



SCIENCE & SECURITY March 2014

CASRA NEWSLETTER – ISSUE 6

In the beginning of 2014 CASRA has been able to launch new interesting research projects. Of course, we are going to keep you informed on their findings in our upcoming newsletters.

In this newsletter we continue making new scientific findings available to the public and we show how it can be put into practice.

The first article describes a study that analyzes relevant situational factors which influence the work performance of airport security officers (screeners). It provides reference points on how to maintain and improve performance by focusing on working conditions.

The second article takes a look at how the Canadian Air Transport Security Authority (CATSA) manages its computer-based training for X-ray image interpretation at approximately 80 airports.

We hope that you enjoy reading this newsletter and we welcome any feedback you might have as well as topics you would like us to address in upcoming newsletters.

Prof. Dr. Adrian Schwaninger

Dr. Diana Hardmeier

TOPICS IN THIS ISSUE:

RESEARCH PUT ACROSS

WORKING CONDITIONS AND EMPLOYEE HEALTH: INVESTIGATING IMPORTANT DETERMINANTS OF SCREENER PERFORMANCE

Despite the availability of modern and advanced security technologies, human resources (screeners) at airport security checkpoints are of crucial importance for the inspection of baggage and passengers. Screeners have to make highly relevant decisions in a challenging work environment. This article analyzes relevant situational factors that influence work performance of cabin baggage screeners and provides starting points on how to maintain and improve performance, i.e. security and efficiency, through the enhancement of working conditions.

SECURITY IN PRACTICE

MANAGING COMPUTER-BASED TRAINING OF X-RAY IMAGE INTERPRETATION AT APPROXIMATELY 80 AIR- PORTS – A REPORT FROM CANADA

Wide-area network connectivity is nowadays rather the rule than the exception in large organizations. But how does it work if you need to manage X-ray image interpretation training of 5,000 screening officers at approx. 80 airports in six time zones? The Canadian Air Transport Security Authority (CATSA) allowed us an insight into challenges and solutions.

WORKING CONDITIONS AND EMPLOYEE HEALTH: INVESTIGATING IMPORTANT DETERMINANTS OF SCREENER PERFORMANCE

Text: Nadine Strebel & Milena Kuhn

In order to maintain and improve security and efficiency at airport security checkpoints, it is important to recognize the challenges screeners have to deal with in an airport environment. From a socio-technical system perspective it is assumed that working conditions are relevant for the work performance of screeners by influencing their health. Therefore, work-related stressors and resources were analyzed and correlated with health indicators. Based on the results, recommendations for the design of beneficial working conditions are made.

Despite the availability of modern and advanced security technologies, human resources (screeners) at airport security checkpoints are of crucial importance for the inspection of baggage and passengers. Screeners have to make highly relevant decisions in a challenging work environment. The airport as a workplace in general and the work at security checkpoints in particular impose a number of demands on screeners. These include amongst other:

- › operation of modern security technologies such as X-ray machines
- › social interaction with passengers and staff
- › irregular workload due to high and low passenger flow
- › irregular working hours
- › compliance with strict regulations
- › fulfill covert and overt tests
- › high demands on concentration
- › high degree of responsibility

From a socio-technical systems perspective, the question is how working conditions influence the performance of screeners. The aim of the presented study was to analyze relevant situ-



ational factors that influence work performance of cabin baggage screeners and to provide starting points on how to maintain and improve performance, i.e. security and efficiency, through the enhancement of working conditions.

STRESSORS AND RESOURCES AND HOW THEY INTERACT WITH HEALTH AND PERFORMANCE

Numerous previous research findings suggest that negative aspects of work (so-called stressors) affect performance negatively whereas positive aspects of work (so-called resources) have a positive impact on performance. Furthermore, the effects of working conditions on performance can occur

both directly and indirectly (see [1]). Direct effects of stressors and resources are recognizable, e.g. interruptions which aggravate the screener's work. Indirect effects can occur when stressors (e.g. time pressure) negatively affect a screener's health (e.g. through exhaustion), which in turn affects their performance (e.g. see [2]). These different relations are visualized in Figure 1.

