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CASRA NEWSLETTER – ISSUE 18

Our first newsletter in 2018 features two interesting topics. In the section "Research Put Across", we explain the benefits of 3D simulations of airport security checkpoints. As for the "Security in Practice" section, we conducted an interview on aviation security with Enrico Eichner from the Government of Upper Bavaria at Munich Airport.

We hope that you enjoy the reading and we are looking forward to receiving any feedback you might have as well as your input on topics you would like us to address in upcoming newsletters.

We wish you a nice spring season,

Dr. Diana Hardmeier
Director

Prof. Dr. Adrian Schwaninger
Chairman

RESEARCH PUT ACROSS

3D SIMULATIONS OF AIRPORT SECURITY CHECKPOINTS

Passenger volumes at airports are increasing worldwide and if queues get longer, travelers might start considering other airports or alternative modes of transportation for certain destinations. 3D simulations offer new possibilities to design and evaluate process optimizations. In this article we explain how that can be achieved for airport security checkpoints using a sociotechnical approach.

SECURITY IN PRACTICE

AVIATION SECURITY AT MUNICH AIRPORT

Munich Airport is Germany's second largest airport and it has received the title "5 Star Airport" from Skytrax in 2015. In our interview, Enrico Eichner from the Government of Upper Bavaria at Munich airport answers questions regarding the organization of aviation security, challenges and solutions. He also addresses training and certification processes of airport security officers at Munich airport.

3D SIMULATIONS OF AIRPORT SECURITY CHECKPOINTS

Text: David Hügli

Passenger volumes at airports are increasing worldwide and with queues getting longer, travelers might start considering other airports or alternative modes of transportation for certain destinations. Explosive detection systems for cabin baggage screening (EDSCB), unpredictability and risk-based screening create new options for the optimization of airport security checkpoints. In this article, we explain how 3D simulations can be used for the design and evaluation of smarter airport security checkpoints using a sociotechnical approach.

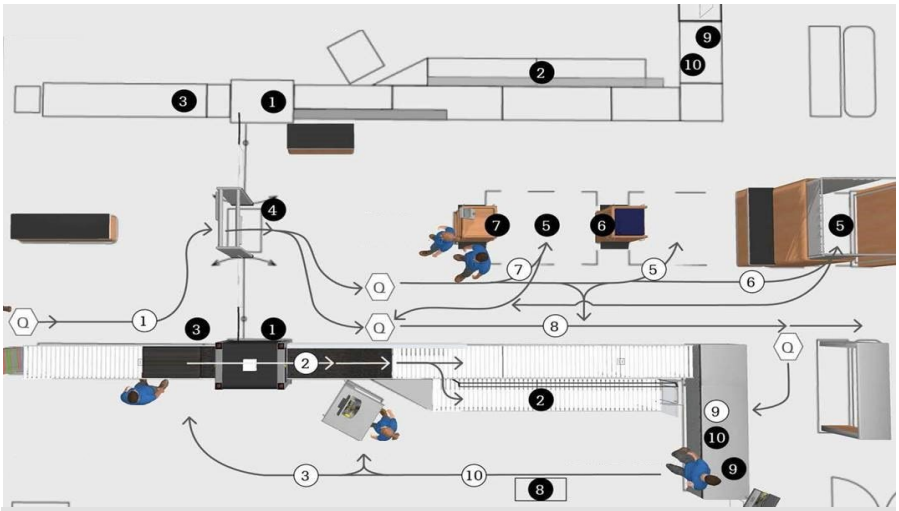

Figure 1: Example of a process flow at an airport security checkpoint

X-ray machine (1), bypass belt (2), cycle belt (3), metal detector lock (4), metal detector handset (5), explosive trace detector (6, with randomizer 7), liquid explosive detector (8), unpacking table (9) and liquid explosive detector randomizers (10)

THE VALUE OF 3D COMPUTER SIMULATIONS

Better technology (e.g. EDSCB) and process optimizations (e.g. risk-based sreening and unpredictabililty) have the potential to increase security and facilitation at airport security checkpoints. Testing different implementations in the field is very time consuming and expensive. With modern 3D computer simulations, it is possible to design and evaluate different airport security checkpoints much more efficiently. Many combinations of technology and process parameters can be tested at a fraction of the costs compared to live trials. This can also help avoiding unnecessary confusion of passengers and stress of screeners when conducting pilot tests at airports. The following examples illustrate how 3D computer simulations can be used to evaluate new technology and processes to better decide which changes are worth testing in live trials.

