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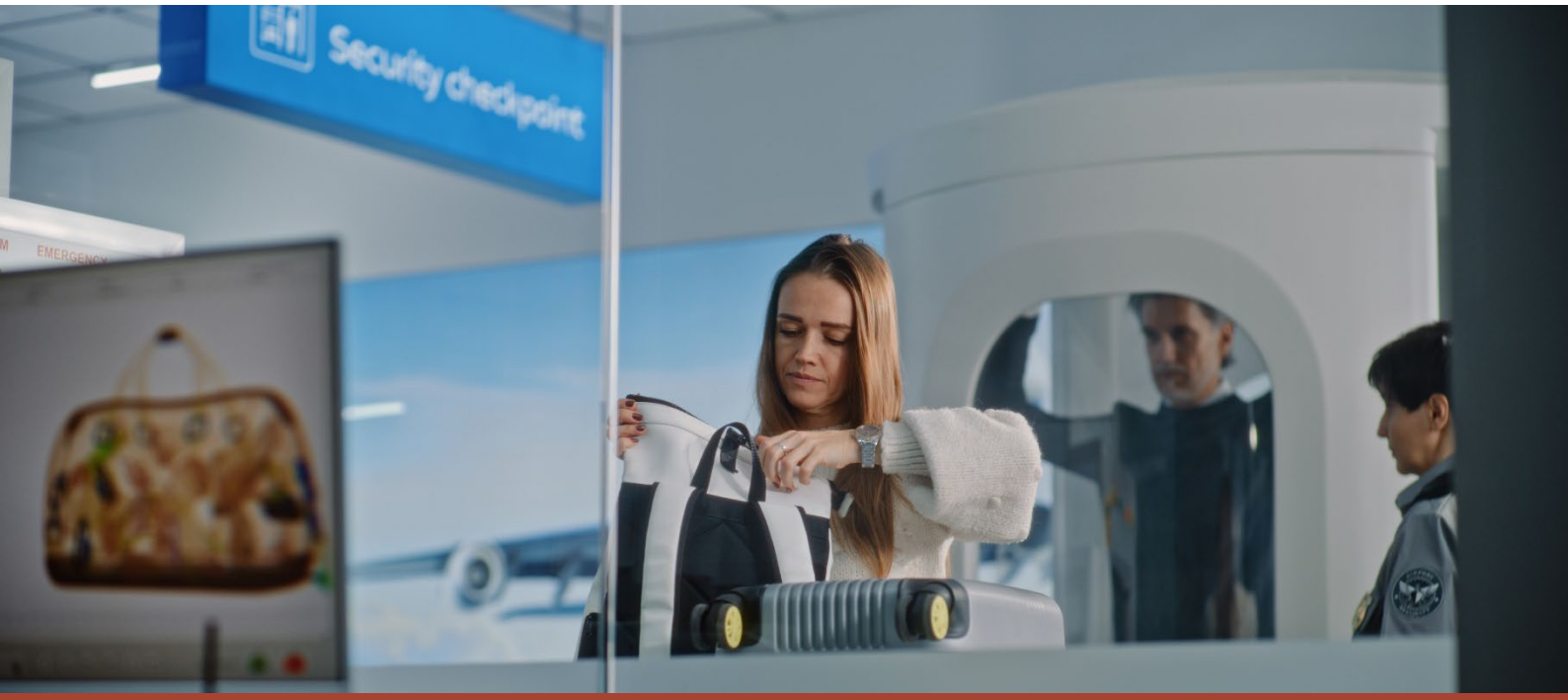
SECURITY AND FACILITATION



Toolkit on Human Factors and Technology

Aviation security continues to rapidly evolve around innovation and technology, seeking to capitalize on increased effectiveness and efficiency offered by newly developed and certified equipment.

The use of complex technology may simplify tasks but also offers challenges to aviation security staff whose job continues to change.

Aviation security technology currently deployed for screening, such as:

- Automated prohibited items detection systems (APIDs)
- Body scanners (also referred to as security scanners)
- Equipment for testing liquids, aerosols and gels (LAGs)
- Explosive trace detection (ETD)
- Explosive vapour detection (EVD)
- Shoe scanners
- Walk-through and hand-held metal detectors (WTMD and HHMD)
- Conventional and algorithm-based X-ray, such as explosive detection systems (EDS)

Many of these machines use semi-automated decision-making but rely on the screener for the final security decision, requiring a balance between the human-machine interface. Newer technologies such as EDS and APIDs are also capable of being fully automated, requiring no input from a screener, and further challenging our understanding of human factors in aviation security operations.

August 2025
International Civil Aviation Organization

‘Designing for’ the human: User/Human based design

When a new technology is introduced in a screening operation, the training, environment and processes should be redesigned to consider the required changes. Ideally, human factors have already been considered when the technology was designed.

Below is a checklist that can be used to include human factors in the design process.