In this study, the indirect relation with work performance was examined by collecting data of health indicators which were then analyzed with regard to their relations to stressors and resources at security checkpoints (see Figure 2).



Figure 1: Relations between stressors, resources, health and work performance.



Figure 2: Topic of the study

SCALES	DESCRIPTION	NUMBER OF ITEMS ¹
STRESSORS		
SHIFT-WORK	Possible strain due to shift-work (irregular working hours)	1 ^a
SURROUNDING FACTORS	Possible strain caused by noise, poor lighting, unpleasant temperature and lack of space	4 ^b
MONOTONY AND CONCENTRATION	Challenge of staying focused while executing repetitive tasks	2 ^c
RESPONSIBILITY AND PRESSURE TO PERFORM	Possible strain because of the responsibility of tasks and constant performance control	1 ^d 3 ⁱ 1 ^e
PASSENGERS	Uncomprehending, disrespectful and unkind passengers	2 ^f
EFFORT	Possible strain because of time pressure, interruptions, disturbances and increased volume of work	3 ^e
RESOURCES		
REWARD	Possible rewards in terms of respect from superiors, positive work situation, job security, respect and prestige, job promotion prospects and adequate salary	7 ^e
RECREATION OPPORTUNITIES	Enough recreative breaks and break rooms available	4 ^g
SUPPORT FROM SUPERIORS	Support from superiors in terms of respect, taking care of promotion prospects, job satisfaction, work scheduling and conflict resolution	5 ^h
SUPPORT FROM CO-WORKERS	Assistance, support and understanding from co-workers	2 ^h
FEEDBACK	Feedback from superiors and co-workers about the quality of work	2 ^h
SUPPORT FROM COMPANY	Support from company in terms of considering private environment, setting a high value on good health and well-being and offering social benefits	3 ^c
INFORMATION FLOW	Adequate information flow by receiving relevant information in time	2 ^h
PARTICIPATION	Possibility to influence shift planning, development opportunities and collaboration	3 ^b
COMPUTER BASED TRAINING (CBT)	Individually adaptive computer based training with X-Ray Tutor (XRT)	4 ⁱ

Table 1: Contents of the survey.

SCALES	DESCRIPTION	NUMBER OF ITEMS ¹
HEALTH		
HEALTH INDICATORS	Health complaints, physical exhaustion, emotional exhaustion, general state of health, ability to work within the next two years based on current health condition thoughts about resigning	1 ^b 5 ^h

Table 1: Contents of the survey.

¹ Number of questions posed on the respective topic

^a SALSA: Salutogenetische Subjektive Arbeitsanalyse (Rimann & Udris, 1997)

^b ISTA: Instrument zur Stressbezogenen Tätigkeitsanalyse (Semmer, Zapf & Dunckel, 1999)

^c DlgA: Diagnose gesundheitsförderlicher Arbeit (Ducki, 2000)

^d EOQ: Error Orientation Questionnaire (Rybowiak, Garst, Frese & Batinic, 1999)

^e ERI: Effort-Reward Imbalance at work (Siegrist, Wege, Pühlhofer & Wahrendorf, 2009)

^f KSS: Skalen zur Erfassung von kundenbezogenen Sozialen Stressoren (Dormann & Zapf, 2004)

^g FASS: Fragebogen zur Arbeitssituation an Schulen (Krause, Kaempfer, Petersen & Schröder, 2004)

^h COPSOQ: Copenhagen Psychosocial Questionnaire (Kristensen & Borg, 2000)

ⁱ own created items

COLLECTION OF SURVEY DATA

For this study, information on stressors, resources and health indicators was collected by conducting a written survey with a representative sample of a medium size European airport. The survey was based on the findings of a previous study about the specific work environment of a screener, which was carried out in 2010 and which included a workplace analysis, expert interviews, and also a written survey. The current survey was composed of scales and items from various established and scientifically validated psychological questionnaires and instruments in order to obtain reliable and valid results (see Table 1 for details).

HOW STRESSORS, RESOURCES AND HEALTH INDICATORS WERE RATED

Stressors and resources had to be rated on a Likert scale from one to five. The results (mean values and standard

deviations) regarding stressors and resources are displayed in Figures 3 and 4. The three stressors which were rated the highest were unpleasant temperature, passengers and increased volume of work and the three high-

est rated resources were recreative breaks, responsible work and Computer Based Training (CBT).

Screeners' health was evaluated using the following six aspects: health com-

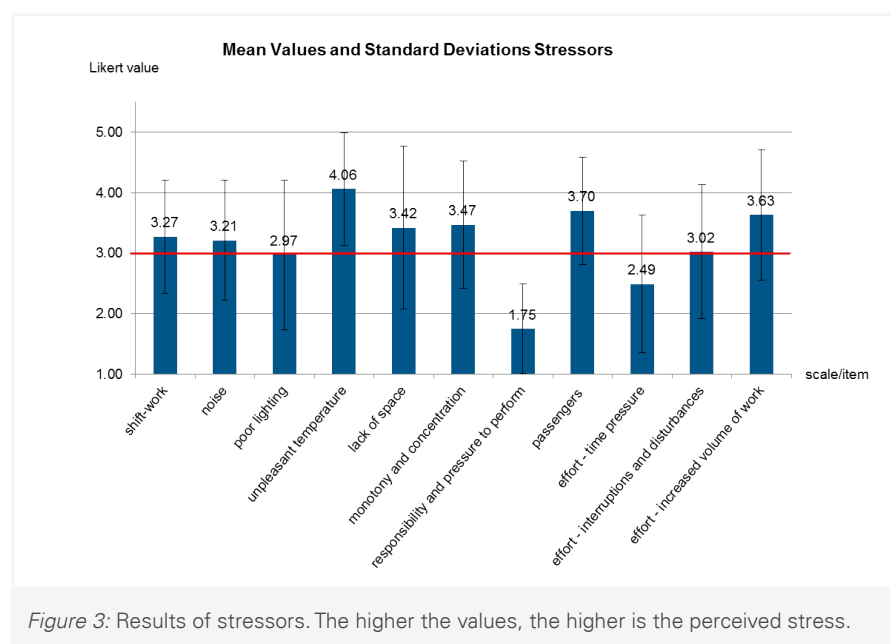
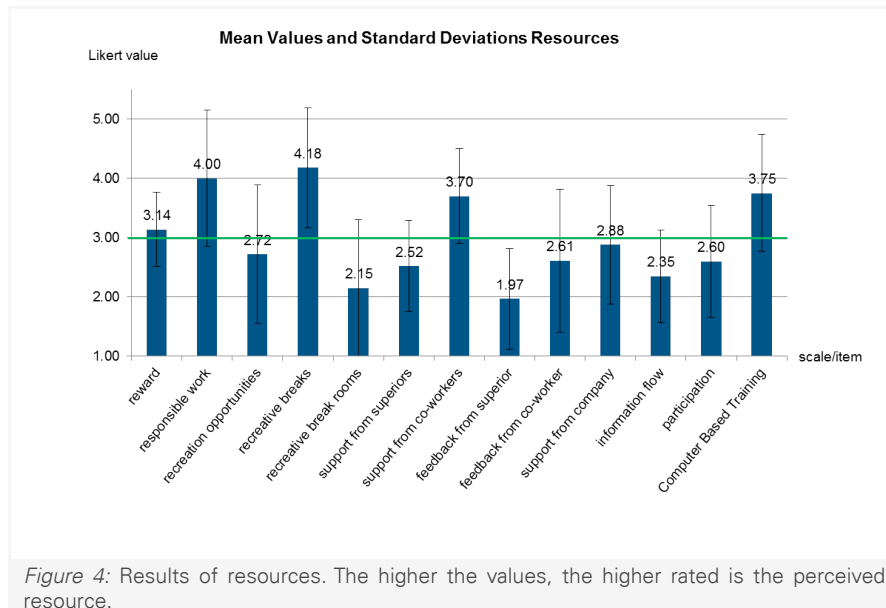


Figure 3: Results of stressors. The higher the values, the higher is the perceived stress.



plaints, physical exhaustion, emotional exhaustion, general state of health, ability to work within the next two years based on current health condition, and thoughts about resigning. The results are displayed in Table 2.

