



# SCIENCE & SECURITY November 2015

CASRA NEWSLETTER – ISSUE 11

This year is already coming to an end, and we would like to take the opportunity to thank all readers for your interest in our newsletter and your valuable input.

In the last issue, we gave you an insight into *how* we work. In this newsletter, we place our focus back on *what* we do and *why* we do it.

In the section “Research Put Across”, we picture the EU FP7 project XP-DITE which is aimed at developing and evaluating security checkpoints in a holistic manner.

In the section “Security in Practice”, we present a pilot study on certification which was conducted together with the Croatian Civil Aviation Agency (CCAA).

We hope to have given you some interesting reading material for the holiday season and sincerely wish you a nice advent season and a good start into the New Year!

Dr. Diana Hardmeier  
Director

Prof. Dr. Adrian Schwaninger  
Chairman

## TOPICS IN THIS ISSUE:

### RESEARCH PUT ACROSS

#### XP-DITE – INTRODUCING A SYSTEM LEVEL APPROACH TO EVALUATING AIRPORT SECURITY CHECKPOINTS

Security checkpoints pose central elements at airports across the world today. Their design, technical equipment, and processes determine security, throughput, and passenger satisfaction. However, as of today, airport security checkpoints are neither developed, nor evaluated in a holistic manner. Equipment and staff are extensively tested and certified, but the performance of the system as a whole is rarely taken into account from the start, nor is it consistently evaluated. The EU FP7 project XP-DITE aims at changing this.

### SECURITY IN PRACTICE

#### CERTIFICATION PILOT STUDY WITH THE CROATIAN CIVIL AVIATION AGENCY (CCAA)

In aviation security, even the best technology is ineffective without competent personnel who can put its functions to use. Thus, as much attention should be devoted to the human operator as to technological innovations. This involves a reliable selection process, sound training of personnel, and the periodical verification of the respective competencies. This article describes the practical implementation of a certification procedure conducted collaboratively with the Croatian Civil Aviation Agency (CCAA).

## XP-DITE – INTRODUCING A SYSTEM LEVEL APPROACH TO EVALUATING AIRPORT SECURITY CHECKPOINTS

Text: Christoph Meier and Yanik Sterchi

Security checkpoints pose central elements at airports across the world today. Their design, technical equipment, and processes determine security, throughput, and passenger satisfaction. However, as of today, airport security checkpoints are neither developed, nor evaluated in a holistic manner. Equipment and staff are extensively tested and certified, but the performance of the system as a whole is rarely taken into account from the start, nor is it consistently evaluated. The EU FP7 project XP-DITE aims at changing this.

XP-DITE (Full name: Accelerated Checkpoint Design Integration Test and Evaluation, [www.xp-dite.eu](http://www.xp-dite.eu)) is a research and development project which brings together 14 organizations across Europe to develop and demonstrate a comprehensive, passenger-centered, outcome-focused, system level approach for the design and evaluation of airport security checkpoints. The project, which is funded by the European Commission as part of the 7th Framework Programme (see Infobox), started in 2012 and runs until spring 2017. XP-DITE's consortium consists of different partners with complementary expertise. The 15 million Euro project is led by TNO (Netherlands Organization for Applied Scientific Research) and is a co-operation with other research and consulting organizations: the German Fraunhofer-Institute for Chemical Technology (ICT) and the Fraunhofer Ernst Mach Institute (EMI), FOI – Swedish Defence Research Agency, UK based Iconal Technology Ltd, University of Freiburg in Germany, ID Partners from France, and ourselves, CASRA. Manufacturers Smiths Detection, Safran Morpho, Cascade Technologies, Alfa Imaging, as well as the R&D depart-

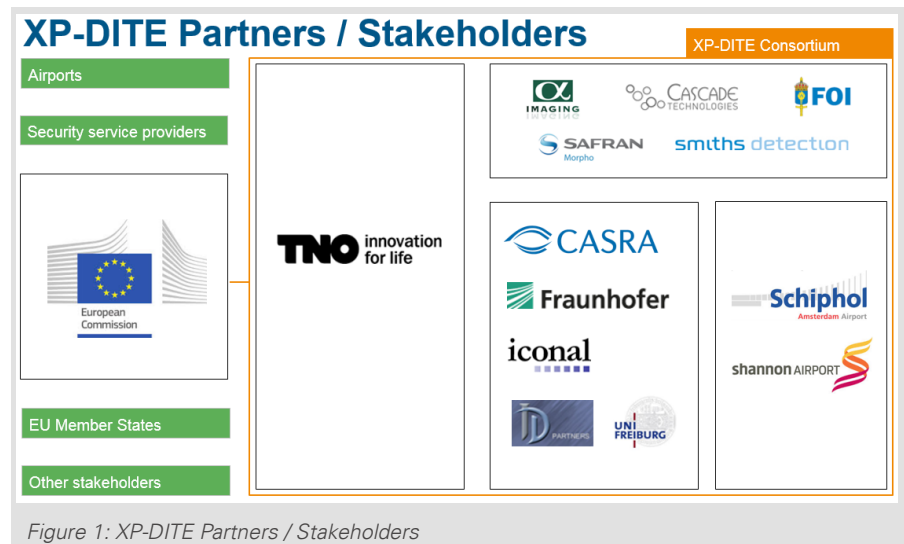


Figure 1: XP-DITE Partners / Stakeholders

ment of FOI contribute to the project by developing equipment with novel technology in order to test the system level approach. Furthermore, there is a strong link to airports with Amsterdam Airport Schiphol and Shannon Airport in Ireland, both being part of the consortium (see Figure 1).

All these organizations are working together towards XP-DITE's main goal: to provide tools and methods that can establish the fundamentals of a proper system level approach for designing and evaluating airport security checkpoints. Different performance areas are taken into account: security, cost, and passenger related. Performance indicators at the level of the checkpoint system can be balanced against each other to find the best way of meeting the requirements of the airport and the security regulator.

### XP-DITE'S SOFTWARE APPLICATIONS

XP-DITE's main deliverables involve two interdependent software tools. On

the one hand, the Airport Checkpoint Design Tool supports airport security checkpoint designers during the creation of new checkpoints or the enhancement of existing ones, providing a graphical user interface layout tool combined with a comprehensive repository of state-of-the-art equipment that the designer can select from. The so-called Shared Evaluation Platform (SEP) evaluates the checkpoint design by predicting the (key) performance indicators in the three performance areas: *security and compliance* with regulations, *cost and operational* factors, such as throughput, and *passenger convenience and satisfaction*. The SEP comprises a calculation engine which uses component level information to derive system level performance using mathematical calculations and Monte Carlo simulations as well as the Empirical Checkpoint Evaluation Plan (ECEP). The latter is a collection of test methods and instructions on how to empirically assess the performance indicators of a live checkpoint.

Using the XP-DITE tools, airport oper-

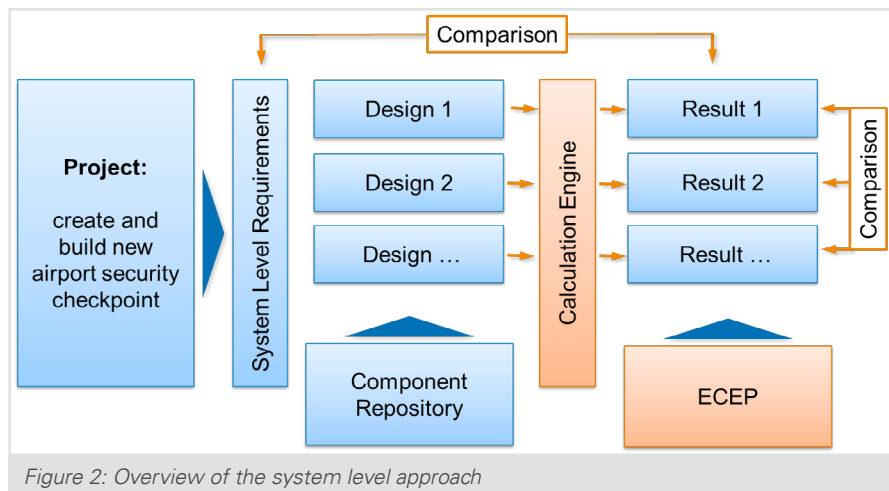


Figure 2: Overview of the system level approach

ators and regulators will be able to predict the overall performance of airport security checkpoints, allowing them to compare designs (Figure 2) and explore the implications of new regulations and new security technologies. The concept of system level performance is tested during the project by using the Design Tool together with the SEP to design two innovative airport security checkpoint designs. These proof-of-concept checkpoints will then be built at Amsterdam Airport Schiphol and at Shannon Airport. The predicted performance will then be compared with the actual performance using the ECEP.

#### INFOBOX: THE 7TH FRAMEWORK PROGRAMME

The 7th Framework Programme (FP7) for Research and Technological Development is a support program created by the European Commission. Its main goal is to support and strengthen research in the European Research Area by providing funding of over 50 billion Euros. CASRA is involved in another FP7 project: ACXIS (see [www.acxis.eu](http://www.acxis.eu)). FP7 is nowadays succeeded by Horizon 2020.

CASRA, as one of the work package and task leaders, bears a crucial part of the responsibility within XP-DITE. Firstly, we specify and develop the Design Tool. This tool is interfaced with the SEP, which is being developed by the Fraunhofer Ernst Mach Institute. Secondly, the Design Tool is connected to a large database of component level input data (for example detection rates, costs, dimensions, etc.). Thirdly, CASRA is leading the development of the ECEP using our extensive expertise and experience in aviation security system evaluation.

#### COMPONENT VS. SYSTEM LEVEL APPROACH

In Europe, the European Civil Aviation Conference (ECAC) uses a so-called Common Evaluation Process (CEP) framework to establish the expected performance of different components (e.g. security scanners and explosive detection systems). The results are made available to the ECAC Member States which then decide on national certification to allow equipment to be used at the respective national airports. In addition, EU regulation states that aviation security officers are required to be recruited, trained, and certified ac-

ordingly. These are obviously all appropriate aviation security building blocks. However, the focus is put only on the components (equipment and personnel) of an aviation security checkpoint. In other words, each equipment and security officer which is part of the security checkpoint needs to achieve or exceed a certain performance standard.

This type of component level approach to security is traditionally applied across the globe. However, airport security checkpoints are socio-technical systems. Their performance depends on the complex inter-relationships between technical equipment, operating staff, and organizational factors. To obtain the best results, state-of-the-art screening equipment should be combined with optimized procedures, processes, and concepts of operation. Last but not least, different modi operandi have to be taken into account. A modus operandi refers to the way how and with what kind of threat a terrorist tries to pass through the security checkpoint. This is important because different attack scenarios could have different optimized combinations of counter measures. That is why the XP-DITE consortium is committed to strengthen and promote the system level approach to security checkpoints!

There are more arguments in favor of looking at the system as a whole. On the one hand, the security performance of an airport checkpoint is important. For instance, an Improvised Explosive Device (IED) cannot be allowed to pass the security checkpoint, it must be stopped. At the end of the day, though, it does not matter which component actually detected the threat item - as long as it was detected by the system. On the other hand, one should also consider passenger throughput. Airports are interested in maximizing the amount of passengers they can bring through a

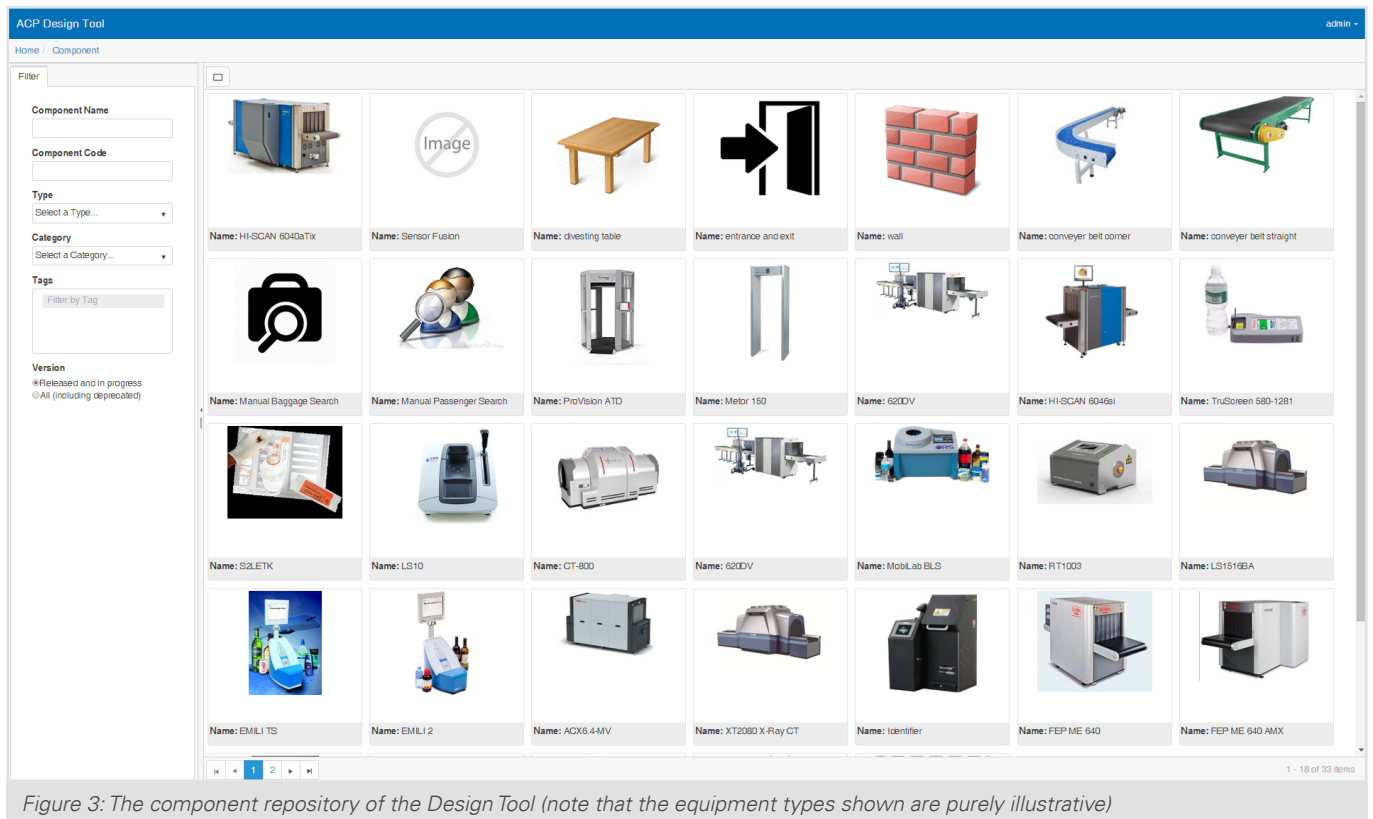


Figure 3: The component repository of the Design Tool (note that the equipment types shown are purely illustrative)

checkpoint within a certain amount of time, and in reducing the queues and delays that are frustrating to passengers. To purchase components with a higher throughput might be rendered useless if there remains a bottleneck created by other components. For example, even though a whole body imaging security scanner allows for faster alarm resolution, throughput might not be increased because passengers need to wait in line to divest their possessions. Consequently, airports must look at the system as a whole if they wish to successfully influence the checkpoint's performance and processes. Finally, there is the aspect of passenger experience. Whether or not the experience of passengers is positive rarely depends on single components, but on the whole experience from entry to exit with all its components, processes, environmental aspects, and so on.

With the Design Tool, a designer has more freedom in designing a checkpoint because a system level approach is pursued. Since the performance requirements are defined at system level, it will no longer be required that each and every single component meets the current regulations, i.e. also novel and innovative detection components can be used which on their own might not meet all the requirements in the regulations, but which, in combination with other, complementary detection components, have a better overall performance.

#### THE DESIGN TOOL EXPLAINED

The Design Tool is organized in a way that a user, for instance an airport checkpoint 'designer', works in so-called projects. A new project is kicked-off with the aim to create and build, for example,

a new centralized security checkpoint. In a very first step, the requirements for this centralized security checkpoint are specified within the project. In addition to general requirements in text form, the tool can handle parameterized system level requirements (e.g. passenger throughput/hour > 200) based on the predefined performance indicator list organized in the three performance areas *compliance and security*, *cost*, and *customer* (passenger). The foreseen use case is to create several designs and then compare them with each other and against the project's requirements set.

At the heart of the Design Tool is the integrated detection component repository. Eventually it will contain all relevant information on all available state-of-the-art aviation security detection equipment: dimensions, investment



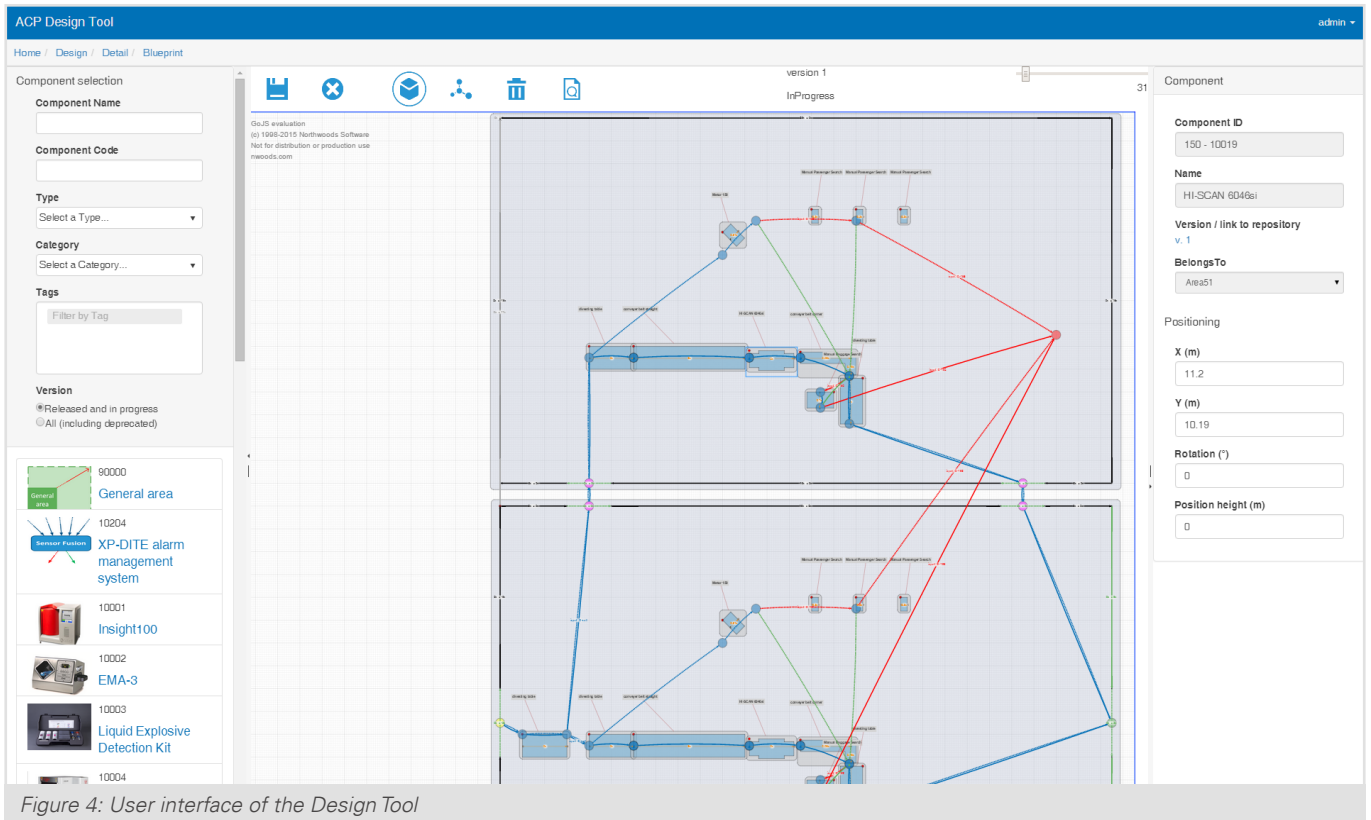


Figure 4: User interface of the Design Tool

costs, detection capability per threat item, concepts of operation, to name but a few. In the version developed so far, a carefully made selection of components is represented.