Function/Tasks

- Assess the changes to the task or function for users
- Confirm if the decision-making process has changed
- Assess whether there is an impact on how staff communicate with each other

Automation

- Balancing of responsibility between the user and the automated equipment
- Equipment limitations and capabilities for which the user must compensate

Ergonomic requirement

- Confirm that the display and controls can be used by all staff users comfortably and have options (e.g. mouse vs keyboard)
- For any tools, confirm these are easy to use even after continuous use, e.g. ETD wands

Process/protocols

- Confirm if processes/protocols require updating
- Key decision points

Environment/Location

- Physical work environment (e.g. noise/light/temperature)
- User-interface with equipment
- Changes to working patterns/shift/time on task

Training/Competency

- Confirm if new knowledge and skills require top-up training
- Requirements for screeners, supervisors and managers
- Enhancement of instructors’ skills

Trial/pilot (where possible)

- Test processes and protocols
- Get feedback from all users
- Opportunity to make improvements
- Consider the impact of changes on the human (change management practices)

CASE STUDY: INTRODUCING EDS IN HOLD BAGGAGE SCREENING

EDS has automated decision-making functionality, which in hold baggage screening does allow some bags to be cleared without the image being seen by the human screener. This can change the role of the screener significantly, requiring a review of their job, tasks and processes. A trial or pilot of the equipment can help with establishing the new requirements and also test new processes/protocols. In the case of EDS, a switch to 3D images will also require a period of image-based training to allow screeners to build competency and become familiar with a new user interface.

Screeners, supervisors and managers will require training to understand and use the new equipment – and any changes to decision protocols, the processes they use and the resolution of alarms.

Decision-making – flowchart with technology

How we make decisions can be influenced by technology – both positively and negatively. This applies to all types of technology, but is more pronounced when the technology has an element of automated decision-making capability. Examples of this would be ETD (clear/alarm) and EDS (bounding boxes).

How we make decisions can be impacted by decision-making biases. Cognitive bias is a systematic error in thinking, affecting how we process information, perceive others, and make decisions. It can lead to irrational thoughts or judgements and is often based on perceptions, memories, or individual/societal beliefs.

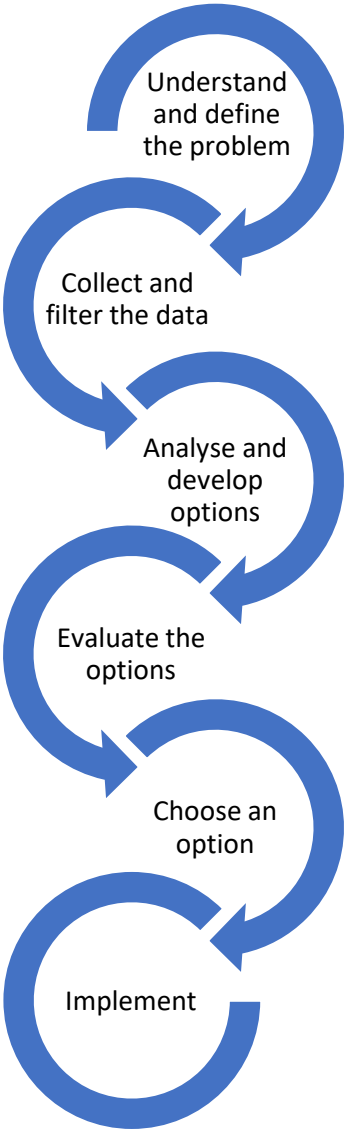
- Unconscious bias is the association or judgement made about different groups of people or situations, often without being aware of them.
- Cognitive bias may inform some of our unconscious bias, and although they relate, they are not identical concepts.
- Confirmation bias is the unintentional tendency to process information by looking for, or interpreting, information that is consistent with existing assumptions, values and knowledge.

Impact of technology

- Technology helps us gather data – e.g. ETD results
- Unreliable data increasing filtering requirements (trust)
- May increase cognitive load (more data to analyse), e.g. 3D based X-ray

- Decision bias apply – e.g. making a default decision can be easier (clear rather than reject)
- Availability bias – more credibility to data frequently exposed to
- People tend to accept the recommendation made by the algorithms – this can increase complacency