RELATIONSHIPS BETWEEN STRESSORS, RESOURCES AND HEALTH

All examined stressors except noise, unpleasant temperature, interruptions and disturbances, significantly correlated with at least one of the health indicators. The correlation coefficients (r) are between .35 and .66, thus the relationships can be considered to have medium to high strength (see [3]). About half of the resources (rewards, responsible job, recreation opportunities, support from superiors and co-workers, feedback from co-workers, support from company and information flow) also show significant relationships with health indicators of $r = .38$ to $r = .68$, which are again medium to high.

In summary, these significant correlations show that a high value of stress-

ors is related to the subjective rating of bad health, whereas a high value of resources is related to the subjective rating of good health.

It should be noted that correlations provide information on the statistical strength of a relationship and directional causality cannot automatically be inferred. However, the presented results are in line with previous studies showing that stressors and resources are of high causal importance regarding strain, psychological or physical health and wellbeing (e.g. see [1], [4], [5] and [6]).

IMPLICATIONS FOR THE DESIGN OF BENEFICIAL WORKING CONDITIONS

In order to promote and ensure good health conditions and thereby enhance performance, it is advisable to consider an occupational health management approach. This encompasses a broad concept that systematically combines person-related (behavior prevention) and condition-related (situational prevention) measures. The goal is to strength-

en personal health competency, to foster employee's active participation and to improve organizational and working conditions (e.g. see [7]). The results of the current study provide starting points on how to enhance working conditions which in turn could benefit performance.

It is advised to approach the negative conditions (stressors and lack of resources) which correlate high with health indicators first. This applies to the working conditions shift-work, lack of space, monotony and concentration, passengers, increased volume of work, recreation opportunities, support from superiors and from company as well as information flow.

A particular challenge exists due to the peculiarity of the working environment of an airport or, more specifically, the operational work at the security checkpoint. Shift-work is inevitable as is the interaction with passengers. Moreover, security screening can be monotonous (unless threat image projection and frequent covert tests are conducted), but nevertheless demand a high level of concentration. Screeners work and interact in lively and noisy environments (unless remote screening is available), yet a potential miss of a threat would have fatal consequences. Even though certain aspects of work cannot be changed, it is still possible to reduce some strains by enhancing suitable resources (e.g. see [8]).

Although airports are different, it is still possible to provide some recommendations which apply to most security screening work environments:

- **Designing and optimizing shift schedules:** Take into account results of scientific studies when designing or optimizing shift schedules (e.g. rotate shifts in a forward manner).

HEALTH INDICATORS	RATING SCALE	RATINGS
HEALTH COMPLAINTS	1 "never/hardly ever" – 5 "always"	$M = 2.91, SD = 1.40$
PHYSICAL EXHAUSTION	1 "never/hardly ever" – 5 "always"	$M = 2.22, SD = 1.18$
EMOTIONAL EXHAUSTION	1 "never/hardly ever" – 5 "always"	$M = 2.09, SD = 1.30$
GENERAL STATE OF HEALTH	0 „worst possible general state of health“ – 10 „best possible general state of health“	$M = 7.06, SD = 1.98$
ABILITY TO WORK WITHIN THE NEXT TWO YEARS BASED ON CURRENT HEALTH CONDITION	1 „unlikely“ – 3 „quite likely“	$M = 2.84, SD = 0.51$
THOUGHTS ABOUT RESIGNING	1 „never“ – 5 „every day“	$M = 1.78, SD = 1.13$

Table II: Results of health indicators

- › **Keep job rotation and consider job enrichment:** Job rotation (changing between screening tasks) can reduce monotony and relieve some of the high demands on concentration. Even more effective is job enrichment and further education (e.g. training on how to improve team work and performance or training in suspicious behavior observation techniques with the possibility to gain additional responsibilities).
- › **Train screeners in communication techniques:** Interactions with passengers cannot be avoided. But it should be considered to train screeners in communication techniques in order to enable them to better cope with impatient and unfriendly passengers.
- › **Invest in passenger awareness of a screener's job:** By promoting the value of screening and its operators and by providing relevant information on the process and its aim, the appreciation and understanding of passengers may be raised.
- › **Promote superiors' support:** Support by superiors is important regarding both the coping with stressors as well as health and work performance. Possible measures to improve this resource may consist of systematic conversations between screeners and superiors in order to evaluate needs and possibilities of support. A further advantage of periodic meetings is the possibility to strengthen the information flow by updating screeners regularly on relevant news and procedures. It may also be considered to introduce trainings or a coaching system for superiors in order to improve their leadership competencies.
- › **Improve recreation opportunities:** It is essential to carefully analyze the reasons of why they often are perceived as insufficient by screeners. Depending on the results, it might be sensible to adjust the shift schedule or even to reorganize the work at the checkpoint in order to allow for more or longer breaks.

