CARGO SCREENING:

ENHANCEMENT OF HUMAN FACTORS

In the last decade, security measures have been strengthened substantially in passenger screening. Interestingly, cargo screening did not quite follow suit at the same pace, despite its relevance to the global economy and the fact that cargo is often transported by passenger aircraft. Most ports and airports now use X-ray security screening for unit load devices (ULDs) and containers. This technology is particularly useful as it provides an image of the content of ULDs or containers without the need for physical interference. Yet it is still the human operator (security officer) who needs to identify prohibited items in the X-ray image and take the decision on whether the inspected unit can be regarded as harmless or not. Marcia Mendes, Stefan Michel and Adrian Schwaninger explore how we can enhance operators’ ability to identify threats. Most X-ray systems are, after all, only as good as the people tasked to interpret the images they generate.

According to visual cognition and object recognition theories, objects which are dissimilar to the ones stored in visual memory are difficult to recognise (see [1] and [2]). According to [3] knowledge-based and image-based factors have a large impact on human detection performance. Knowledge-based factors relate to knowing which items are prohibited, what they look like in X-ray images and how they can be distinguished visually. They are especially relevant for objects that are rarely seen in everyday life and that look quite different in an X-ray image (e.g. improvised explosive devices - IEDs). Image-based factors refer to characteristics of X-ray images. Objects are more difficult to recognise if depicted from an unusual viewpoint or when superimposed by other objects (effect of superposition). Recognition is also affected by the complexity of the image which depends on the number and types of other objects.

Compared to passenger screening, in cargo screening, taking the decision whether the ULD or container is OK or NOT OK is even more difficult since the inspected containers can be very large while the prohibited items can be comparatively small (e.g. an IED or contraband goods). Taking human factors into account is therefore of utmost importance for improving cargo security screening. Pre-employment assessment, computer-based training (CBT) and competency assessment are powerful tools to enhance human factors as has been shown in several applied research studies.

Pre-employment Assessment

The abilities required in security screening are not equally common for all individuals (see for example [3] and [4]). Reliable, valid and standardised pre-employment assessment tests are important to select persons who are suited for the security screening task. The X-Ray Object Recognition Test (X-Ray ORT) is an example of such a test, which was developed based on applied visual cognition research [5]. It contains images of passenger bags, yet, this test may also be used by applicants for cargo screening positions, as the abilities to cope with effects of viewpoint, superposition and image complexity are also important in cargo security screening. The test contains 256 images of passenger bags in greyscale and prohibited items with common shapes (guns and knives) to accommodate the limited knowledge of novices. Threat items are depicted from different viewpoints, at different levels of superposition by other objects and depicted in X-ray images of varying complexity. The test can measure in a reliable, valid and standardised way how well applicants can cope with image-based factors such as effects of viewpoint, superposition and bag complexity (for more information see [3], [5] and [6]).

Computer-Based Training (CBT)

Training is of utmost importance regarding knowledge-based factors. Screeners need to learn which prohibited items exist, what they look like in reality, how they appear in X-ray images and how they can be visually distinguished. CBT can be a very effective tool for the enhancement of human factors (see [2]). In this context, individually adaptive training software such as the X-Ray Tutor (XRT), which contains training levels based on the user’s individual detection performance and learning progress, has shown to be very effective in strengthening X-ray image interpretation performance in cabin and hold baggage screening (see [6], [7], [8] and [9]). Whether this also holds true for X-ray cargo screening was investigated in a study that is described in more detail below (for more information on advantages and considerations regarding CBT see [10]).

Competency Assessment

Initial and recurrent certification is used to assess screener competency. This allows for quality control and provides valuable information to evaluate the strengths and weaknesses of X-ray screeners.

However, there are challenges to the implementation of security screening certification tests, namely in the form of questions regarding the precise competencies to be assessed, the specific method of implementation, as well as the issue of international standardisation. The certification results are of high relevance for authorities and security providers alike, and so the tests employed should meet scientific criteria. In fact, decades of psychometric research have shown that reliability, validity, standardisation and fairness are essential qualities of a test.

An example of such a test is the X-Ray CAT for cargo screening (C-CAT). This test was developed based on the X-Ray CAT CBS, a test for cabin baggage screening, which is applied at several European airports for screener certification. It was developed to be a reliable and valid instrument in accordance with scientific principles (for detailed information on the X-Ray CAT CBS see [3] and [11]).

Training Evaluation

As an example of training evaluation in the domain of cargo security, a recent study investigated whether a customised CBT can improve the X-ray image interpretation competency of cargo screeners (see [12]). The XRT training system was adapted to fit the needs of cargo screening (C-XRT) for the study. The task of the trainees was to categorise ULD X-ray images as OK or NOT OK and to mark any prohibited items. Figure 1 contains an example in greyscale and in pseudo colours.
During training, the user received an immediate response feedback on whether the answer was correct or not. In case a prohibited item was contained in the image, information on this item was also provided. The study was conducted in collaboration with TNO (the Dutch Organisation for Applied Scientific Research) and Dutch Customs. In order to evaluate the effectiveness of the implemented training software, two groups were formed, one training group and one control group. The training group conducted recurrent C-XRT training (at least 20 min. per week) for three months, whereas the control group did not conduct any training. The C-CAT was utilised to test detection performance before and after the training period. The C-CAT was composed of 240 images, half of which contained prohibited items relevant for customs (e.g., drugs, weapons) as well as security screening (e.g., explosives, IEDs). The task of the screeners was to distinguish between clear images (OK) and images containing prohibited items (NOT OK). The results of the study revealed significant increases in detection performance for screeners having trained weekly using the C-XRT, while the control group did not improve significantly (see Figure 2). The effect of training was particularly high for the detection of IEDs. A higher number of training hours resulted in better test performance on the level of individual participants. Results were similar for displays in greyscale and pseudo-colour. Further, a general decrease in the inspection time per image was revealed for the second measurement. It is noteworthy that the baseline detection performance before training was rather low for certain prohibited items, further underlining the significance of training for cargo X-ray screening.

Conclusion

Given the importance of cargo security for the functioning of the global supply chain, the challenges it poses should be tackled swiftly. The interaction between human operators and security screening machines deserves attention as efficient and effective screening of large ULDs and containers is a very demanding task, and the final decision remains with the screeners. The human factor in cargo X-ray screening can be taken into account by means of effective pre-employment selection tests, CBT and standardised, reliable and valid competency assessment tests. Scientific results have demonstrated that there is large po-tential for improvement, not only in cabin and hold baggage screening, but also and particularly in cargo screening. The use of customised CBT can significantly improve the detection performance in this important security domain.

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References:


