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CASRA NEWSLETTER – ISSUE 8

Most of our readers have travelled through many different security checkpoints. Some of them are well lit, quiet and offer enough space, others are badly lit, noisy and crowded. Oftentimes, the latter do not make for the best of travel experiences: Even as a passenger, most people feel the impact of situational factors on their well-being and stress level when they pass through the checkpoint.

CASRA researchers wondered which situational factors would affect the task performance of those people who are daily exposed to the checkpoint environment: the airport security screeners. In the section "Research Put Across", we present to you the interesting results of a multi-method study that investigated this issue.

In the article on "Security in Practice", we deal with the topic of X-ray screening as a means of security for the Swiss Armed Forces. More specifically, we would like to show you the steps that we took to integrate X-Ray Tutor as a training tool for X-ray image interpretation competency in the Swiss Armed Forces' internal Learning Management System for online learning.

We hope that one or both of these articles will spark your interest. We wish you a good completion of work this year and are looking forward to providing you with more insights on security in research and practice in 2015!

Prof. Dr. Adrian Schwaninger

Dr. Diana Hardmeier

## TOPICS IN THIS ISSUE:

RESEARCH PUT ACROSS

### SECURITY CHECKPOINTS: WHICH SITUATIONAL FACTORS INFLUENCE THE SCREENING TASK?

Security operators' (screeners) primary work task at the airport security checkpoint is to inspect X-ray images and to decide whether or not the passenger bag is containing a prohibited item. Their performance is of high importance for the overall security of the air transportation system. A recent study by CASRA examined different situational factors and their influence on the screeners' primary work task.

SECURITY IN PRACTICE

### ADAPTING X-RAY TUTOR TO SPECIFIC REQUIREMENTS: A CASE STUDY WITH THE SWISS ARMED FORCES

The Swiss Federal Department of Defense, Civil Protection and Sport (DDPS) is responsible for the protection of Switzerland, its inhabitants and infrastructure. In 2012, the DDPS approached CASRA with the request to integrate the X-Ray Tutor into their internal Learning Management System. For this purpose, very specific adaptations had to be made. This article is going to present to you what it took.

# SECURITY CHECKPOINTS: WHICH SITUATIONAL FACTORS INFLUENCE THE SCREENING TASK?

Text: Nicole Hättenschwiler & Sandrina Ritzmann

**X-ray screeners primary work task at the airport security checkpoint is to inspect X-ray images and to decide whether or not the passenger bag is containing a prohibited item. Their performance is of high importance for the overall security of the air transportation system. A recent study by CASRA examined different situational factors and their influence on the screeners' primary work task.**

X-ray screening at security checkpoints is a process that relies not only on technology but also heavily on human operators (screeners). The primary work task of X-ray screeners is to visually inspect X-ray images of passenger bags for prohibited items and decide whether a bag is OK or not in a reasonable amount of time. Screener performance is dependent on individual factors like the screeners' abilities and aptitudes as well as on training (e.g. [1] and [2]). Additionally, workload, fatigue, stress, anxiety or motivation have to be taken into consideration to get an enhanced understanding of the determinants of task performance. Situational factors also influence task execution and performance. Examples for situational factors are team constellation, interactions with customers or the work environment with its specific climate (temperature, lighting, noise level etc.). If relevant situational factors are known, elements such as task sequence, team interactions or the work environment can be changed to be more beneficial for the workers and for task performance. To our knowledge, the question asked at the beginning - what **situational factors** might influence a screener's primary work task? - has not yet been investigated systematically. One of CASRA's goals is to understand security as a system with its social and technical components (i.e. using a sociotechnical systems approach) and to identify levers for a human-centered task design. Therefore, CASRA researchers conducted a scientific job analysis using a multi-method approach: Different methods were employed in combination in order to identify relevant situational factors at a security checkpoint. More specifically, the research team conducted observations, interviews and an online survey.

## A MULTI-METHOD APPROACH TO EXPLORING SITUATIONAL FACTORS

The aim of using more than one method to collect data was to combine their strengths and foci so that they could complement each other. We first applied qualitative work observation in the Cabin Baggage Screening (CBS) area to identify situational factors. Then, interviews with experts were conducted to gain further insights on which situational factors could be relevant for X-ray screening by human operators. These methods provided the basis for a survey conducted with a larger sample of X-ray screeners in order to obtain ratings of a) how relevant situational factors are and b) how often they occur. But let us take a closer look:

Qualitative work observations using

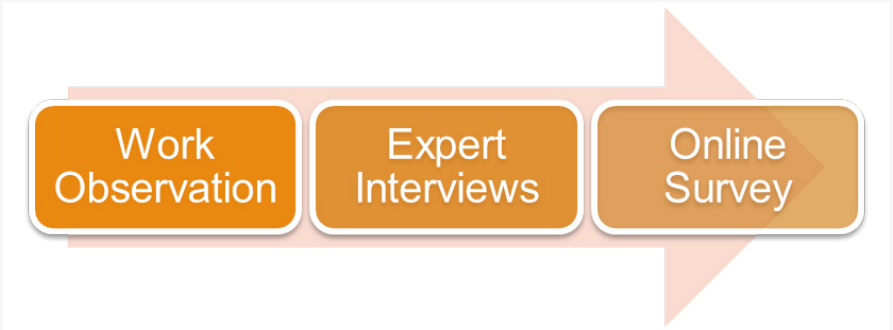


*Figure 1:* The three main components of the multi-method job analysis conducted in this study.

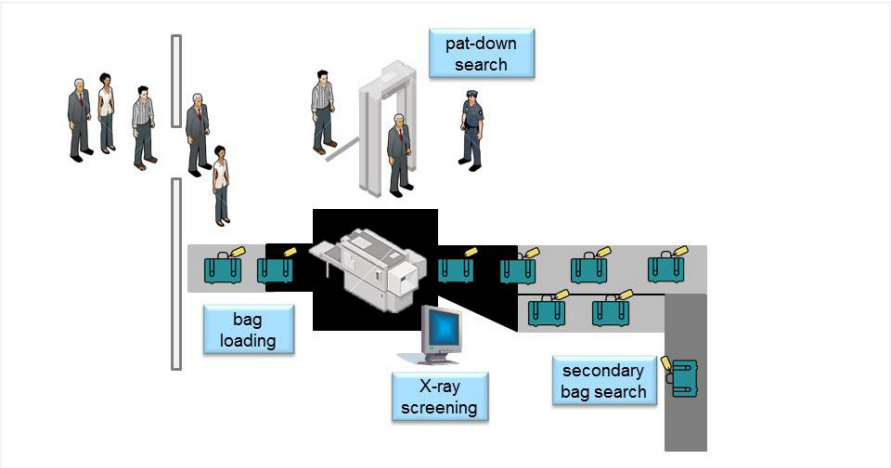


*Figure 2:* Illustration of a security checkpoint with the four positions of screeners (bag loading, pat-down search of passengers, X-ray screening of passenger bags, secondary search of passenger bags).

structured observation protocols were conducted at a medium-sized European airport to gain a first impression of situational factors affecting X-ray screeners' primary work task at the security checkpoint. Typically, security officers work in a crew with four positions (see Fig. 2). The screener at the position of the loader supervises the placing of bags on the conveyor belt. Meanwhile, the screener at the position of X-ray screening (i.e. the X-ray screener) visually inspects X-ray images for prohibited items in passenger bags and decides whether a bag is OK or not. If the X-ray screener decides that there is a suspicious item present (NOT OK decision), the bag will be handed over to the position of secondary bag search for follow-up action (e.g. manual search, rescreening or trace detection of explosives). The fourth position involves resolving alarms of metal detectors by pat-down search of passengers. Screeners rotate between positions over the course of a shift. All four positions were observed. Observations focused on factors related to the screeners' work tasks (uncertain situations, monotony, time pressure, interruptions), their work equipment and the workplace (influence of team and processes, environmental aspects such as noise, temperature and lighting). Observations took place on three occasions covering different work areas and work shifts.

Based on these qualitative observations, expert interviews were conducted. 18 persons participated, including 8 screeners, 2 team managers, 4 sector managers, 2 employees of the personnel dispatching center and 2 employees of the instruction center. The interviews aimed at differentiating previously observed situational factors and at identifying additional situational factors. Interview partners were first asked for relevant situational factors on a general level and afterwards more specifically with questions like "What would you say is influencing the work as an X-ray screener the most?" and "Do you think the passenger queuing has an influence on the X-ray screener? If yes, how and when?"

Observation and interview data were subsequently analyzed and a list of situational factors was assembled. In order to investigate impact and frequency of these factors, a representative online questionnaire survey was conducted in a next step. Altogether, 73 screeners completed the online survey. Each factor found throughout the process of the observations and the interviews had to be rated using a 10-point scale regarding frequency (e.g. "How often do you feel time pressure?") and impact (e.g. "How much does time pressure influence the X-ray screeners' primary work task?").

## RELEVANCE OF SITUATIONAL FACTORS

Taken the data of the three research methods together, the following main categories were derived: a) passengers and their belongings, b) time pressure, c) team work and team constellation, d) interpretation of X-ray images, e) work environment and work equipment, and f) further situational factors and processes. Based on the results of the online survey, the frequency and impact ratings were used to determine the perceived relevance of every situational factor (Table 1). For example, a factor was assigned a high relevance if the screener rated it with a high frequency and high impact in the online survey.

## WHAT DO THE RESULTS TELL US?

When focusing on the factors with high and medium perceived relevance, a number of insights and recommendations can be highlighted. We found that the "nature of the bags" has the highest relevance for the primary work task of an X-ray screener. This was related to the bag's content, i.e. the amount of electronic devices, superposition and bag complexity. The more electronic devices a bag contains, the harder it is to inspect the X-ray image of this bag. As prohibited items can be more or less superimposed by other objects, the presence of many electronic devices

| RELEVANCE | SITUATIONAL FACTOR |
|---|---|
| HIGH | › Nature of bags (bags with many electronic devices, bag complexity) |
| MEDIUM | › Large bags<br>› Transport trays (nature of loading)<br>› Bad quality of X-ray images<br>› Liquids with more than 100ml content<br>› Passengers (fuss and hassle)<br>› Team (communication, work of loader and secondary search, time pressure, poor mood)<br>› Work environment (noise, light, screen reflection, temperature, poor air quality, draughts) |
| SMALL | › Passenger (stressed passengers, delayed passengers, high passenger volume, fluctuation, asking questions, distractions)<br>› Team (distractions, working speed of loader and secondary search)<br>› Briefings of supervisor |
| NONE | › Amount of trays (too many, not enough)<br>› Amount of bags for secondary search<br>› Characteristics of passengers (e.g. effect of age in uncertain situation)<br>› Allocation of bag to passenger |

*Table I:* Relevance of situational factors.

may lead to areas in the X-ray image of the bag which appear dark and therefore could obscure prohibited items (effect of superposition). Furthermore, bag complexity, determined by the number and type of other objects in a bag, can impair detection performance and the primary work task. Superposition and bag complexity (along with the rotation/viewpoint of a prohibited item) have been identified before in several studies as image-based factors that determine X-ray image difficulty (see e.g. [2]). It is interesting that the present study involving a different methodological approach came to the same conclusion. The high relevance attributed to large bags, transport trays (nature of loading), quality of X-ray images and number of prohibited liquids (> 100ml content) should also be interpreted by taking into account the above mentioned image-based factors.

