Transitioning towards CT screening

An operator training- and monitoring perspective

A knowledge article by Point FWD in cooperation with various key industry players

Point.FWD consultancy

About this article

With this paper we focus on the human aspect of CT implementation. Taking the security operator as the centre of attention; in our opinion the enabler for the quickest and most constructive way to success in state-of-the-art technology implementations. We invite you to gain more insight on how to manage the modern human-machine interaction whereas we focus on training, coaching on the job and continuous monitoring. Seeking to answer the 'why' questions to 3D image analysis difficulties, providing for solid grounds when approaching your implementation project in a broader sense. Security checkpoint stakeholders should perceive this integrated solution approach as keeping a marriage happy. This will only work if there is enough collaboration, communication and understanding.

Various industry perspectives

The insights shared in this knowledge article have the purpose of including the experiences of a rather broad group of industry stakeholders to the CT transition in the security checkpoint. While many insights originate from Point FWD guidance during implementation projects, the bigger picture is being supplied by representatives from key industry players in the Aviation Security working field. We would like to sincerely thank all our contributing partners on their efforts to compose this series of papers.

Authors

This paper is written by Point FWD's Femke Lettinga and Robin van Gemert. Femke is the former quality coordinator for training and development at security company G4S. In her prior role responsible for huiding operators through CT implementation at several national airports. Robin bringing his integrated view on CT implementation projects and the focus Point FWD has in providing data-driven guidance to airports and other security checkpoint stakeholders.

Femke Lettinga

Robin van Gemert

About Point FWD

Point FWD is a Schiphol based consultancy company with a mission to bring security checkpoint environments to the next optimal state of performance. Our future is a world in where aviation security checkpoint stakeholders have 100% insight in their security operations, being able to adequately, promptly and coherently react to regulatory changes, strategy redirections and deployment expansions. In this paper we share our experience on CT equipment implementations, operator performance monitoring and guidance on operator CT training programmes. Point FWD exists as an innovation partner for our clients through conceptualization and (re)definition of the security process, always with a data-driven, yet human-sensible mindset.

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Supporting experts

In this paper, input from various industry experts is integrated to assess the 360° stakeholder perspective on CT implementation and 3D image analysis. Collaborating companies and their experts for this paper series include Airports, Security Companies and OEM of screening software as well as Training Software. Cooperating companies and their representatives are included on this page.

Security Operators

Securitas Transport Aviation Services

Jan Cuypers, Aviation Business Transformation Manager; Marcia Awouters, Aviation Technology Development Manager.

Securitas is a global knowledge leader in security. From a broad range of specialized services, technology solutions and consulting, Securitas Aviation customizes offerings that are suited to the individual customer's needs, in order to deliver the most effective security solutions.

CTSN

Cheryl ten Brink, Service Delivery Manager

The security operator is the Dutch subsidiary of ICTS, having expertise in the deployment of CT and EDS in checkpoint situations in the early phases of the CT transition. CTSN has a collaboration with InnerEye - a revolutionary EEG (electroencephalogram) interface designed to facilitate real time threat analysis of visual data.

I-SEC Netherlands

Aza Amin, Quality & Training Business Partner

I-SEC is specialised in delivering advanced aviation security. I-SEC provides services for airlines and airports worldwide. These include handling services, safety training, advisory services and security technology. I-SEC Netherlands has developed a complete portfolio of innovative services and technological solutions that create a safe environment for organizations.

Airport Companies

Eindhoven Airport

Mariëlle Sijm, Airport Operations Manager.

After a successful pilot, EIN started deploying a total of 8 ATRS security lanes by the end of 2019 to meet the airport's capacity requirements, while making optimal use of the limited available footprint. Eindhoven became one of the first airports in the world to screen 100% of its passengers' carry-on luggage with CT screening technology.

Rotterdam the Hague Airport.

Alexander Dilweg, Aviation Security Policy Advisor.

Aligned with terminal expansions, RTM's central security checkpoint was upgraded with new equipment and is in operation since the start of 2020. After a short testing phase by the end of 2019, the airport implemented CT equipment, 5 ATRS security lanes and security scanners and therewith Rotterdam also belongs to those few airports operating on CT technology for 100% of their security screening.

OEM's and Resellers

Stage Gate 11

Michiel Poppink, Chief Commercial Officer

Stage Gate 11 is a company focusing on improving the effectiveness and efficiency of airport security departments. They build bridges between technology and this market. They develop own technology and next to that bring third party computer based training software for CT equipment to the market.

Vanderlande PAX Solutions

Darren Durham, Product Manager

As part of Vanderlande's next generation of scalable solutions Vanderlande offers PAX CHECKPOINT. This combines state-of-the-art automated screening lanes with a configurable multiplex screening software to create a fully integrated checkpoint solution. Scalable and flexible, it offers increased throughput and an improved passenger experience while allowing for easy expansion.

Introduction

Explosive Detection Systems for Cabin Baggage (EDS CB) are becoming the new standard in screening cabin baggage on commercial airports across the world. Enhanced equipment enables automated screening of cabin baggage on explosives and is being implemented in various standards. For most of the bigger airports the transition towards EDS CB implicates the implementation of Computed Tomography (CT) x-ray equipment, therewith enabling the operational concept where liquids and electronics can remain inside the luggage during the security check. Replacing common x-ray equipment – mostly single and dual view systems – with CT equipment has various potential benefits.

Gunther van Adrichem (Managing Director, Point FWD) sees this transition as "the long awaited solution to make a step change in security checkpoints worldwide, providing for a better screening experience for both passenger and security operator." He adds: "and this is just a beginning, introduction of these new technologies will allow for even bigger leaps in future detection and operational insights through available data."

Better inspection capabilities

Eliminating the need to take out liquids and electronics can mean less trays used per passenger, increased security throughputs, a more positive passenger experience and eventually a more cost-efficient security operation. One of the enablers for these benefits is the capability of 3D imaging. 3D image analysis can be used particularly to better analyse the more complex images, for example those with electronics inside of baggage. A 2D image provides difficulties for visual analysis since laptops could be blocking the sight on other items, with the consequence to manually inspect a bag which in most cases means additional screening of belongings.

The overall experience operators have regarding 3D image analysis seems positive; operators experience increased visual analysis capabilities thanks to additional manipulation and analysis functionalities. This results in less manual searches, which eventually tend to become more targeted of aim. The introduction of 3D imaging however implicates a different way of screening as compared to 2D images. It provides for novel features – such as rotation and separation – operators have not worked with before, which take time and training to be successfully adopted into their standard image analysis capability.

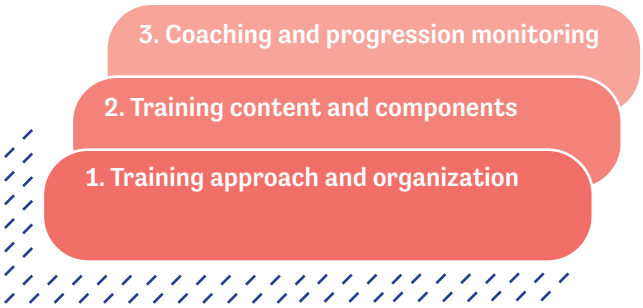
To achieve CT implementation success it is crucial to have a quick and consistent operator adaption to new 3D screening capabilities. After all, the best equipment is of limited value if the people who operate it are not trained appropriately.

The human factor to CT systems

With this article we focus on the human aspect of CT implementation. Taking the security operator as the centre of attention; to our opinion the enabler for the quickest and most constructive way to success. We invite you to get more insight on how to manage the modern human-machine interaction whereas we focus on training, coaching on the job and continuous monitoring. We seek to answer the 'why' question to 3D image analysis challenges, providing for solid grounds when approaching your implementation project in a broader sense. Security checkpoint stakeholders should perceive this integrated solution approach as keeping a marriage happy. This will only work if there is collaboration, communication and understanding.

Read all three parts of this paper

The content of this paper is built around three main pillars deep diving into the operator training perspective when transitioning towards CT. At first, the organization around training programs is looked at, setting the context and requirements for a CT training program. Then, focus is on the content of training and the actual transition of moving from 2D to 3D image analysis. At last, a perspective on the continuous monitoring and enhancement of operator performance is discussed.



Part 2

Image analysis, training content and -components

Included in this part

- Human capability for visual analysis
- Differences between 2D and 3D image analysis
- Focus for 3D image analysis
- Training components

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Image analysis and training content

One of the core activities of a security operator in the security checkpoint is to visually inspect baggage by screening x-ray images for a high variety of items, such as sharp objects, firearms, IED's and other prohibited items. Terrorists continue becoming increasingly sophisticated in their methods to conceal threats, which are therefore more difficult to detect. This automatically implicates the need to enhance and evolve the operator approach on image analysis in a proactive manner. In this chapter we specifically look at the contents of a CT training program. We start at the core dynamics of the human brain in visual content analysis, that can be used to understand the capabilities required for 3D image screening and analysis.

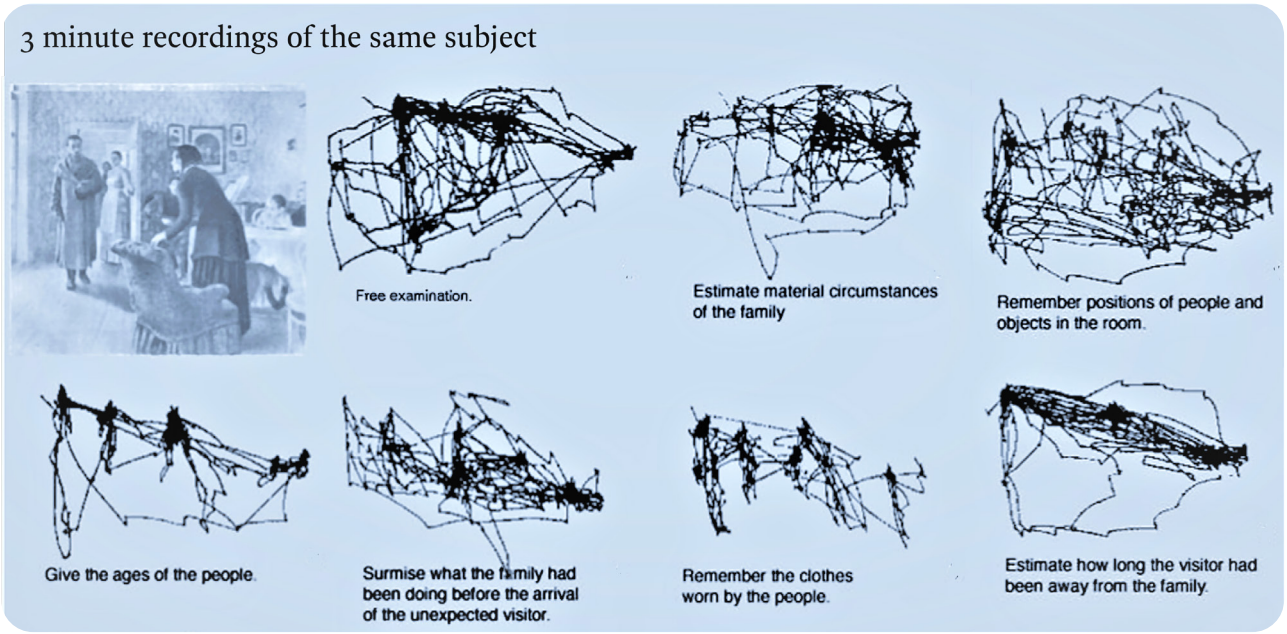
The basics of visual content analysis

Often is thought that visual information would be registered in a smooth and continuous way whenever eyes are open. Likewise, that visual experience is a connected, or single visual scene that scans and examine at will. However, both ideas are mostly an illusion and can be disconfirmed easily by a simple observation.

When you would watch someone's eyes while reading you will see that the eyes do not sweep smoothly across the line of print. Instead, they jerk across the line, bit by bit, with pauses between the successive movements. These eye sweeps from one point to another in fast moments called saccades - movements that are interrupted by pauses called fixations. The saccade is quite fast, taking anywhere from 25 microseconds to about 100 microseconds, depending on how far away the next fixation is. And it takes up to 200 microseconds to trigger the movement. During the saccade, there is suppression of the normal visual processes. The eye takes in visual information only during fixation. It is as if we are blind during the actual sweeping saccade movement.

Assuming something in the range of 250-300 microseconds for an entire fixation-saccade cycle, at that rate, there is enough time for about three or four complete visual cycles per second.
Each cycle registers a distinct and separate visual scene, although only a radical shift in gaze would make the input of a single cycle completely different from the previous one.

In 1967, Yarbus presented qualitative data from one observer showing that the patterns of eye movements were dramatically affected by an observer's task, suggesting that complex mental states could be inferred from scan paths.



Yarbus´ 1967 qualitative research results on eye movement patterns

Human logics applied to screening CONOPs

Besides the visual scanning patterns, several other cognitive abilities apply to the operator screening process. These include things as mental rotation, figure-ground segregation, logical thinking and the specific knowledge of how forbidden objects look like in x-ray images. Following Yarbus' observation about the complexity of images and the resulting state of mind, with 3D analysis, every other perspective of a tray or trolley provides for another image to analyze. And with every new perspective, the mind is naturally trained to use the applicable cognitive dynamics to screen the image.

Visual segregation enables us to separate an object from its setting. This separation of figure and ground allows people to recognize shapes we are familiar with, but the same process also occurs with figures that have no particular meaning. Perceptual problem solving takes the figure-ground segregation a step further. Please focus on the example image below to test your capability to visually segregate.

How and when do more complex images impact the screening process? The starting point for content analysis is having the target clear. In the screening process, this target is defined by the CONOPs that is being deployed. Because the patterns of eye movements are primarily affected by the task. The more complicated or diverse the CONOP is, the more complex the eye movement patterns get. And yes, that is a dalmatian sniffing the ground.

EDS and on-screen resolution

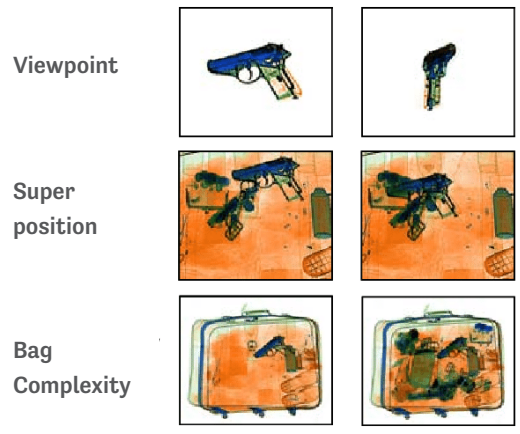
One of the choices is to implement a CONOP where operators search for all prohibited items in images without an EDS alarm, except for IEDs. Images that contain an EDS alarm must be searched for all prohibited items, including IEDs. Whether OSR or non-OSR is applicabe. The biggest advantage of this CONOP is however not the number of threats to search for is decreased by one. The advantage is that the most complex threat to search for is decreased significantly. Hence: 85 to 90% of the images doesn't have an EDS alarm! So why is an IED your most complex threat?

- Less complex threat items usually consist of one component. An IED consists of multiple components.
- IED components can manifest in multiple forms; explosives can resemble a chess piece, or the content of a soda-can, and the power source can be an iPad.
- Numerous combinations are possible between the IED components.
- The components can also be for daily use, such as a laptop.

In summary, the eye movement patterns tend to be more complex within the search for an IED, and therefore, it takes much significantly longer to search for an IED in an image. Also, reporting an IED – as a High Threat – has more impact on the operation than reporting a sharp or a gun. This effect can influences the search time for IEDs as well.

Focus for 3D visual inspection

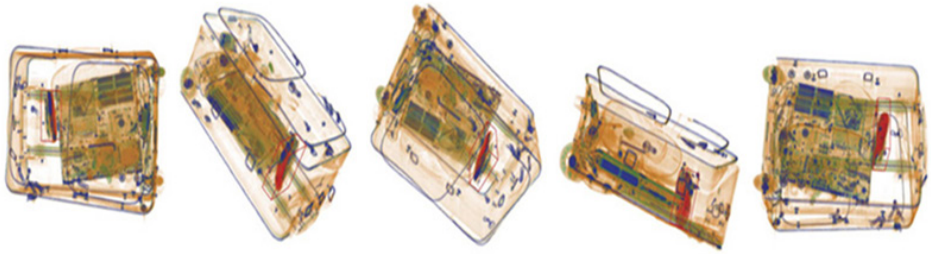
Important impact factors on operator screening performance are the viewpoint, visibility and superposition operators have to their image. Specifically, in 2D X-ray images these factors strongly influence the difficulty of analyzing. With 3D rotatable images, superposition and viewpoint might become less important. Analyzing 3D X-ray images can however be very challenging in other ways. Below is a list of challenges obtained for practice, that need focus in training operators for 3D deployment.



Visual inspection impact factors on the operator

CT controls and analysis features

Eindhoven Airport experienced that “the analysis of CT images as compared to x-ray was not the biggest challenge, but rather the controls of this new equipment”, **Mariëlle Sijm** explains. 3D image analysis provides new functionality to manipulate the image. The image can be rotated, and the operator is now able to slice through the image. Due to these functionalities, operators are provided multiple viewpoints, which usually take more time together to provide a decision on. In training, operators should be educated for most effective and efficient use of these functionalities. **Aza Amin** (I-SEC Netherlands) explains that in order to adapt to the new functionalities, “operators should also understand the ‘why’ behind these new functionalities on the operator interface. Why it is important for an operator to use the slice-functionality? If you don’t know, you can’t analyze the image effectively.”