Building a checkpoint works like using a modular construction system. By using drag and drop functionality, security checkpoints can be designed in a graphical user interface (Figure 4). As well as detection components, auxiliary elements, such as tables, walls, and barriers, can be included in the design. Furthermore, information about the concept of operation can be added, including how alarms are resolved on passenger and baggage paths.

If the designer is satisfied with a first version of the checkpoint, the tool's interface with the SEP's calculation engine is used to compute system

level values per performance indicator. These values can then be compared with the initial requirements defined for the project. The tool even makes suggestions on how to improve the checkpoint: a replacement of certain components is proposed based on component data and the database is searched for designs meeting the project's requirements more accurately. Manual adjustments can also be made, which again can be evaluated by the SEP. An iterative process of design creation, evaluation, adjustment, and improvement is supported. The resulting designs' values can then be compared and the most suitable can be selected.

The use of calculation and simulation methods to predict checkpoint performance from component data has some limitations. Especially when it comes to performance indicators reflecting

the perception of passengers - like passenger satisfaction - even elaborated calculation and simulation methods can only provide an indicative estimate. In addition, the calculation of quantitative performance indicators relies on a complex set of assumptions, the correctness of which needs to be confirmed.

#### THE EMPIRICAL CHECKPOINT EVALUATION PLAN

The ECEP complements the SEP by providing methods and tools to empirically measure performance indicators at real, existing checkpoints. A questionnaire will, for example, allow assessing how satisfied passengers generally are with a newly built checkpoint, but also how they are affected by certain alarm resolution procedures and how they perceive specific aspects of the checkpoint. The duration of the

different processes and process steps as well as the occurrence and distribution of relevant events can also be measured with observation procedures, to give another example.

In a first step, the ECEP will provide the basis for gathering data from the two new innovative security checkpoints, which will be built within the XP-DITE project. This empirical data will allow improving and validating the calculation and simulation methods of the calculation engine. The ECEP is intended to form the basis of a system testing methodology for the future, which will be needed by regulators acting in a regulatory environment where the concept of system level security performance is introduced. They will depend on reliable and accepted tools and methods that allow for the (empirical) evaluation of security checkpoints on system level. Finally, the ECEP will provide airports with reliable methods to measure performance indicators, especially those where passengers' perception is concerned to complement values predicted through computation.

port airport checkpoint design teams and regulators alike in evaluating checkpoints not only on component, but on system level.

## OUTLOOK

The XP-DITE project has just passed its half way mark. The Design Tool exists in a basic form that is already in use within the project. Two proof-of-concept airport checkpoint designs are nearly complete. These will be built at Amsterdam and Shannon Airport in 2016. The ECEP will also be completed by the beginning of 2016. In terms of the Design Tool, the remainder of the project will be used to add further functionality and enhance the user experience.

Looking forward to the completion of the project in spring 2017, we are positive that XP-DITE's deliverables and especially the developed tools will sup-

## CERTIFICATION PILOT STUDY WITH THE CROATIAN CIVIL AVIATION AGENCY (CCAA)

Text: Slavtcho Groshev

In aviation security, even the best technology is ineffective without competent personnel who can put its functions to use. Thus, as much attention should be devoted to the human operator as to technological innovations. This involves a reliable selection process, sound training of personnel, and the periodical verification of the respective competencies. In order to assess a security officer's (screener's) X-ray image interpretation competency, reliable and valid certification tests are legally required in the European Union. The Commission Regulation 185/2010 (Official Journal of the European Union, 2010) mandates that all persons operating X-ray or explosive detection systems (EDS) shall conduct initial and recurrent certification using standardized X-ray image interpretation tests (at least every 3 years) in order to make sure that they achieve and maintain the required image interpretation competency. This article describes the practical implementation of a certification procedure conducted collaboratively with the Croatian Civil Aviation Agency (CCAA).

Croatia's nine civil airports are currently transporting more than five million passengers per year and this number has been growing constantly. Having pioneered European security officer certification in Switzerland ten years ago, we were asked **to provide expertise for the introduction of computer based competency assessment tests in Croatia in collaboration with the CCAA**. In order to determine the current level of competency of airport security officers, a pilot study was conducted from December 2013 to February 2014. The information gained from the data was necessary to derive plausible performance standard suggestions for each



security screening area, i.e. cabin baggage screening (CBS), hold baggage screening (HBS), and cargo screening. The next sections describe the steps involved in the process.

