Assessing Human Factors in UK Military UAVs

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1.0 INTRODUCTION

- Automation is a key attribute of modern UAV systems
- But the Human has an important role that varies in detail according to the type of UAV
  - Common roles that are likely to be essential to safety:
    - Planning
    - Managing Failure/Emergency states and other 'non-nominal' situations
    - Supervision/control
- The design of the UAV system impacts on the ability of the Human to fulfil the required role without undue error but operational and maintenance issues cannot be ignored by the assessment

Automation is a key attribute of modern UAV systems. In the UK, for example, one of the most common user requirements is for launch and recovery to be completely automatic, which is the case with QinetiQ's Observer UAV.

But the Human has an important role that varies in detail according to the type of UAV. The level of detail and the assessment philosophy must be adapted to the size and role of the UAV. Clearly, a 5 kg 'mini-UAV' will present different challenges than a large, High Altitude Long Endurance UAV. The assessment will need to take into account the complexity of the system but the underlying principles of the assessment of different UAVs will be similar.

Some of the common human roles that are likely to be essential to safety include:

- Planning;
- Managing Failure/Emergency states and other 'non-nominal' situations; and
- Supervision/control.

The design of the UAV system impacts on the ability of the Human to fulfil the required role without undue error and is often the main focus of any assessment, but operational and maintenance issues cannot be ignored.

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2.0 AIM

- The aim of this presentation is to discuss the context and the principles that should lie behind the assessment of Human Factors in UK Military UAVs
  - Intended as a brief after-note to previous Human Factors presentation
  - UK perspective on UAV Human Factors assessment to fellow Flight Test Engineers and UAV designers
  - Not based on any specific projects, but on personal experience on the generic assessment of a variety of UAV systems
  - Reflects the authors' personal view not official policy

The aim of this presentation is to discuss the context and the principles that should lie behind the assessment of Human Factors in UK Military UAVs:

- Intended as a brief after-note to previous Human Factors presentation, so it will focus on just 2 main issues that are the most important drivers in any UK UAV assessment – Safety and Automation.
- This is intended to be a UK perspective on UAV Human Factors assessment to fellow Flight Test Engineers and UAV designers.
- Not based on any specific projects, but on personal experience on the generic assessment of a variety of UAV systems.
- Reflects the authors' personal view not official policy.

3.0 HUMAN FACTORS ASSESSMENT REQUIREMENT – SAFETY

- UAVs must be safe in role
  - UAVs will need to approved with a Release To Service (RTS)
  - RTS based on a Safety Case
- All assessors must have clear understanding of the role of the human in the System and the human responsibility in relation to Safety
  - Can the human mitigate problems when required?
  - Does the human have the right information at the right time?
  - Has the human got access to the necessary communication facilities?
    - Can the aircraft commander manage the crew resources?
- Occupational Health and Safety
  - Must satisfy Health and Safety Legislation - Not trivial
    - Consider such matters as Control of Substances Hazardous to Health (COSHH) and Manual Handling
    - Assess hazards in the working Environment, temperature and exposure to noise

UAVs must be safe in role. Those UAVs entering service with the UK Armed Forces will require to be approved with a Release To Service (RTS) (which is in effect issued after a 'certification' process). The

RTS is based on a Safety Case which must be supported by evidence. The role of the human must be considered in this Safety Case and the assessment must produce evidence that the human can discharge all the required safety responsibility.

All assessors must have a clear understanding of the role of the Human in the system and the human responsibility in relation to safety. The human has to be considered throughout the system design, it's not just the layout of knobs and buttons on the control station. The human has to be considered as part of the philosophy of the system. The Human Factors' assessment will be a comprehensive part of the overall system assessment including design, Standard Operating Procedures (SOPs) and maintenance. Some questions that could be asked during the assessment are:

- Can the human mitigate any problems when or if they occur?
- Does the human have the right information at the right time?
- Has the human got access to the necessary communication facilities?
    - Can the aircraft commander manage the crew resources? Crew Resource Management is as important in UAV operation as with manned aviation. Assessments of UAVs often conclude that the necessary communications were not considered during design of the systems. For example, it is often not easy for the UAV navigator/pilot (known as the UAV-p) to change radio frequencies.

      (It should be noted that equipment is often Commercial Off The Shelf (COTS), and there are obviously occasions when, since the COTS kit wasn't designed specifically for the role, that modifications could be recommended to improve Human Factors. However, modification is often not cost-effective, so other means (such as operational constraints or limitations) may be needed to resolve the issue.)