Work-related strains may harbor serious risks for the general state of health which in turn can affect the performance of screeners substantially. The presented study showed possible ways how to analyze working conditions, which provides the basis for interventions in order to reduce stressors and enhance resources. Such measures are an important investment in the screener work force which helps achieving and maintaining a high level of performance.

REFERENCES

- [1] Binnewies, C., & Sonnentag, S. (2006). *Arbeitsbedingungen, Gesundheit und Arbeitsleistung*. Retrieved from <http://nbn-resolving.de/urn:nbn:de:bsz:352-opus-57901> [28.01.2014].
- [2] Wright, T.A., & Cropanzano, R. (2004). The role of psychological well-being in job performance: A fresh look at an age-old quest. *Organizational Dynamics*, 33, 338-351.

[3] Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences*. Hillsdale: Lawrence Erlbaum Associates.

[4] Frese, M. (1985). Stress at work and psychosomatic complaints: A causal interpretation. *Journal of Applied Psychology*, 70, 314-328.

[5] Siegrist, J., Peter, R., Junge, A., Cremer, P., & Seidel, D. (1990). Low status control, high effort at work and ischemic heart disease: Prospective evidence from blue-collar men. *Social Science and Medicine*, 31, 1127-1134.

[6] Sonnentag, S., & Frese, M. (2003). Stress in organizations. In W.C. Borman, D.R. Ilgen & J.R. Klimoski (Eds.), *Handbook of Psychology. Industrial and organizational psychology*, 12 (pp. 453-491). New York: Wiley.

[7] Zimolong, B., Elke, G., & Bierhoff, H.-W. (2008). *Den Rücken stärken. Grundlagen und Programme der betrieblichen Gesundheitsförderung*. Göttingen: Hogrefe.

[8] Zapf, D., & Semmer, N.K. (2004). Stress und Gesundheit in Organisationen. In H. Schuler (Eds.), *Organisationspsychologie - Grundlagen und Personalpsychologie* (pp. 1007-1112). Göttingen: Hogrefe.

MANAGING COMPUTER-BASED TRAINING OF X-RAY IMAGE INTERPRETATION AT APPROXIMATELY 80 AIRPORTS - A REPORT FROM CANADA

Text: Wicher Visser & Claudia Lüchinger

Wide-area network connectivity is nowadays rather the rule than the exception in large organizations. But how does it work if you need to manage X-ray image interpretation training of 5,000 screening officers at approx. 80 airports in six time zones? The Canadian Air Transport Security Authority (CATSA) allowed us an insight into challenges and solutions.

Research and applications are once again the two main topics of our newsletter, consistent with CASRA's aim to deliver effective and efficient solutions based on scientific research and close collaboration with operational experts and end users.

One partner with whom CASRA's research and development program has been particularly successful is the Canadian Air Transport Security Authority (CATSA). Well-known internationally, CATSA is recognized by many as one of the most important and innovative authorities in the field of civil aviation security. CATSA is a crown corporation responsible for securing specific elements of the air transportation system – from passenger and baggage screening to screening airport workers. Established on April 1, 2002, CATSA is fully funded by parliamentary appropriations and is accountable to Parliament through the Minister of Transport. CATSA is mandated with protecting the public through effective and efficient screening of air travelers and their baggage at all airports in Canada.

Security screening services are sub-contracted to three private companies who together provide around 5'000 screening officers. They conduct regu-



CATSA ACSTA

CASRA and CATSA collaborate on research and development since ten years now. Important milestones are listed below.

