SCIENCE & SECURITY November 2012

CASRA NEWSLETTER – ISSUE 2

We have received very positive feedback regarding the first issue of our newsletter Science & Security and would like to thank all readers for their interest.

In the first issue we focused on two important aspects in X-ray screening: The systematic selection of personnel and the development of reliable, valid and standardized certification tests. In the second issue we complement these topics by presenting which characteristics a computer based training system needs in order to increase image interpretation competency of X-ray screening security officers (screeners) efficiently and effectively. Well-trained screeners are essential for achieving and maintaining high security standards and high-quality training is an important prerequisite to successfully pass certification tests.

The second article in this issue of Science & Security is a report on the IEEE International Carnahan Conference on Security Technology that was held in Boston, USA, in October 2012. We briefly describe this important conference with a long tradition and present a summary of a paper and presentation by CASRA on blended learning in air cargo.

We wish you a nice end of the year with good ideas and thoughts for 2013 and we are looking forward to continue our information exchanges, collaborations and partnerships!

Prof. Dr. Adrian Schwaninger   Dr. Diana Hardmeier

TOPICS IN THIS ISSUE:

RESEARCH PUT ACROSS

PAPER ON BLENDED LEARNING AT THE IEEE INTERNATIONAL CARNAHAN CONFERENCE ON SECURITY TECHNOLOGY

Scientific conferences on security related topics are important platforms for information exchange and innovation. This year, a delegation of CASRA once again participated at the IEEE International Carnahan Conference on Security Technology (IEEE ICCST) and presented two papers. One of them, a study on the application of blended learning in air cargo security, is summarized in this issue. The second paper will be presented in the next issue of Science and Security.

SECURITY IN PRACTICE

COMPUTER BASED TRAINING FOR SECURITY OFFICERS – WHAT SHOULD BE CONSIDERED?

Computer based training (CBT) for security officers is an important topic to be considered for every security provider. This article explains the benefits of CBT, which CBT offers the biggest advantages and which aspects should be taken into account when deciding on a particular system.

CASRA

PAPER ON BLENDED LEARNING AT THE IEEE INTERNATIONAL CARNAHAN CONFERENCE ON SECURITY TECHNOLOGY

Text: Philipp Sury, Marcia Mendes & Sandrina Ritzmann

Conferences, congresses and symposia are important events for security practitioners and researchers alike to disseminate ideas, exchange information, review recent developments, discuss trends and stimulate innovation. In this article, we would like to give you an overview of the 46th IEEE International Carnahan Conference on Security Technology (IEEE ICCST) that was held in Boston, USA, from October 15th to 18th 2012, with a special focus on the CASRA presentation on blended learning.

Since 2004, representatives of CASRA have been attending the annual IEEE ICCST to share their latest findings and learn from others. The conference is sponsored by a number of international organizations that share a common interest in the exchange of information related to security technology. IEEE ICCST creates a forum where engineers, physicists, scientists, security professionals and social scientists come together to communicate and discuss the research and development in the field of electronic security technology, operational testing of technology, as well as to disseminate ideas and information on both new and existing technology and systems. Every year, selected research studies are presented to the conference participants and the corresponding papers are printed in the conference proceedings. The IEEE ICCST is the world's longest-running international technical symposium on security technology. Since the 1968 conference, the contributions to security technology are documented and published through its proceedings.

The sessions of this year's conference covered topics of wide general interest, such as security systems engineering and evaluation, biometrics, information security, wireless communications, transportation security, advanced technologies and adaptive systems, insider threats, and video and imaging.

Members of CASRA have continuously attended the IEEE ICCST since 2004 to present the current status and the results of the research conducted at our center and to share and exchange knowledge, specifically in the field of aviation security. In previous years, research on topics such as computer-based and web-based training in X-ray screening, security screener performance, selection and pre-employment assessments of security screeners and the evaluation of screening technologies has been presented and published. This year, representatives from CASRA have presented two studies. The first study investigated how leaving laptops inside passenger bags affects detection performance of X-ray screening officers, when state-of-the-art technology providing single-view images is used. The study will be described in more detail in the next issue of our newsletter (March 2013). The second study dealt with the implementation and evaluation of blended learning in the field of air cargo security and is described in the next section.

