Lots of human-automation role and responsibility questions … yet to be answered!

B. Doris Dehn

There is a dilemma between 'keeping the human in the loop' and 'workload reduction through automation'.

- Example: Medium-Term Conflict Detection (MTCD)
  - MTCD - where implemented - used as additional source of information, rather than as automated conflict detection
  - fine for safety, but what about efficiency/workload reduction?
- Do we need to give up the idea of keeping the human in the loop?
- What kind of loop are we talking about anyhow (information processing, decision making, …)?

C. Paul Krois

Workstation Integration Challenges

- How to incrementally converge tools and concepts into the controller workstation?
  - Decision support tools, conformance monitors, and alerts
  - Mixed equipage traffic environment
- What display capabilities should be common between Radar and Data Controller workstations?
- Need to validate human factors benefits incrementally to assure that the workstation supports controller's tasks

- How will integration ensure trust in the automation?
- Maintain controller situation awareness in relation to expectations and off-normal operations

D. Richard Kennedy

Air-Ground Integration Complexities - Example of 4D TBO:

- Where in the calculation/negotiation process do ATCOs/Pilots need to accept or to be involved? What's automated?
- Flight crew awareness of updated / amended trajectories. Which need flight crew acceptance? How are Pilot workload issues during descent to be considered?
- Trajectory recalculations on board after up-linked update in high workload / high density operations, time needed, workload impact?
- In case of non-compliance with negotiated trajectories (control by exception), Pilot & ATCO actions and procedures, in particular:
  - FD and ground displays;
  - voice or data-link communications;
  - ground automation for detection and solution (presenting options to be accepted by ATCO);
  - pilot acceptance needed, presentation of multiple options
- Flight deck sequencing and merging / airborne separation: when to transition, downlink of A/C commands for ATCO awareness / display? Who has final responsibility for separation assurance?

IV – Session Summary

Can we have shared responsibility?

No clear answer. There was some agreement that there had to clear lines (and understanding of) responsibility. If one has responsibility, one must also have authority and the tools necessary to carry out the responsibility. Automation must be designed to ensure this and to avoid situations where humans are just "monkeys pressing a button".

Workload and situation awareness

- Workload is a many faceted thing. We need to break it down into its components. This has been long recognized by workload researchers, but today many are treating this too much as a "single" thing. As we introduce more automation, we need to make sure that the amount a type of controller work is sufficient to avoid potential for new forms of human error.

Workload conundrum: people can be busy and still be effective, and people can not be busy yet not able to handle new situations.

Situation awareness needs to be defined in the context of specific concepts of operation. The situation of which humans need "awareness" depends on their specific roles and responsibilities during nominal and off-nominal operation. New automation redefines situation awareness in terms of what information is needed, how much time is needed to act on that information, and if it is safe to have less time. We need better methods to measure and predict situation awareness.

Safety

In the case where responsibility is shifted away from the controller, how does this effect defining the safety case? For a new system to be 'as safe,' what does this mean in relation to a redistribution of functions that together comprise a safe system? What are the effects on analytic underpinnings?

Dynamic shifts in responsibility pose challenges in relation to liability and roles across controllers, pilots and AOCs.

Need to ensure safety cases for new automation, using the right methods. ANSPs do not always build the business case but invest in new technologies without clear benefits. NextGen/SESAR should validate the safety cases to ensure best investment decisions. Need methods and guidance to evaluate the safety case under different operational conditions and scenarios.

The field of human factors has sometimes been disconnected from safety cases. Beware of this mistake in the future. In particular, as the safety case shifts to become more system-related, one must find ways to bring the human element back in.

An issue is how safe can the system be? For example, how safe is see-and-avoid in an absolute sense? In a relative sense?

Just as continuous descent approaches are redistributing the noise over a community, we will likely see a re-distribution of safety as the human role changes.

The road to automation

Are there principles regarding human roles and responsibility? How much really depends on specific operational concepts? Viewpoints on this vary a lot – the answer is probably "both".

Where controllers are given tools to help them but are still responsible for separation, there is some evidence that, when they get busy, they change their working methods, often reverting to basic procedural methods and don't use the tools.

When automation shifts from giving information to giving recommendations, then there is a shift in responsibility in some manner. The controller has the right to overrule automation but on what basis? Does it even make sense to design a system like this? (In an experiment where there is very good automation for conflict detection and resolution and the controller has the ability to override this automation, Tom Prevot found that there are instances where the controller and the automation "fight one another". One audience member recounted that in the Shanwick Oceanic system, automation generated a 'conflict free' clearance which the controller could accept – initially controllers verified the clearance was conflict free but after ten years controllers were frequently observed to just push the button to accept without checking the clearance.

The nuclear power industry exemplifies challenges in which humans have to compensate for less-than-perfect automation.

Tom's opening remarks about 3 minutes being a critical threshold for controller's ability to deal effectively with conflicts was supported by research on ERASMUS. There was a view that controllers are not necessarily against having less time to deal with conflict situations as long as automation reduces the complexity of the situations they have to quickly resolve.

Effective automation design necessitates working with end users, as a human factors practitioner best practice. That said, researchers need to be cautious not to reject new ideas because they are not "the way we've always done it". When a new runway status light system was introduced at Boston Logan airport, controllers were initially opposed to it, but after some experience with it, they changed their view and agreed that it was helpful.

New concepts are only useful to the extent to which one can safely transition to them.

Culture

Increasing automation poses changes in the psychosocial aspects of the controller's job. Big transitions can involve a paradigm shift for the controller workforce, but not much progress has been made in understanding

this and learning how to deal with it. Some in the audience felt that there is a need for decisions about the future to narrow the focus of research. Simulations show controllers are concerned about changes in responsibility.

Future needs

More verification and validation, in all phases of the concept research, development, and implementation cycle.

More and improved fast time models to understand human behavior in ATM studies. These should take advantage of the progress that has been madein human performance models and find ways to overcome the brittleness of fast time models in dealing with off-nominal conditions. The fast time models should be paired with simulations. Finally, controller simulations do not always need to be high fidelity.

A challenge for human factors researchers is to make sure they offer sound contributions to explore new ideas and avoid the perception that they are pouring cold water on new ideas.

Need more integration of air and ground sides. Need better joint strategy between regulatory bodies, national ANSPs, and research organizations.