Further situational factors with medium perceived relevance are the passengers and the constellation and communication in the team. The influence of passengers causing fuss and hassle and communications within the screener team working at the airport security checkpoint have already been identified as relevant factors in previous research [3]. Often, passengers are not pleased to have to pass through security and therefore screeners need high interpersonal skills, especially good communication skills. These skills are also required to communicate within the screener team, particularly when considering that screeners mostly are randomly assigned to a crew and especially at bigger airports sometimes might not even know each other. Thus, communication within a team and with passengers can be assumed to play a key role in ensuring an efficient workflow. Also, good cooperation between the team members seems relevant when considering the dependencies between the different working positions of screeners (e.g. bag loading, X-ray screening etc.). One recommendation that could be derived would be to specifically train non-technical communication and cooperation skills in screeners. In aviation, this is for example common practice for air crews (pilots and flight attendants; see e.g. [4]). Another aspect of team work that emerged as relevant is time pressure. It seems that screeners associate time pressure more with the working speed or overt pressure of their team members than with the amount of passengers, although they are the ultimate cause. With time pressure being an important situational factor, resistance to stress could be an important characteristic of the personality of screeners. Thus, it might be advisable to assess this characteristic already during the selection process.

Further, the work environment (noise, light, screen reflection, temperature, air quality and draughts) was already identified to have an impact on performance in previous research (e.g. [5]). Depending on the specific factor, measures such as noise reduction elements around the X-ray screen or anti-glare computer screens can be installed to support smooth task execution.

In summary, this study provided important insights on situational factors that seem to influence screener performance. Extending this research could entail conducting similar studies at other airports and investigating the relationship of situational factors and operational performance measures.

For an in-depth description of this study please contact us at [info@casra.ch].

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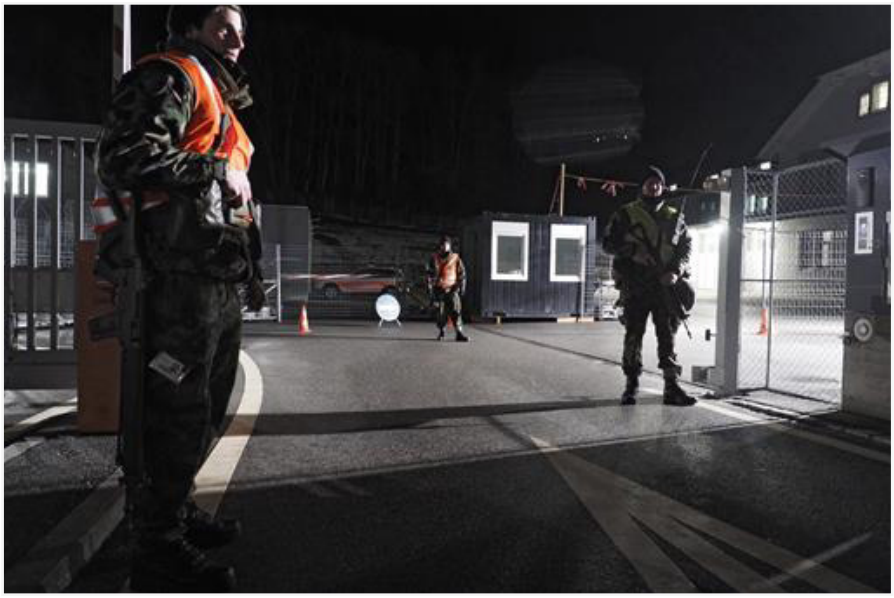
# ADAPTING X-RAY TUTOR TO SPECIFIC REQUIREMENTS: A CASE STUDY WITH THE SWISS ARMED FORCES

Text: Sandrina Ritzmann & Florian Schmid

**The Swiss Federal Department of Defense, Civil Protection and Sport (DDPS) is responsible for the protection of Switzerland, its inhabitants and infrastructure. The Swiss Armed Forces are the main organization to fulfill this task. X-ray screening as a security measure is highly important in this context. Consequently, training of X-ray image interpretation competency is crucial, as it is in other areas such as aviation. In 2012, the DDPS approached CASRA with the request to integrate the X-Ray Tutor into their internal Learning Management System. For this purpose, very specific adaptations had to be made. This article is going to present to you what it took.**



Two organizations within the Swiss Armed Forces employ X-ray screening as a security measure: The Headquarter Battalion (HQ Bat), which is responsible for the protection, security and access controls of important military sites, as well as the Military Police (MP), which assures the security of military events and operations with mobile security checkpoints. The MP is also responsible for the security controls during the World Economic Forum in Davos. Until 2012, X-ray image interpretation training was conducted on a number of stand-alone training stations with local installations of X-Ray Tutor (XRT). This situation proved to be suboptimal to assure sufficient training for all soldiers entrusted with X-ray screening. Therefore, the idea to combine XRT with the DDPS Learning Management System (LMS) emerged. This integration took a considerable programming effort, but with a number of adaptations of the system and the training courses, a tailor-made solution was developed and successfully implemented.