3D computer simulations on EDSCB

EDSCB can be a very valuable addition to human operators who visually inspect X-ray images passenger bags. Sterchi and Schwaninger [1] conducted a study using 3D computer simulations to investigate how different machine settings of EDSCB, X-ray screener working experience, and different durations of alarm resolution with explosives trace detection (ETD) influence throughput. Data from a human-machine interaction experiment and a work analysis were used to define parameters of a discrete event simulation. Simulations were run for three screener groups, 15 false alarm rate levels of the EDSCB, one condition without EDSCB as baseline, and three durations of alarm resolution at the recheck station using ETD. In total, 192 different conditions were simulated. For each condition, one hour of screening was simulated 200 times; resulting in 38'400 simulated screening hours. This illustrates why such research is impossible to accomplish in a live trial, as you would need about 6 years for investigating all these conditions (assuming 18 hours of screening per day at one checkpoint). Based on the computer simulations, Sterchi and Schwaninger [1] could develop recommendations on how to implement EDSCB for increased security without a negative impact on throughput.

For many questions, simple math cannot be used for finding answers due to the interdependencies between the different sub-processes. For example, a single ETD might only affect throughput if it draws resources from manual bag search and this eventually leads to a backlog. While spreadsheet calculations have difficulties in modelling interdependent stochastic processes, discrete event simulation was developed to close this gap. This allows simulating an event sequence, with each of the events changing the system, whereas the process logic of the system stays the same.

Valid and reliable 3D computer simulations allow the variation of passenger, baggage and checkpoint technology parameters in

Figure 2: Current 3D computer simulation

order to examine whether such variations cause changes in effectiveness, efficiency, passenger experience or employee performance. Therefore, many airport security checkpoint design projects use computer simulation nowadays.

THE IMPORTANCE OF HUMAN FACTORS

Airport security checkpoints are complex sociotechnical systems in which the interaction of humans and technology (e.g. X-ray machines, body scanners, metal detectiors or ETD) aims at preventing passengers from bringing prohibited items on board of an aircraft. Despite the technological advantages in recent years, checkpoints still have to rely on screeners' decisions and detection performance [2-3]. The human factor is thus an important element to consider in 3D computer simulations.

One of the human factors is the individual modification of concepts: Security personnel sometimes deviates from the original process, as they experience on the job how things can be done more easily and quickly. This is not bad per se, as long as the new process meets the security standards. However, if the real life execution differs from the simulated processes, this raises problems. The goal of the simulation is not to simulate the original checkpoint in every detail but the relevant aspects that determine performance. Therefore, empirical data is an important source for 3D computer simulations.

3D computer simulations on empirical basis

In a more recent 3D computer simulation of an airport security checkpoint, Wyssenbach, Sterchi, and Schwaninger performed several steps to build and validate a simulation model on an empirical basis [4]. The simulation model represents a checkpoint in Switzerland and is illustrated in Figures 1-3.

In a first step, a qualitative data analysis of relevant documents (regulations an process descriptions) was carried out and observational interviews with screeners were conducted. In a second step, a video analysis collected data on the existing processes and important parameters of the checkpoint on two separate occasions. A category system with event sampling and observable frequencies of actions was used to gather data. In a third step, all data underwent a statistical analysis to compute the relevant parameters, which were then implemented into the simulation model. Finally, the fourth and last step consisted in building the 3D computer simulation model. This included a systematic verification by comparing model predictions with empirical data.

