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people in complex systems

Human Factors Considerations in Airport Security

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Introduction

Protection against terrorism at our airports is achieved in several ways. The most visible of these is by screening passengers and baggage, but there are also other security systems in place to restrict access to parked aircraft and other sensitive areas. A range of technologies is used for airport security, but all of them must be monitored, interpreted and controlled by human operators. Thus, the effectiveness of detecting and preventing the terrorist threat at airports will, ultimately, be determined by the level of human performance that can be achieved when the different technologies are in every day use within an airport setting, rather than the intrinsic capability of the technology.

Direct evidence about the level of human performance with different security systems is limited, but there are some performance data within the public domain. For instance, in unannounced tests at US airports the following performance was reported:

- *Access to restricted areas*: Access to parked aircraft achieved on over 67% of attempts (Dillingham, 2001).
- *Detection of suspect items in baggage using X-Ray*: 21% of items missed (Mead et al, 1987)
- *Detection of suspect items on passengers using metal detectors*: 17.5% of items missed (Mead et al, 1987)

Unfortunately, these confirm findings from industrial studies, that monitoring and decision-making tasks such as those that typify airport security tasks, can be disappointing. However, for a range of similar tasks, such as visual inspection, radiograph examination, radar watchkeeping etc., it has been possible to achieve significant performance improvements by systematically assessing the impact of different factors that can affect human performance.

Currently, human factors interventions in airport security tasks appear to focus very strongly upon training issues, specially the training of visual search strategies. Training is certainly important and performance can be improved by well directed training programmes. However, the turnover on many airport security jobs is generally very high – with annual turnover rates of between 100% and 200% being commonplace, so that most workers get little opportunity to become adequately trained and experienced on their jobs. These high turnover rates suggest that motivation is particularly low, and this will further degrade performance. To some extent this is a reflection on the remuneration rates that are provided, but increasing the payment rates will not on its own ensure that security personnel will be highly motivated, or that performance will be lifted sufficiently. Therefore, it is also necessary to consider other working conditions, such as the job design, and the working environment to further motivate the workforce and improve detection rates.

Whilst improvements in the training provided and the operators' motivation will certainly be beneficial, there are other features of the task and interface design that can improve the operators' perception and recognition of potentially suspect items, or that can influence the operators' the operators' vigilance. Unfortunately, there is no comprehensive body of knowledge that provides specific ergonomics guidance for the design of security tasks. Nevertheless, experience with tasks that share some of the important psychological features with security work, provides an initial indication of the features of particular security tasks that are most likely to be influence performance. Armed with this knowledge it is then possible to experiment with specific changes to the workstations at which security tasks are undertaken, or the way that these tasks are organised.

In the remainder of this paper, a discussion is made of the human factors issues associated with typical airport security tasks.

Baggage Checking

NATURE OF CHECKING TASKS

In order to illustrate where there is a potential for human error in baggage checking tasks, a model of the typical checking task is presented as Figure 1. This is based upon the widespread X-ray aided visual examination of baggage for prohibited items. However, similar errors would be found in other baggage checking tasks, including the unaided manual inspections that are undertaken at some smaller airports.

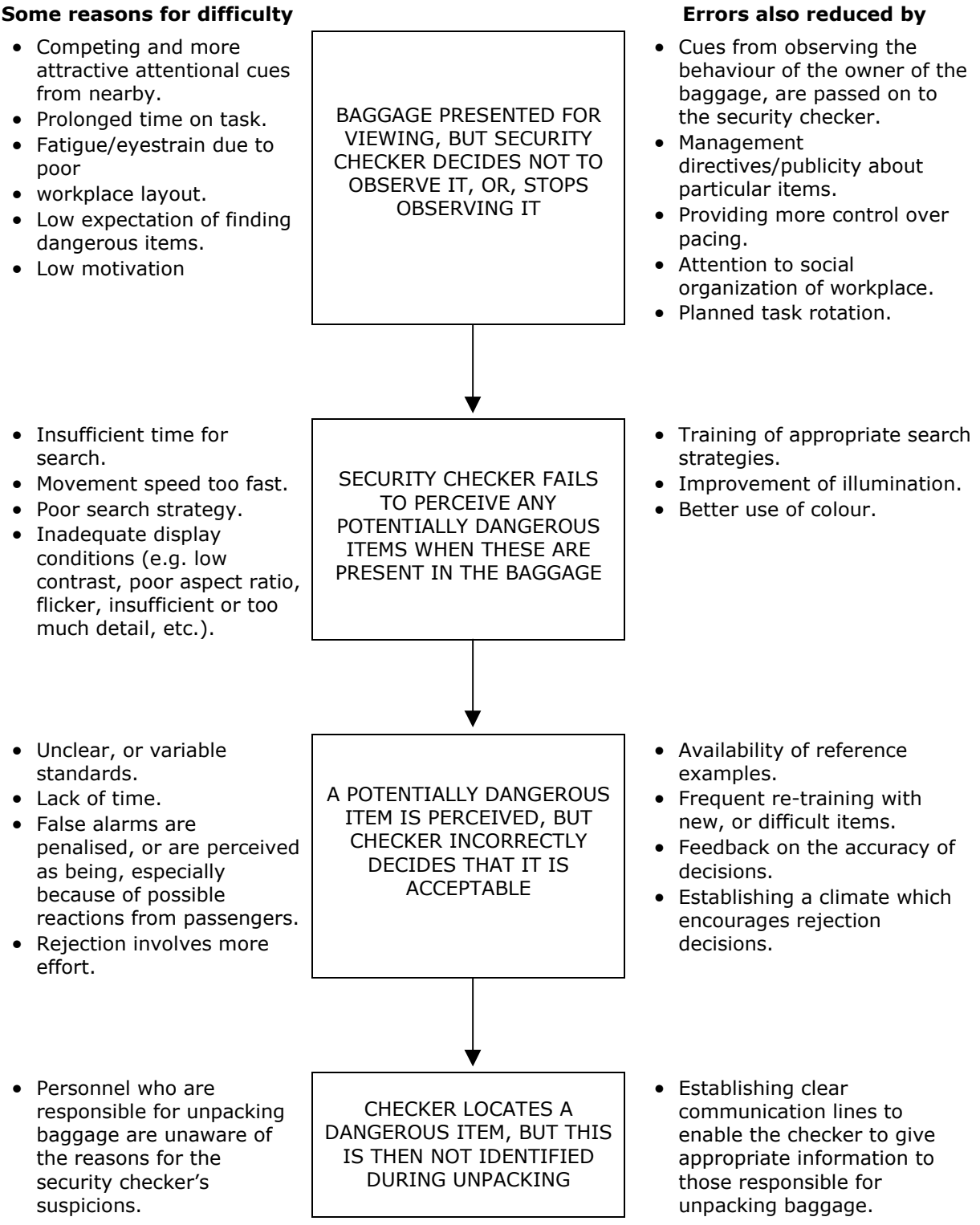

Figure. 1 *Possible human errors during the examination of baggage, that could permit a potentially dangerous item to remain undetected*.

The most modern X-ray inspection systems present a coloured image, using false colour to define different X-ray densities, to the checker and permit the movement of the item, or its image on the VDU screen, to be halted for more detailed examination. However, some older X-ray systems only provide monochrome images and the rate of movement past the observers may be set rate, so that the checker has little, if any, control over the inspection rate. However, it must be stressed that even where the observer has direct control of the inspection rate, there is implicit external pacing due to passenger flow, which Gale *et al*. (2000) consider is between six and ten seconds per item.

If the checker identifies any item that they are unsure of, the baggage is unpacked and then examined visually by another checker. Thus, there are a large number of false alarms, but the cost of dealing with these is relatively low and so this high false alarm rate is tolerated by the airport authorities. However, it is the manual checking that causes many of the delays, and whilst many passengers are comforted by seeing these checks, others are irritated by them.