### CERTIFICATION TEST CHOICE

The main task of Croatian security officers is to detect prohibited items in X-ray images of passenger baggage, hold baggage, or cargo. Therefore, **certification tests had to be chosen that measure the X-ray image interpretation competency of X-ray screeners in a scientifically reliable, valid and standardized way**. It should be noted that covert testing results and threat image projection (TIP) data could theoretically have been used for certification as well. However, these methods are much more challenging if it must be ensured that they fulfill the required standards and are of high scientific quality. As far as the image difficulty of the tests to be used is concerned, research has shown that the probability to detect a prohibited item depends not only on the knowledge and competencies of the screener, but also on the general difficulty of the presented threat item. Furthermore, image-based factors influence detection performance, namely rotation of the

prohibited item (view difficulty), superposition by other objects, and number and type of other presented objects in the bag (bag complexity). It is thus necessary to carefully design the test images, taking into account and balancing their general difficulty.

Based on these considerations, the CASRA team recommended the use of the X-Ray Competency Assessment Test (X-Ray CAT) in the three relevant versions (CBS, HBS, and Cargo) for certification in Croatia. Test development for these tests had followed the necessary steps to ensure high scientific quality, as any certification test should be fair and should not produce mere chance results. The objective of the X-Ray CAT is to distinguish security officers showing sufficiently high detection performance from security officers showing insufficient detection performance through the use of an objective, reliable, valid, and standardized instrument for measuring detection performance. These properties have been defined as a standard for certification tests in the EU regulations (EU 185/2010) and the White Paper (see [1]) on certification and competency assessment, which has been included in the European Civil Aviation Conference (ECAC) Handbook (Doc 30) (see [2]).

The X-Ray CAT was an ideal choice for the needs of the CCAA as it has been applied for security officer certification at all airports in Switzerland in regularly updated versions since its introduction in 2005 and is being used at many other airports in Europe and overseas. All versions contain high-quality X-ray images (minimum of 160) that are handpicked based on the results of a series of pre-tests and on scientific criteria. Test candidates have to judge whether an image contains a prohibited item (i.e. is "not ok") or is clear and does not contain a threat (i.e. is "ok"), while the images are displayed for a duration comparable to operational conditions. By default, the tests include 50% of bag images containing a prohibited item. This ratio was chosen because it guarantees that the resulting data is maximally informative and satisfies the requirements for sound statistical analyses.

The **measures that define the detection performance in such a certification test are hit rates and false alarm rates**. When a screener correctly reports that an X-ray image contains a threat, the response is counted as a hit. However, if a clear image not comprising any prohibited item is reported to contain a threat, the response is categorized as a false alarm. To facilitate the standardized interpretation of test results and make them more comparable, it is highly advisable to combine hit and false alarm rates into one single statistical measure, for example  $A'$  or  $d'$  (see Figure 1).

## CERTIFICATION PROCESS IMPLEMENTATION

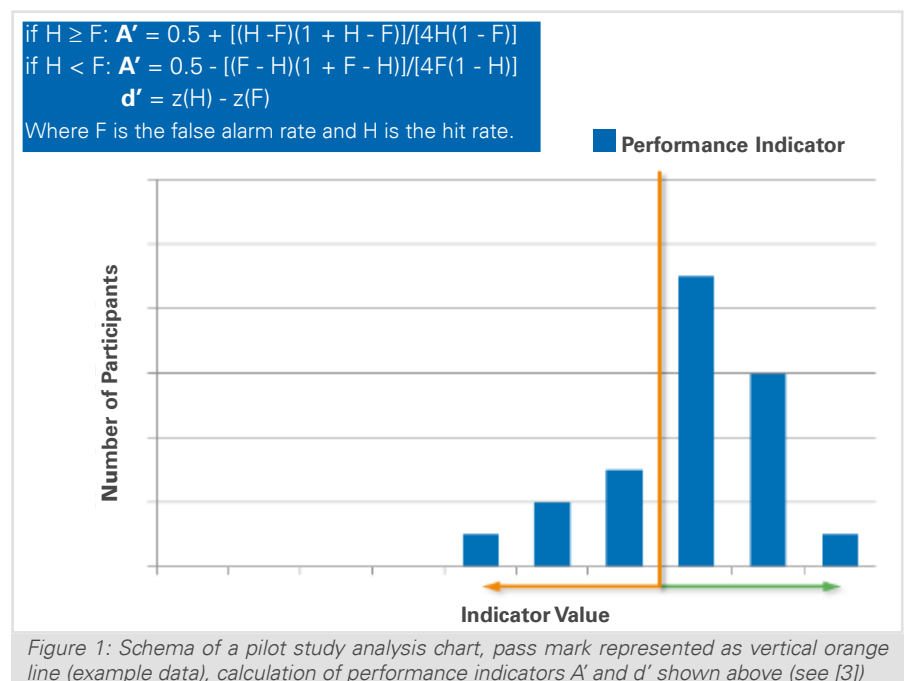
Having discussed the aspects that had to be considered in the test selection for Croatia, we can now turn to the **factors that had to be taken into account for the introduction of the certification tests and the definition of the certification procedure**, since many macro