## XRT INTEGRATION: TECHNICAL ASPECTS

The software was installed on a central virtual server that can be accessed from three different internal networks. In total, over 30'000 computers of the Swiss Armed Forces are linked to these networks and provide access to XRT. Usually, XRT is set up as a web service, with a URL leading to the application. However, for the DDPS, it was integrated as a course into the LMS. Technically, the integration was realized through a SCORM interface (see infobox): XRT was linked to the user administration of the LMS on one hand and its reporting and performance monitoring system on the other hand. Whenever a user logs in to the LMS and starts XRT, a process is activated that checks whether the LMS user already exists in XRT. If not, an XRT user account is created automatically. When the user completes his XRT training session, he receives a detailed performance feedback within the application itself. Moreover, information on the status, training duration and result are sent back to the LMS reporting and performance monitoring system, where administrators and trainees can check the training progress. Additionally, administrators can use a predefined URL within the military networks to log in to XRT's own reporting system, where more profound and detailed performance information is available.

## CONTENT AND STRUCTURE: DESIGN OF SPECIFIC COURSES

The X-ray screening task of the two military divisions within the DDPS, the HQ Bat and the MP, differs from the X-ray screening performed at airports. Firstly, all electronic items need to be recognized and inspected. However, only electronic items with data-, image- or sound-recording functionalities or GPS and land survey features are indeed prohibited in classified military facilities. Secondly, guns are prohibited, but with the exception of the service rifles and guns of the Swiss Armed Forces. These special requirements needed to be mirrored in the XRT training content. There-

fore, special training courses were developed for the DDPS.

- First of all, the category electronics was included in addition to the standard categories of prohibited items incorporated in XRT (guns, knives, improvised explosive devices and others). Apart from the response options OK (no prohibited item present) and NOT OK (prohibited item detected), a third button for ELECTRONICS was added.
- Second, adaptations of the image libraries were necessary. A specific image library with a large number of electronics was created to use them in training (XRT merges the training images "on-the-fly" with an individually adaptive merging algorithm, see Newsletter No. 2). Additionally, a specific bag set which does not contain any electronics[1] was provided.
- Third, a way had to be found to train the detection of all electronics and guns on the one hand, but also the distinction between the prohibited and permitted exemplars within these categories on the other hand. The solution was implemented using XRT's response feedback window. When an image contains a prohibited item, the feedback window shows a photograph and the X-ray image of the item. For the DDPS, the indication "service rifle" (category guns) or the indication "prohibited in classified premises" (category electronics) was added to the feedback (see Fig. 2) for the respective items in the categories.

Structural changes to XRT were also made to fulfill the requirements of the DDPS. In general, the levels of XRT gradually increase in difficulty. The difficulty of the presented images is varied based on the three image-based factors bag complexity, superposition and viewpoint[2]. Additionally, XRT is individually adaptive: Objects that were not correctly recognized are shown to the trainee with a higher priority. These characteristics are the centerpiece of XRT's operating mode and were not changed. However, it was necessary to redefine the XRT levels to match the available training time of the HQ Bat and the MP, with a focus on the basic training time of 18 hours. The transition from one level to the next is conditional on the number of images viewed, the hit rate and the correct rejection rate. These parameters were adjusted to allow the trainee to view about 10'000 images during basic training (quantity) and to achieve the maximum possible training effect in this time (quality). The adjustments were made in collaboration with the Swiss Armed Forces based on CASRA's ample experience and scientific studies on the XRT level design. After the adjustments of the training levels, they were mapped onto lessons in the LMS. Level 1 corresponds to lesson 1 and so forth. A lesson is registered as completed as soon as the corresponding level is completed. A lesson can only be started when the criteria of all previous lessons, i.e. levels, have been successfully met.