BLENDED LEARNING IN AIR CARGO SECURITY

Terrorist attacks on air cargo pose a major threat to an important pillar of the world economy. Because a considerable amount of air cargo is transported on passenger flights, attacks also endanger the lives of travelers worldwide. In order to reach the required level of security, extensive security measures need to be implemented. As there is always a human operator at the end of the decision process whether an object is secure or not, high quality

training of screening officers still is a key factor for success despite the high standards of modern technology. One aspect of training is computer-based training (CBT) of X-ray image interpretation[1]. However, theoretical and practical training content such as knowledge of threats, handling of equipment and detection of suspicious consignments, even in situations when technical measures (e.g. X-ray) do not indicate any threat, are of high importance as well.

The study presented at the conference investigated the effectiveness of blended learning for theoretical (e.g., knowledge of recent terrorist incidents in aviation) and practical training (e.g., handling of X-ray machines) in air cargo. Blended learning is a combination of CBT and training by an instructor in a face-to-face (FTF) setting. The goal is to draw from the strengths of both

training methodologies to create a comprehensive and efficient learning experience.

In cooperation with a handling agent, a balanced and concerted blended learning program was introduced (consisting of basic training and refresher training; see also [1]). Training was designed in a collaboration of subject matter experts and CASRA learning experts. The CBT followed Gerson's guidelines for online classes ([2]) as presented in Table 1. It was implemented on the CASRA Learning System platform, a learning management system that allows the creation, implementation, and evaluation of web-based courses (see Figure 1). Using theoretical approaches rooted in learning science to design and implement highly practice-oriented content that appears concise and learner-friendly is a vital success factor

of blended learning, but needs considerable psychological expertise.

To assure the quality and effectiveness of the blended learning program, trainees were given questionnaires to evaluate the courses. Furthermore, their success in the written and practical exams conducted at the end of the courses was taken into account. Questionnaire results showed a high satisfaction among trainees with the blended learning program concerning its overall success, its basic conditions, training sessions, instructors, and quality of the software products used. Training sessions were for example judged as appropriate in length, practically relevant and highly varied in their content. Instructors were, amongst other things, rated as competent, able to help, and following good didactics. Regarding the exams, all trainees passed successfully.

STEP	ACTION
EXPLAIN	Used to motivate the trainees by explaining the lesson's purpose and connected benefits.
CLARIFY	The main part where theory and the learning content in general is being presented.
LOOK	In this part, one or several examples are being presented to illustrate what was previously discussed in theory.
ACT & SHARE	In this part, trainees are supposed to act and work with the learning content, for example by solving problems, write summaries, give presentations, engage in group discussions, etc.
SELF-EVALUATE	In the self-evaluate part, trainees solve test questions autonomously to verify whether they have reached the lesson's learning objectives or not. Based on this verification, they are supposed to go back and restudy relevant parts or move on to the next chapter, discussions, etc.
SUMMARY	The summary provides a "take home message", in other words the most important parts of the lesson condensed into a few short sentences to be more easily remembered.

Table I: The E-Class structure of a blended learning lesson

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[1] See other article in this newsletter.

Despite the highly positive results, a few aspects still leave room for improvement. First, the study had the nature of a pilot project, with a small number of participants. Future evaluations should include more trainees. Second, trainees wished for a more elaborate course book. The course book was kept short because all content was available and accessible online. However, trainees would have preferred a reference book in paper format. Third, observations by instructors showed that trainees skipped text in the e-learning modules although text passages were kept as short as possible. A further improvement of the learning content would thus be to find other presentation formats that convey the same amount of information as text and support learning, but are more entertaining than text. Especially a higher amount of interactivity seems promising for future blended learning programs.

In summary, the study showed that the CASRA blended learning approach is of high quality and effectiveness. Reactions to the presentation at the conference were very positive and showed high interest in blended learning, not only in air cargo security, but also in other security areas.

Blended learning, the CASRA Learning System and the importance of a scientifically founded psychological approach to the design of blended learning will be treated in more detail in a future issue of this newsletter. Also, you can contact Philipp Sury for further information: philipp.sury@casra.ch. The full conference paper can be downloaded here [Download PDF].

REFERENCES

[1] Ph. Sury, J. Nef, A. Schwaninger, Improving secure handling of air cargo by means of web based blended learning. *Proceedings of the 45th IEEE International Carnahan Conference on Security Technology, Mataro Spain, October 18–21, 2011.* [Download PDF]

[2] S.M. Gerson. (2000, Dec.). E-CLASS: creating a guide to online course development for distance learning faculty. *Online Journal of Distance Learning Administration.* [Download PDF]

Figure 1: Element of a learning module created and displayed inside the CASRA Learning system

COMPUTER BASED TRAINING FOR SECURITY OFFICERS – WHAT SHOULD BE CONSIDERED?

Text: Sandrina Ritzmann, Slavtcho Groshev & Alex Kunz

X-ray screening is an inherent part of the security measures taken at airports and in other sensitive areas such as courts or prisons. In the European aviation sector, security officers operating X-ray machines are mandated to train six hours every six months (see EU regulation EC 300/2008 and commission regulation EU 185/2010).

This article deals with the question why training of X-ray image interpretation is extremely important, what role computer-based training (CBT) plays and what characteristics and aspects are important for high-quality CBT.

Depending on the number of passengers or cargo handled, security officers deal with X-ray images for several hours a week – do they still need training? The answer is yes. Research has shown that visual knowledge of threat items and their appearance in X-ray images (the so-called knowledge-based factors) is one essential prerequisite for good X-ray detection performance.

This knowledge has to be acquired and maintained through regular training. The reason is that quite often the X-ray image differs substantially from the regular appearance of an object, and some objects, such as Improvised Explosive Devices (IEDs), are hardly ever seen in everyday work. Thus, training is needed to assure that security officers know what prohibited items look like in X-ray images to successfully detect them.

In this line, a number of studies have shown that training with computer-based systems could significantly improve the image interpretation competency of security officers.
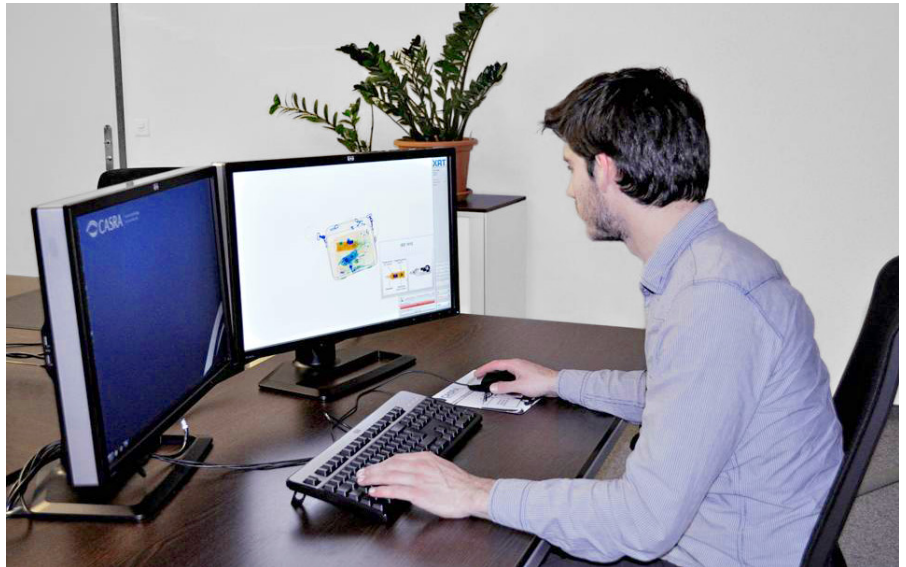
ADVANTAGES OF COMPUTER-BASED TRAINING

Given the fact that training is needed, the next question is what kind of training is optimal to enhance the image interpretation competency of security officers. Which form of training is the most adequate depends on the type of skill that is trained. To specifically target the visual knowledge of prohibited items, CBT has several advantages over forms of training that are conducted face-to-face such as classroom training, practical training, or training on-the-job (although these forms are certainly useful for other skills).

One advantage of CBT lies in its function as a standardized training tool, meaning that once a training system has been implemented, it can be used effectively by a large number of people.

Furthermore, the individual progress is flexible and not dependent upon an instructor or other trainees (as it would, for example, be in a class setting) allowing for higher training efficiency. The flexibility of CBT is also important because it facilitates the implementation of distributed practice. General research on human learning and training has shown that regular, distributed practice sessions (e.g. 20 min. of training every week in the case of X-ray screening) lead to better results than "massed" practice (e.g. several hours of training at once every few months).

Other very important aspects of CBT are its capacities for progress measurement and skill assessment. For instructors in a face-to-face setting, it is very challenging to measure progress or assess skills in an objective and reliable manner, especially when dealing with a large group of people. CBT also provides direct user interaction and feedback, which can easily make it more motivating than instructor-centered training.

However, not every CBT is good just for the sake of it. There are important

aspects to consider when the quality of CBT is assessed. Two facets will be highlighted in more detail below.