PERFORMANCE ISSUES

X-ray aided baggage examination shares many of the characteristics of industrial visual inspection and the examination of medical X-rays (for a comparison with medical X-ray examination, see Gale *et al.* (2000)), in that it involves a repetitive visual search for particular target items that must then be classified as being either acceptable, or meriting further investigation. Thus, from a psychological perspective there are four sets of issues that must be considered:

1. The perceptual cues must be made as prominent as possible, so that targets stand out very clearly. These aspects of performance can be measured using a psychological theory known as signal detection theory (SDT), in terms of the '*detectability*' of targets. In the X-ray inspection situation this is achieved by providing clear contrasts between potential targets and more innocuous items, by reducing speed and direction of movement effects, and by pacing the inspection rates so that there is sufficient time for targets to be detected from a complex background.
2. Ensuring that, when a checker has to decide about a borderline item, they must make a cautious decision and select that luggage for a manual search. It is important to note that this is a different construct from detectability, so that two people seeing exactly the same perceptual information may treat it differently because they have adopted different accept/reject criteria. SDT defines this as the observer's 'criterion' and it is influenced by different factors than detectability. It is not sufficient just to instruct the checkers to reject all items if there is any doubt, because different individuals will set their rejection criteria at different points. Therefore, it is necessary to design the tasks in a way that reinforces a cautious criterion. In particular, the checkers must be isolated as far as possible from inadvertent social pressures that can build up when the manual checkers have become overloaded, or there is pressure from passengers.
3. After undertaking any visual monitoring task for even a limited time, the observer's vigilance starts to decline and performance is degraded. This situation is exacerbated by lapses of attention when there are other perceptual cues competing for the observer's attention. The psychological theories of vigilance, arousal and attention can provide help to understand these issues and there are proven ways to reduce the vigilance decrement and to sustain attention that have been applied effectively to improve similar tasks.
4. There are, presumably, a relatively small number of potentially dangerous items, thus the bulk of the feedback that the checkers receive is from false alarms, which will tend to make them adopt less cautious criteria. In the US attempts have been made to overcome this situation by introducing artificial targets, known as threat image projections (TIPs), that can be added to the images obtained directly from baggage. By interspersing these during normal work, the operators can then be provided with feedback about their detection performance. However, it is necessary

to use a large number of these artificial targets and to update them regularly. Otherwise, there is a risk that the operators could be sensitised to looking for artificial targets and could ignore real targets that did not conform to the target library that they had become accustomed to.

By focusing upon these psychological performance issues it is reasonable to expect that detection rates could be considerably improved. Such changes to the task and interface design for X-ray assisted baggage examination could also have important the important spin-offs of improving motivation, which would mean that more experience would be retained, and of reducing the cost and disruption of the current very high level of false alarms.

Passenger Checking

Passenger checking is usually undertaken by metal detection and explosive detection devices, supported by manual body searches. The detection aids are either walk-through systems, or else hand held monitors are used to scan passengers. In either case, the operator is alerted to a potential problem by a clear auditory or visual signal that is given if a particular criterion level is exceeded. Unfortunately, in many cases, there is such a high false alarm rate that the task has changed from one of detecting dangerous items, to one of trying to explain the reason for a signal. This is completely unsatisfactory and the social pressures upon the checkers from irate passengers can be very high. This must predispose the checkers to accept spurious reasons for the sensors being triggered, which is clearly undesirable.

It is also clear that during body searches most personnel adopt relatively invariant search patterns that often ignore particular body areas. During busy periods, there can also be strong social pressures to rush these inspections.

Much can be done to overcome some of these problems by providing more training, but it is considered that there is also an urgent need to redesign these tasks.

Access Control

Access control to the air side of airports is largely governed by the use of magnetic cards, access codes and identity badges. However, the success of these systems is also heavily dependent upon personnel fully complying with the security procedures. For example, the most sophisticated card systems can be negated if doors are held open so that the magnetic swipe card is not needed. Therefore, most security systems will only be effective if the procedures are not cumbersome and easy to bypass.