- › 2004: X-Ray Tutor 2 (XRT2) was installed at Halifax and Kingston for operational trials.
- › 2005: The success of these two trials resulted in a decision to deploy nationally at all airports, with the exception of 3 remote sites.
- › 2007: Applied research was completed to define a standard measure for determining certification pass marks, XRT2 user levels and recommendations for training system configuration.
- › 2008: The impact of the XRT2 training system on screener performance is further investigated. Data since 2004 is analyzed across the national workforce.
- › 2011: The foundation for the next generation nation-wide X-ray image interpretation training started (XRT3). Close collaboration on functional requirements lead to the inception of the new level design and the integrated Management by Objectives concept.
- › 2012: XRT3 was deployed nationally.

lar X-ray image interpretation training. Since 2004, CATSA uses X-Ray Tutor (XRT) for this purpose (for more information on XRT, see CASRA Newsletter Issue 2). The screening contractors have onsite management and screener leads that oversee screening operations and screening officers at all airports within their regions.

The administration of the nationwide training is aggravated by geographical aspects. The organization is spread 3'000 miles across the country using different bandwidths across six time zones with many different types of technologies. In 2012 a big technological step was made, when the new web-based X-Ray Tutor training system (XRT3) was introduced.

TECHNICAL NEEDS AND SOLUTIONS

The management of nationwide training poses major challenges regarding technology and organization. Several technical needs must be met with one system. First, the Ottawa headquarters require instant access to data permanently generated across the country. Second, all airports need a server connection for the computer-based training system, as large libraries of images have to be enhanced regularly to keep training up-to-date regarding new and emerging threats. Third, there are many airports with a large demographic who train simultaneously at peak times, and also there is a variety of connection capabilities among sites.

CASRA has developed XRT3 featuring a modern network architecture to be able to satisfy all these needs. This includes proxy servers, synchronization with the central repository at the CATSA headquarter, and instantly available reports that are accessible from anywhere in the country at any time.

In the next section CATSA will describe how they succeed in bridging 3'000 miles with their administration.

How do you efficiently administrate several thousand user accounts for regular X-ray image interpretation training of screening officers?

CATSA: All-in-all we administer around 5'000 screening officers at three screening contractors. XRT3 integrates with Microsoft Windows Active Directory Technology. This allows us to manage our complex hierarchical structure with regions, airports, contractors and groups of users and it enables single sign-on and automatic updates. With user verification, the respective rights and scopes are assigned automatically. The rights determine the permissions a user has within the XRT3, whereas the scope defines the access to user data in the reporting and administration area. The scope depends on the hierarchical assignment within the organizational structure.

What are your main aims regarding X-ray image interpretation training of screening officers?

CATSA: The main objective of X-ray image interpretation training is to increase and maintain the ability of screening officers to detect threats. In addition, we aim to increase baggage throughput by improving screening officers' ability to identify threats efficiently. For this training we use XRT3.

However, X-ray image interpretation training is not limited to the detection of threat items. Another important component for us is the appropriate response if the screening officer identifies a prohibited item in an X-ray image. In Canada we distinguish between two types of threat items: non-permitted and prohibited. These items are categorized by Transport Canada, based on Canada's Criminal Code. Liquids are usually classified as non-permitted items, while guns and improvised explosive devices (IEDs) are prohibited and therefore require a different response at the checkpoint. Non-permitted items require the "Search Bag" response whereas prohibited items require an "Emergency Response." (See box below [Ed.])

How do you react to new and emerging threats?

CATSA: We have the ability to adapt the training. For instance, we can add new threat items into our existing XRT3 training courses ourselves. This allows us to quickly react to new threats by adding new images (e.g. the Liberator 3-D printed weapon). The advantage with the XRT3 algorithm is that all new images show up promptly after they are added.

We can also create new courses tailored to our requirements and needs (e.g. focus on different materials, on individual threat categories, etc.) and

assign these supplementary courses to selected users.

What are the objectives your screening officers have to meet in order to fulfil the training requirements?

CATSA: Our screening officers must comply with national training regulations that require a specific amount of X-ray training each month, similar to the EU regulation.

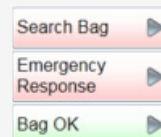
We also set performance goals. The XRT3 approach of "Management by Objectives" allows us to set and manage these goals efficiently with the possibility of designating different criteria to each training course individually and it also ensures that the same guidelines for X-ray screening education and training progress are valid for all our users. These unified targets are clearly defined through the level and lockout design. (For more information, see textbox on next page [Ed.])