INDIVIDUALLY ADAPTIVE TRAINING

A first central aspect to consider is whether the CBT is individually adaptive or not, since this functionality makes a big difference in the effectiveness of training. In a study of CASRA researchers, the effectiveness of recurrent CBT for security officers after three and six months of training at two European airports was compared. In each setting, one group of security officers used the X-Ray Tutor (XRT), an individually adaptive CBT, while the other group used conventional, non-adaptive CBT. All participants did approximately 20 minutes of training per week.

The results showed large training effects for the individually adaptive training system, particularly for IEDs. The tested non-adaptive CBT systems failed to produce training results in one case and resulted in rather small improvements in the other. **A number of explanations can be given for the higher effectiveness of the adaptive CBT system**, two of which are of special interest:

› The XRT features **adaptive training algorithms**, taking each trainee's progress and weaknesses into account. More specifically, each security officer progresses individually through the training levels with increasing difficulty depending on his or her skills. Additionally, prohibited items that were not correctly recognized are shown more often to the trainee until they can be identified successfully.

› The individually adaptive CBT works **with dynamic combinations of threat items and bags as opposed to the fixed combinations of the conventional systems**: the X-ray images in training are created "on-the-fly" by a merging algorithm. This feature is vital for the adaptiveness of the training system because it allows for the presentation of individual threat items that are difficult for the respective person without showing the trainee the exact same image (bag and threat item) over and over again. Furthermore, the merging prevents that trainees simply learn the images by heart, because it is highly unlikely that the algorithm composes the same image twice (especially when drawing on a large image library, see below).

Speaking of training levels, difficulty and merging, it should be pointed out what lies at the heart of the individually adaptive algorithm. In addition to the knowledge-based factors mentioned above, the so-called **image based factors** significantly influence detection performance in X-ray screening: These factors are **bag complexity, superposition and viewpoint** of the threat item.[2] In a complex bag with a high number and variety of other objects, threat detection is complicated because one's attention is distracted. If an object is superimposed by other objects, it is more difficult to recognize. Finally, an unfamiliar viewpoint hinders one's ability to recognize an object. An individually adaptive algorithm has to systematically vary these aspects to gradually increase the difficulty of training along with the progress a trainee is making. The prohibited objects to which the security officer did not correctly react receive a higher priority and are then presented with a level of superposition and bag complexity that individually meets the competence of the trainee.
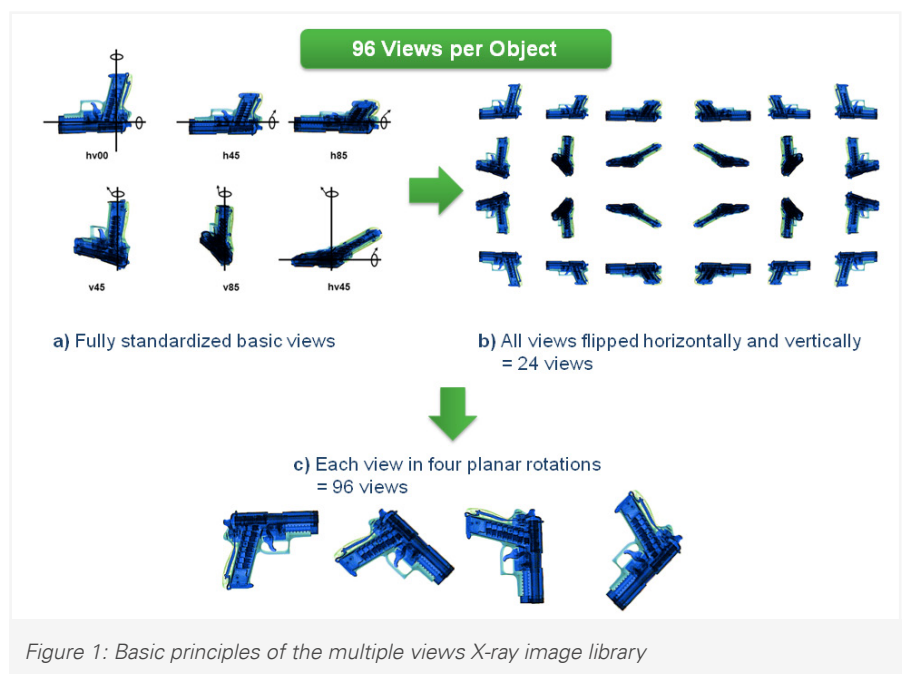

96 Views per Object

hv00   h45   h85

v45   v85   hv45

a) Fully standardized basic views

b) All views flipped horizontally and vertically = 24 views

c) Each view in four planar rotations = 96 views

Figure 1: Basic principles of the multiple views X-ray image library

[2] For more information on image-based factors, see the first issue of our newsletter, Science & Security.