level decisions influence the success of a certification process. Ten years of experience with certification in Switzerland, where CASRA develops and conducts certification tests on behalf of the appropriate authority (the Federal Office of Civil Aviation), have shown that a nationally harmonized certification process has important advantages. The following factors had to be considered in the establishment of the process:

- › **One single certification test was to be used per screening area for all airport security officers** that were to be certified in Croatia. Only in this way could it be ensured that the test conditions are fair, standardized, and comparable. One central aspect of standardization is realized when the testing procedure and the test analysis follow given rules and are objective and independent of the test environment and the test instructor. We provided the CCAA with presentations for their instructors in addition to the integrated instruction of the X-Ray CAT to achieve this goal.

Benchmarking and comparisons of different airports were only possible if the same test was to be used for everyone.

- › Standardization also involves the establishment of a **norm of the relevant comparison group** (i.e. the airport security officers of Croatia). This included the determination of the group's performance distribution in the pilot study, so that individual scores could be assessed in relation to it using the same type of certification test as it was to be introduced later. The pilot study had to be non-jeopardizing and served to determine the level of competency in the given population of airport security officers. To facilitate the pilot study, CASRA coordinated the data collection with the CCAA using our secure web-based platform, so that data could be collected from different Croatian airports efficiently and in a centralized manner.
- › The pilot study data was used to





provide evidence-based input for the **determination of challenging yet realistic performance level requirements** (definition of the so-called pass mark). As the pass mark had to take hit rate and false alarm rate into account, we recommended the CCAA to use the statistical measure *A'*. It is calculated based on the hit rate and the false alarm rate and usually varies between 0.5 and 1.0, with 0.5 indicating detection at mere chance level and higher values indicating better detection performance (see Figure 1).

- › The determination of the pass mark called for expertise in psychometrics and scientifically sound analyses of the test data, because an inadequate pass mark would have had negative consequences: Sufficient image interpretation competency could not have been assured, with potentially severe consequences for security, or (in case of too high a pass mark) too many test candidates could have failed the test and lost their approval to work as aviation security officers (obviously also resulting in an adverse motivational effect overall). Ideally, an initial pass mark had to be defined at a reasonably high and attainable level.
- › We recommended the CCAA that the **pass mark should be reviewed** on a regular basis and, if necessary, adapted to increasing competency levels to ensure a continuously high standard. Based on our consulting, the pass marks in Croatia were already raised since the introduction of the tests in 2014.
- › The **certification frequency had to be determined**. Our experience at CASRA has shown that a three-year cycle as allowed in the EU regulations might be rather long when

certifications are initially introduced. Certification as a means of increasing the competency of security officers is much more efficient in a shorter certification cycle. Once a certain standard is achieved, the certification cycle can be extended. We recommended the CCAA to use a shorter cycle than three years.

- › Finally, a **communication strategy had to be defined**. Security officers needed to be informed by the CCAA of the background and the objectives of certification tests, how they were conducted and what the consequences were if a test was failed. It had to be outlined that if the training requirements were adhered to, passing the certification test was highly likely since the pass mark was set on the basis of pilot study data.

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