What milestones must screening officers achieve in their training development?

CATSA: Beginners start training with the XRT3 pre-board screening course which consists of various levels. The first levels focus on building recognition and identification of threat items and selecting the appropriate response to each.

XRT3 allows the user to select from different responses if a threat item is detected in an X-ray image of a passenger bag.

In addition to marking the prohibited object, the screening officer has to decide the appropriate response, depending on the threat item. The specific actions can be defined by the customer to meet the requirements of national regulations and/or internal procedures.

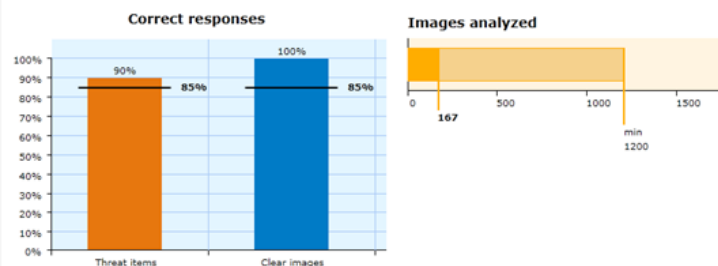


The level criteria,

- › % correct responses on threat images,
- › % correct responses on non-threat images, and
- › the minimum number of images a user has to analyze,

increase continuously throughout the level and must be completed in a specific time. These values are called lockout criteria in XRT3 and can be defined for each level in a course separately.

Level criteria



Lockout criteria



During the first levels users will be stopped automatically when they have completed a session and required to see their supervisor for an individual performance analysis before continuing with the next level. This process ensures that screeners meet the time requirements and allows for close monitoring of progress during the first important weeks of X-ray training. This ensures that they are motivated and individually challenged during training.

After passing the initial examination, the recurrent training is also done with XRT3. The screening officers must continue to meet performance standards. Their progress is closely monitored and additional training may be required.

Who monitors the users' performance improvements and training time?

CATSA: The supervisors and managers of the screening contractor companies must guarantee that all screening officers meet the required times and they are obliged to monitor progress. Additionally, CATSA managers supervise performance at each airport.

For the monitoring purpose XRT3 provides a reporting area where a number of different reports are available to administrators with the relevant authorization. Depending on the situation, the administrator can choose between various reports; for reviewing the performance in a particular level, there is a report "Level Performance" which compares the performance of a security screening officer to the required level and lockout criteria. The report "Level Progress Control" allows resetting locked users in their current level or moving them into a more appropriate level (up-/downgrade).

SUMMARY AND CONCLUSION

This article provided an overview of the needs and solutions regarding X-ray image interpretation training of CATSA, a large, well-known and leading aviation security organization. The next milestone in our ten year history of fruitful collaboration is already set: 2014 all Canadian airports under the responsibility of CATSA will be upgraded to the new X-Ray Tutor version 3.7. This upgrade includes substantial innovations such as multiple threat items within a bag, more sophisticated management of rights

and roles, enhanced user interfaces with even better usability, enhanced network performance and additional reporting functionality, and Infoboard - a software module for instant distribution and management of information.

We want to take the opportunity to thank CATSA for the great partnership in the last ten years. It is an excellent example of a very fruitful collaboration continuously making a difference by innovation.

May we close with a statement of Pierrette Richard, Advisor Reporting & Administration at CATSA:

"CASRA has been very responsive, receptive and ready to accommodate, always sensitive to our needs. Our partnership and collaboration has been key in the success of XRT3 fulfilling our needs and requirements."

Science & Security – CASRA Newsletter

ISSN [1664-5715](#)

Published three times a year

Editors:

Prof. Dr. Adrian Schwaninger

Dr. Diana Hardmeier

Editorial Managers:

Dr. Sandrina Ritzmann

Alex Kunz

CASRA

Thurgauerstrasse 39

8050 Zurich, Switzerland

Phone +41 (0)43 336 01 01

Fax +41 (0)43 336 01 00

E-mail info@casra.ch

Web www.casra.ch