In many ways access control systems are similar to the requirement within high risk industries for personnel to comply with safety regulations and procedures. Human factors has done much to reduce the risk of violations of safety regulations. This involves designing procedures and interfaces in a way that makes unsafe behaviour less likely, often by preventing dangerous shortcuts. This is backed up by the development of a safety culture that makes safety a prime focus for both management and personnel. A similar approach could be adopted to security issues, by making it easier to comply with security requirements than to get round them and by improving the security culture, so that all personnel assume more responsibility for checking that others have the necessary identification for accessing particular areas.

An important feature that would be helpful in developing such a security culture would be the establishment of a comprehensive ‘no blame’ reporting system for security violations.

Perimeter Checking

The boundaries to the secure areas of an airport are monitored by patrolling these areas and by monitoring them by video or infra-red systems. There have been several human factors studies of performance at monitoring banks of video screens and the results from these should be applied directly to the airport security situation.

Selection and Screening of Security Personnel

Although it is clear that some individuals are better suited to particular security tasks than others, there appears to be only limited effort made to develop effective selection tests that could predict whether a person possesses the necessary perceptual and decision-making skills that are the prerequisites for particular security tasks. These could include using tests of criterion level (decision-making cautiousness), perceptual abilities, spatial memory, or visual search for the selection of security personnel. This appears to be a fruitful area both for improving overall task performance and for reducing turnover.

There is also a human factors role in the security clearance procedures that are used to vet potential security staff before hiring. This can involve manual checks and cross-comparisons of different information and databases, often undertaken against some time pressure, because of the large volume of checks that have to be made. Thus, in order to minimize the risk of incorrectly clearing someone who does not meet all the required security criteria, it is necessary to undertake a human factors assessment of the security vetting processes themselves.

Conclusions

The words of Harris (2002) provide a clear indication of the importance of considering the human element in airport security. He summarised these tasks by stating that "*… they require people to perform tasks, under performance-degrading conditions , that they are ill-suited to perform in the first place*" and the limited evidence about detection performance confirms these sentiments. These are as true today as they were when I first became interested in airport security issues before the Lockerbie disaster. In the intervening period there has been some interest in human factors issues, but this appears to have been largely focused upon training and visual search issues. In the UK, this lack of interest in human factors issues is highlighted by the fact that only one out of seventy organizations listed as being involved in aviation security had any human factors capability and this was limited to the selection and training of X-ray examiners (Trade Partners UK, 2002).

Whilst training is certainly important, the impact of any improved training upon detection will always be limited if the jobs that airport security personnel undertake are themselves suboptimal. However, it unfortunately appears that many of the fundamental human factors issues associated with improving perception, reducing the vigilance decrement and increasing compliance with security procedures and regulations have, to a large extent, been ignored. Thus, many of the unique human abilities that could be used to improve airport security are being ignored whilst humans struggle to undertake many tasks that have developed in a way that often makes them needlessly difficult.

Certainly, it is *Synergy's* view that more attention to these human factors issues, particularly the increased application of SDT and vigilance theories, would lead to significant improvements both to detection performance and to preventing the cost of airport security from spiralling out of control. This latter point is important; because if airport security checks become too intrusive, then to some extent one of the terrorists' goals has already been met.

In order to improve the human factors aspects of all airport security tasks it is necessary to approach these issues at both a national and a more local level.

- At the national level there is still much fundamental research that is necessary to fully understand how particular factors can influence human performance. The results of such research must then be disseminated within the industry. It would also be beneficial to develop confidential national reporting systems to record failures of any layer of airport security in order to identify potential human factors weaknesses.
- At the local level, the airports authorities can take some actions that would have a more immediate impact upon specific security tasks by undertaking human factors audits and then implementing the recommendations of these. There is also an urgent need to develop tests of detection performance for key tasks that could be used at the airports to monitor the performance of either individuals or systems.

- Finally, the manufacturers of security equipment must become more aware of human factors issues when they are developing or redesigning their products. Often a relatively modest investment in considering human factors can have a marked impact upon human errors using the interfaces that are provided.

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