## CONCLUSION

Summing up, the XRT has been successfully implemented within the DDPS for the Swiss Armed Forces. The system went live in May 2013. Currently, approximately 190 persons train with the program, and an even larger number of people have completed training. At the HQ Bat, trainees are recruits and soldiers during their annual refresher courses, while at the MP, professional soldiers are trained[3].

To CASRA, such non-standard projects offer the opportunity to learn and get insights into highly particular X-ray

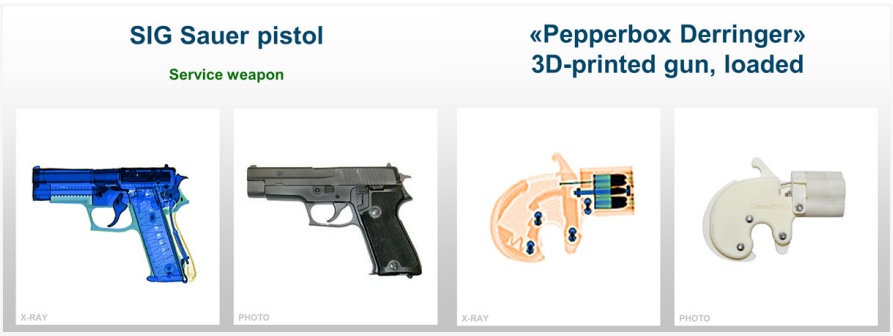



*Figure 2.a: Indication for Service rifles compared to prohibited guns*

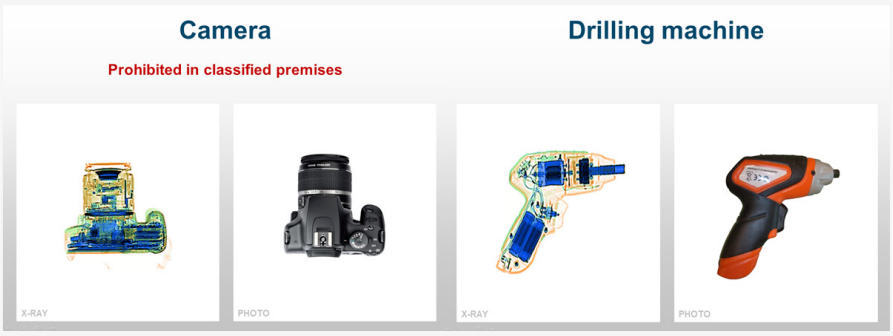



*Figure 2.b: Indication for prohibited electronics compared to allowed electronics*

[1] The bagsets for airports do contain electronics, as they are not prohibited.

[2] For more information on image-based factors that influence the detection of prohibited items in X-ray images see Newsletter No. 1.

[3] The Swiss Armed Forces are organized as a militia system with only a small number of professional soldiers.

screening and training structures. This also helps us to strive for excellence and to further develop our tools and solutions. It has to be pointed out that specific adaptations do not come without considerable effort, but for the vast majority of our project partners, the standard solution with its configurable elements is able to cover all necessary requirements. If this is not the case, it can be concluded from the presented project that XRT is a highly flexible software that allows adaptations to particular situations and circumstances.

### INFOBOX: SCORM IN A NUTSHELL

SCORM stands for "Sharable Content Object Reference Model" and can be described as a set of technical standards for e-learning software. SCORM provides the guidelines for programmers how they should write their code so that it is compatible with other e-learning software. As an analogy, SCORM is similar to the standards of DVDs that assure that any DVD can be played on any type of DVD player. More specifically, SCORM determines how online learning content and Learning Management Systems (LMSs) interact with each other. If an LMS is conformant to SCORM, it can play any content that is programmed according to SCORM, and vice versa, any SCORM conformant content can play in any SCORM conformant LMS. SCORM has emerged as the de facto industry standard for e-learning interoperability. It is a specification that resulted from the Advanced Distributed Learning (ADL) Initiative from the Office of the United States Secretary of Defense. The ADL initiative was launched by the US government to harness the power of learning and information technologies and to standardize and modernize education and training.

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