With this model, simulation experiments can be performed under a full

Figure 3: 3D computer simulation vs. reality (photograph in the magnifying glass).

capacity scenario. So far, a number of simulations were conducted to examine benefits of risk-based screening and unpredictability, i.e. how different implementations of these concepts might affect throughput, passenger density and processing time. In a recent publication, Wyssenbach, Sterchi and Schwaninger [4] illustrate how 3D computer simulations can be used for optimizing airport security checkpoints using a sociotechnical approach.

CONCLUSION

3D computer simulations offer new possibilities to design and evaluate smarter checkpoints for increasing effectiveness, efficiency, passenger experience, and employee performance. This needs to be based empirically using large datasets from existing checkpoints and human factors studies using a sociotechnical approach. This way, it is possible to better define which changes of technology, processes and human factors are worth investigating in live trials.

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AVIATION SECURITY AT MUNICH AIRPORT

Text: Sarina Baumgartner

Munich Airport is Germany's second largest airport and it has received the title "5 Star Airport" from Skytrax in 2015. In our interview, Enrico Eichner from the Government of Upper Bavaria answers questions regarding the organization of aviation security, challenges and solutions. He also addresses training and certification processes of airport security officers at Munich airport.

With two terminals and a satellite terminal opened in 2016, Munich Airport is Germany's second biggest airport as regards the passenger traffic. 44.6 million passengers annually make Munich Airport rank ninth among the European airports. Within the scope of the Skytrax Awards, Munich Airport regularly gets elected "Best Airport Europe" and also received the rating "5-Star Airport" as first European airport. One factor of this success is the efficiency of the handling processes, which also include security controls.

The control of the airport staff is executed by the airport operators with their subsidiary CAP Munich Airport Security GmbH that comprises approximately 700 aviation security officers. Supervisory authority is the Bavarian Ministry for Housing, Building and Transport. The responsibility for the security check of passengers and their luggage lies since 32 years with the Security Company at Munich Airport (short SGM) with their 1500 security screeners. SGM is a company of the Free State of Bavaria under supervision of the government of Upper Bavaria (Southern Bavaria Aviation Office).

Mr. Eichner, what is your role at Munich Airport?

As aviation security authority, we are not only responsible for the decision-making in operational matters, but also for the organization of passenger screening and quality control. In addition to the planning of checkpoints and the procurement of control technology, this also includes the training of security personnel.

INFOBOX: MUNICH AIRPORT

Munich Airport is Europe's only 5-Star airport. First awarded the 5-Star rating in 2015, Skytrax, the international air transport rating organisation, noted in an audit in March 2017 that Munich Airport has further improved and renewed the rating. Being a 5-Star airport means that simplified procedures along the entire travel chain as well as clear signage and routing must be provided. Munich Airport stands out for its exceptional service quality, appealing modern ambience and great comfort compared to other airports. An important criterion is also perfect cleanliness in all areas. Additionally, Munich Airport received the title of Best European Airport in 2017 at the annual "World Airport Awards" for the tenth time in twelve years. With its 44.6 million passengers in 2017, Munich Airport is Germany's second largest airport.

For more information, please visit: www.munich-airport.de

INFOBOX: OBJECT CATEGORIZATION TEST

CASRA developed the **Object Categorization Test (OCT)** to establish the screener's individual training level. The OCT was created to meet the wishes of German customers to prepare their screeners in an optimal way for their recertification. Four items per image must be categorized within one minute. The following categories are currently available: "IED", "Forbidden item", "Other item". The result can be automatically evaluated and the screener receives direct feedback.

In your opinion, what are typical challenges that airports in all of Germany and specifically Munich Airport have to face currently regarding aviation security?

Everybody who works in the area of aviation security is aware of the fast pace these days. Whether it is the introduction of new security technologies, the emergence of new threats or changing legal regulations - adaption to an ever-changing environment is a challenge that authorities and security personnel have to face every day.