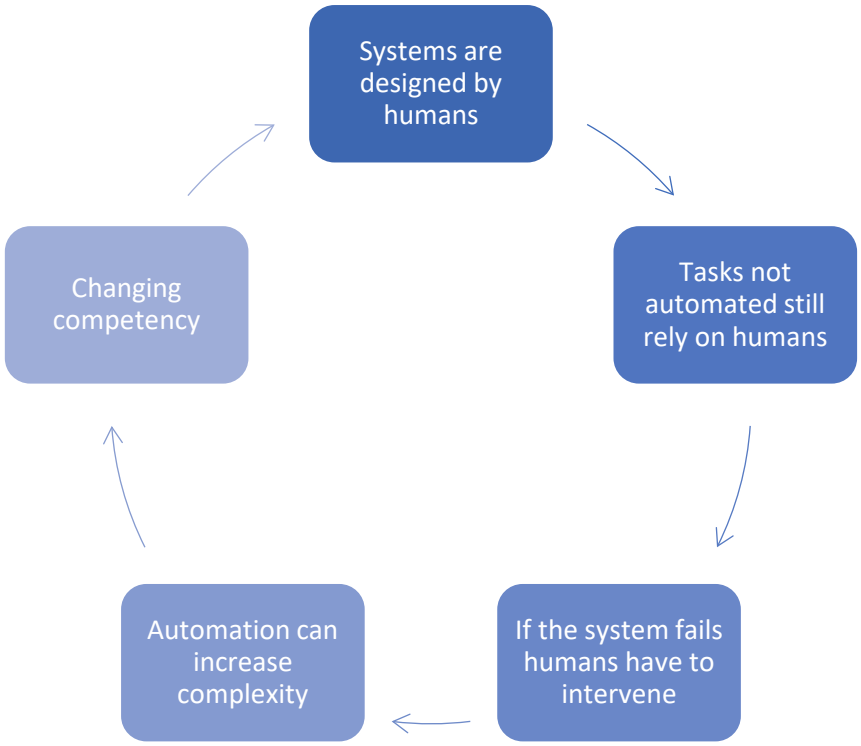
Decision-making process



Ironies of automation[1]

When introducing complex technology that uses semi-automation, such as algorithms (EDS, APIDs, SSC, etc.) the appropriate authority or the screening entity may automate some of the decision points. This brings additional human factor considerations into play.

What considerations need to be taken into account?



How can the above considerations be addressed?

1. Encourage staff to retain situational awareness and curiosity in order to avoid complacency in the technology;
2. Ensure the correct skillset and knowledge is achieved and maintained – including for skills that are not required day-to-day, such as for contingency situations (for example full hand searches when using body scanners);
3. Have clear processes with oversight of the responsibility and authority for decisions between the machine and the human;
4. Careful re-assessment of job roles and tasks to account for inadvertent increases in task difficulty or cognitive load (for example 2D to 3D screening); and
5. Be prepared and avoid surprises – if the equipment is capable of an action, staff need to be aware of it – knowing alarm messages, possible actions, failure modes, etc.

[1] Bainbridge, L. (1983) Ironies of Automation.

Reviewing occurrences involving technology

During any occurrence involving technology, human factors should always be included in the review process and root cause analysis. Ensure that the following aspects are considered.

JOB FACTORS

- Constant disturbances and interruptions;
- Environmental factors, such as noisy and unpleasant working conditions;
- High workload (cognitive and/or physical);
- Illogical design of equipment and controls;
- Missing or unclear instructions; and
- Poorly maintained equipment.

INDIVIDUAL FACTORS

- Complacent staff;
- Health and wellness factors; and
- Lack of training and/or competence issues.

ORGANIZATION AND MANAGEMENT FACTORS

- Deficient coordination of responsibilities;
- Inadequate work planning, leading to high work pressure;
- Ineffective leadership and management;
- Insufficient responses to previous incidents;
- Lack of an effective security culture; and
- Lack of positive recognition.

Training for algorithm-based technology

Sample training module for EDS or APIDs technology.

1. Understand capabilities of the technology

- What can the algorithm detect?
- What are the limitations of the algorithm?
- False alarms
- User interface/controls

2. Know the meaning of bounding/alarm boxes

- Meaning of bounding/alarm boxes (*Refer to 11.5.14.7 of the ICAO Aviation Security Manual (Doc 8973 – Restricted) for the explanation of bounding box*)
- Location and colour
- False alarms
- If in use, how Threat Image Projection (TIP) will work

3. Understand the process of screening with algorithm-based technology

- Screening process from start to finish
- Decision-making points and who makes them (human/machine)
- Decision timing
- Alarm resolution (on screen if applicable and resolution)
- Contingency process if the technology fails
- Switching between new and existing equipment (e.g. 2D to 3D, WTMD to body scanner)

4. Be able to effectively screen using algorithm-based technology

- Practical and on the job training
- Screeners should have significant time to get familiar and train with images out of the operation – this should be done with realistic equipment/images or simulators
- This should be followed by a period of on-the-job training

5. Understand the human factors that may impact on their screening performance

- Risk of overreliance on the bounding box
- Attention and focus on the image
- Increased decision time due to cognitive load
- Risk of complacency – remain curious

Conclusion

As aviation security technology becomes increasingly sophisticated, it is essential to recognize that its effectiveness is inherently linked to the humans who design, implement, and operate it. While advanced screening systems can enhance security outcomes, their integration must be carefully managed to account for human capabilities and limitations. A human-centred approach — through design, training, decision-making processes and organizational support — is crucial to ensuring that technology serves as a tool for empowerment, not dependency. By systematically addressing human factors, the aviation community can build a resilient, adaptable and effective security environment that evolves in step with innovation.

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