But for any adaptive system to be able to do this, a high-quality image library with a large number of bags and different views (rotations) of the prohibited items is essential. This is the second facet of a good CBT.

QUALITY OF IMAGE LIBRARIES

What makes for a high-quality image library? First, it is the nature and quality of the images included and second, it is their quantity. Regarding the nature of the images, especially the image-based factor of viewpoint should be considered. **Only if several different rotations of a threat item are included in the image library, its recognition can be adequately trained**. But which rotations or viewpoints are essential?

Research on visual cognition indicates that if the human brain knows six basic views of an object (0°, 45°, 85° and 135° rotations), it can be recognized from most possible viewpoints through visual interpolation. Thus, a high-quality image library should take these basic views into account.

On this basis, a training software accessing the image library can work with the horizontal and the vertical mirror image of every basic view and four planar rotations, resulting in 96 views per object. What sounds rather complex is illustrated in Figure 1. Concerning the quality of the images in the library, careful construction of threat items (e.g. IEDs), their recording and the processing of the images by security experts is essential. Ideal-

ly, a number of the IEDs are built with real explosives.

Apart from taking into account different rotations of threat items, **a good image library should also incorporate a large number and different types of bags and threat items (aspect of quantity)**. The reasons for this are that not all threat items are well known from everyday experience on the one hand, and that even familiar items can look very different in an X-ray image on the other hand. Furthermore, if the training system is to present new images to the trainees in every training session to prevent them from merely memorizing the images, a large number of bags and threat items in the image library is needed.

INFOBOX: FURTHER ASPECTS TO BE CONSIDERED WHEN EVALUATING CBT PRODUCTS

1. Is the content compliant with international regulation (EC 300/2008 and EU 185/2010) and can it be customized to national and airport specific aviation security training and testing regulations?

2. Was the CBT developed using a well-structured and managed process involving subject matter and psychological experts as well as professional software developers?

3. Is consulting provided on how to introduce the CBT in your company?

4. Is the system easy to use for trainees and supervisors?

5. Does the CBT contain functions to provide feedback and measure learning progress and training effectiveness?

6. Are there management functionalities available for tracking learning progress and training frequency?

7. Does the CBT provide functions to manage the users and assign them to specific courses?

8. Has the effectiveness of the CBT been proven by scientific studies and does the provider know the key principles of training evaluation?

9. Does the provider invest into research and innovation?

10. Does the developer provide updates and is the technical support sufficient for your business needs?

11. Does the system run on your current hard- and software environment including bandwidth requirements?

12. Can the CBT be connected to an existing learning management system?

In summary, individual adaptiveness and large, high-quality image libraries that include current, new and emerging threats are essential for an efficient and effective CBT training. But of course, there are several other points to be considered before investing in any CBT system. They have been described in an article by Schwaninger (see section "Further Reading") and are listed in the info-box on page 7.

To conclude, this article looked at the necessity of training in the area of X-ray screening and outlined the important role of CBT. Furthermore, it was shown that evaluating the quality of a CBT product involves answering a number of questions and especially, having a look at the adaptiveness of training and at the image libraries. To assure that a training program is efficient and effective, this task should be done with careful consideration.

FURTHER READING

Investigating training, transfer, and viewpoint effects resulting from recurrent CBT of X-ray image interpretation:

Koller, S., Hardmeier, D., Michel, S. & Schwaninger, A. (2008). Investigating training, transfer, and viewpoint effects resulting from recurrent CBT of X-ray image interpretation. *Journal of Transportation Security, 1(2),* 81–106. [Download PDF]

Increasing efficiency in airport security screening:

Schwaninger, A. (2004). Increasing efficiency in airport security screening. *Proceedings of AVSEC World 2004, November 3–5, Vancouver, B.C., Canada.* [Download PDF]

The role of recurrent CBT for increasing aviation security screeners' visual knowledge and abilities needed in X-ray screening:

Hardmeier, D., Hofer, F., & Schwaninger, A. (2006). The role of recurrent CBT for increasing aviation security screeners' visual knowledge and abilities needed in X-ray screening. *Proceedings of the 4th International Aviation Security Technology Symposium, Washington, D.C., USA, November 27 – December 1, 2006,* 338–342. [Download PDF]

Computer-based training: advantages and considerations:

Schwaninger, A. (2011). Computer-based training: advantages and considerations. *Aviation Security International, 17(6),* 18–23. [Download PDF]