Your screening personnel is currently training with CASRA's individually adaptive computer-based training program XRT3. How did the screeners react to the upgrade from the old training solution to the new federal police certified XRT3 in 2015?

As the screeners want to stay up-to-date, the feedback on XRT3 has been very positive from introduction until today. Especially the chance to familiarize with the most recent threat objects (see Infobox: XRT3) is one important component to meet the increasing challenges in airport security.

What do screeners have to achieve to meet your training and certification requirements?

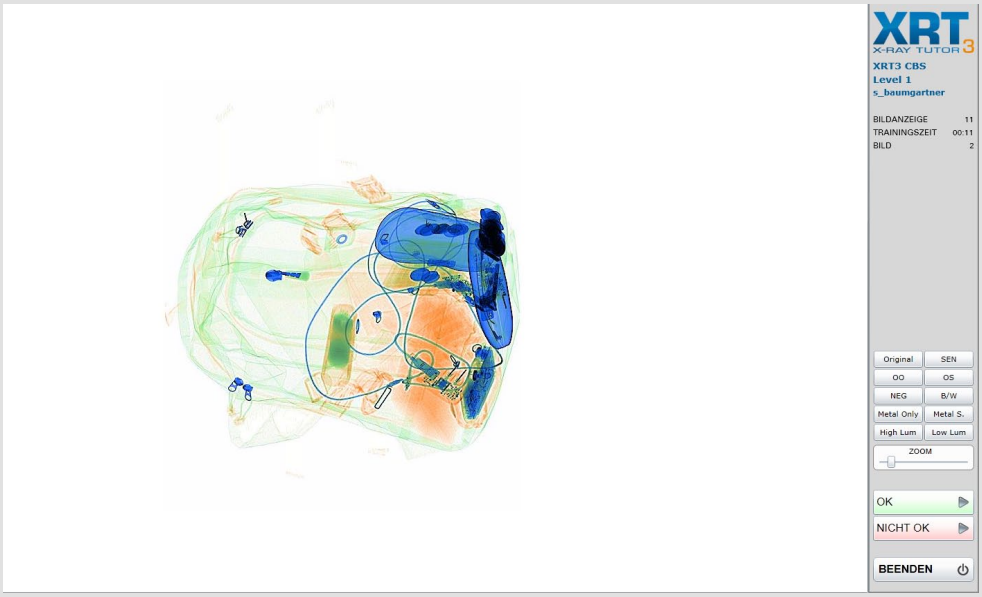
Enhancing skills in image interpretation is in the interest of every security officer and should not be seen as a mere fulfillment of obligations. Yet adequate minimum requirements were established. These include at least 20 hours of training per year with XRT3, in addition to frontal training. The training must take place regularly, which is why at least one hour of training is required every month.

Furthermore, screeners complete semi-annual image recognition tests to establish their individual training level (see

Infobox: Object Categorization Test). These tests also serve screeners as an indicator of their performance level for the recertification tests occurring every three years. If any backlog is seen, further training is intensified accordingly - not just to prepare for recertification but primarily to detect and remedy any deficiencies at an early stage.

INFOBOX: XRT3

X-Ray Tutor is the only training system on the market designed on the basis of scientific studies which takes into account the complex brain processes underlying the perception of visual information. Due to the **individually adaptive algorithm**, every user is presented with images tailored to his or her individual knowledge and skills. Threat objects that were not recognized are presented more often to the individual user to support them and provide optimal training. The level system used in XRT3 maximizes the motivation to achieve higher levels (maximally 18 levels can be reached). Thanks to the built-in merging algorithm, XRT3 is able to automatically generate unique bag-to-threat item combinations on the fly, which reduces the possibility that a particular bag/threat item combination will be repeated during the training. Thus, millions of individual images can be produced that are adapted to the level progress of the user and prioritized by threat items that were not recognized. Moreover, the threat objects included in the system are regularly updated based on a systematic threat assessment aimed at identifying not only current but also new and emerging threats.



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