The consideration of health and safety legislation is important, it's not trivial and could impact adversely on the capability of otherwise good systems. Clearly this is a major subject in its own right but it is important to emphasize that the UK MoD is not exempt from legislation. So the Human Factors assessment must plan to address a range of Occupational Health and Safety matters.

4.0 AUTOMATION

- A key UAV issue - but not just a UAV issue
  - Civil Aircraft
  - Air Traffic Control
- Automation presents different types of problems
  - Automation surprise presents a crew with an aircraft reaction they weren't expecting
  - Automation can mask potential problems
  - Automation can make it difficult to maintain a mental picture of where the aircraft is, and what it is doing, in relation to other aircraft and the terrain (situational awareness).

Automation is probably one of the key issues facing HF assessment in UAVs, It's not just a UAV issue but it's potentially more important than ever to get it right – as the crew is even further removed from the system.

- There is the potential to learn lessons from the assessment of automation in other aviation systems, such as civil aircraft and, perhaps with some direct relevance, from modern ATC systems.

One of the unspoken approaches to human error reduction seems to be to remove the human from contact (or decision making) with the system as that would 'obviously remove human error'. However, such an assumption, that the human is somehow weak and has to be automated out of the system, is flawed. For automation to be beneficial, it must assist the human. We are not yet at the stage of UAV development where we can trust artificial intelligence with safety related decision making.

It is important that the automation is considered from the perspective of minimising human error and improving decision making. The human and machine should be working together not fighting each other:- the system logic must not be at odds with UAV crew's expectation.

Recent experience of UAVs assessment has shown that automation can present different types of problems:

- 'Automation surprise' can present a crew (or a Range Safety Officer) with an aircraft reaction that they weren't expecting.
- Automation can mask potential problems. This is a particular concern when a Ground Control Station (GCS) is expected to control more than one UAV at a time and the system arbitrarily decides the priority of information display.
- Automation can make it difficult to maintain a mental picture of where the aircraft is, and what it is doing, in relation to other aircraft and the terrain (situational awareness).

Detailed design analysis must underpin the assessment. The assessor must understand how and when the human is expected to interface with the system and what actions the human must take.

5.0 ASSESSMENT OF AUTOMATION ISSUES

- Detailed design analysis must underpin assessment
- Training (and Skill/Aptitude/Knowledge) a key issue to take into account
- Human Machine Interface (HMI) must be balanced between need to simplify and the need for detailed information to be available rapidly and prompt action to be taken when required
  - The balance will be derived from Safety Case
  - Some questions that might be asked:
    - Is the HMI produced to a sufficient Safety Integrity Level?
    - Will the human be able to anticipate problems from the information presented?

It is vital to understand the user and not to make simplistic assumptions about their skills and aptitudes. This can only be based on a real understanding of what they already know, and what they can be taught for sensible training expenditure. Some people are going to be better at the role of the pilot/navigator (or UAV-p as they are now being named) than others. It's important to appreciate the real skills of the users during the design process, or mitigation of hazards by a trained and competent crew cannot be relied on.

The HMI needs to present the crew with ALL of the information they need to discharge their responsibility – this information should take into account all likely situations on which the crew are required to act – or as many as it is possible to conceive.

While there is an obvious need to simplify controls and displays, detailed information must be accessible rapidly, and the user must have the skills to act on the information appropriately and promptly. For example, if the crew are alerted to a potential collision with another aircraft by an Air Traffic Controller or Range Safety Officer, they may be required to follow specific instructions. There are UAVs that require the UAV-p to enter such details through a complex set of keystrokes, with the potential for typing errors to occur. It is often far simpler, with such UAVs to install an Independent Flight Termination System (or 'cut-down' system) with a very simple red button and constrain their operation to cleared ranges rather than train the UAV-p to the level of typing skill required.

6.0 CONCLUSION

- Despite automation, the Human has a role in current and future UAV systems
- The Human is likely to be essential to safety and this responsibility must be the subject of assessment and evaluation
- The design of the UAV system impacts on the ability of the Human to fulfil the role without undue error
- How the system is automated is a key design issue that must be assessed
  - But UAV systems include aircraft and lessons can be learnt from other aviation systems, such as ATC systems and manned aircraft

Despite automation the human is still here, and has a current and future role in UAVs. Computers can't be held responsible, for safety related failure.

The Human is likely to be essential to safety and this responsibility must be the subject of assessment and evaluation.

The design of the UAV system impacts on the ability of the Human to fulfil the role without undue error.

How the system is automated is a key design issue that must be addressed, but UAV community can learn lessons from other aviation systems, such as ATC system and manned aircraft, while building on the unique properties of the unmanned aircraft.

Authors:

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