Manipulating images in 3D visually

X-ray image representation

Many objects look quite different in 3D X-ray images: in CBT specific attention needs to go to objects that tend to give distorted representatives. Operators need to be aware of the learning aspect during every baggage search they do during their shifts in operation after the training.

Complexity of the bag or tray

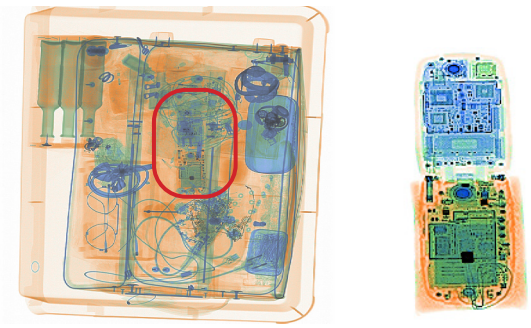
Due to EDS CB C3 CONOP passengers can leave their laptops and LAG’s inside their bag. This makes the image more complex, especially because they are usually combined with many other objects and materials. Plus, passengers tend to take more cabin baggage due to higher costs for check-in baggage and due short trips with cabin baggage only.

Unfamiliarity with objects

Operators may not be familiar with certain objects based on their own life experience– even less with the 3D image. During training it is highly effective to let operators get familiar with different objects, both in photo view as in x-ray view, for example by using Computer Based Training (CBT) programs during training and coaching on the job.

Threat concealment

Some prohibited items resemble everyday objects, such as credit cards that conceal a knife or TNT in the shape of a bar of soap. Due to the presence of electrical components in original structures, digital devices still do provide good basis for concealing explosive material and the components that compose an IED, as can be seen in the picture below.



Enhanced threat concealment

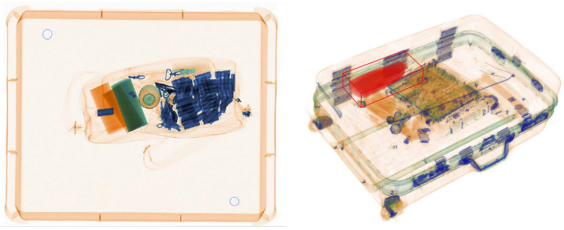
Enhanced image resolution

The resolution of the image quality is higher on CT scanners. The result is that operators have ‘more to look at’ with a limited amount of decision time. This might also influence the degree of fatigue of the

operator. Operators need to learn a new technique to analyze these images. Once they are familiar with the resolution, analyzing becomes somewhat more natural. They get better at recognizing objects and identifying threats. Hence the operator can decide faster and the decision time drops.

Assorted color palette and transparency

The image quality differs from the image quality in the baseline situation. When the image quality of 3D images is compared to that of 2D images, the biggest difference experienced is the intensity of the colors and the transparency. Generally the 3D image is more transparent, and its colors are less intensive than the 2D image. The transition from 2D to 3D image analysis also means getting familiar to an assorted color palette and transparency. Metals, for example, are displayed less intensively in 3D default. Operators should be made aware of this during training.



2D vs 3D color intensity

Screening methodology: 2D vs 3D

Various methodologies can be used for image analysis. The screener performance depends, among other things, on the method and representation that is being deployed. If, for example, a six-step methodology is applied to screen each image, the operator decision time will increase as a logical consequence. Yet, it does provide a feeling of stability for the operators. Contrarily, a methodology can be used that focuses on the expertise and preferences of the individual operator. This method provides a sense of autonomy for operators. The average decision time can hence be decreased to a minimum. **Marcia Awouters** (Securitas Transport Aviation Services) furthermore shares "that all our operators still relied on the 2D image as well to get a first impression of the content. On top of the 2D image, operators now have the ability to use more advanced manipulation of the image such as slicing and singulation of for example laptops and liquids"

> "all our operators still relied on the 2D image as well to get a first impression of the content."
>
> **Marcia Awouters**
> *Securitas Transport Aviation Services*

Training approach and components

The approach to training is seen to be varying across airports and security operators. However a training program usually consists of a multiple layer set-up, mainly by using several common training layers. These components might be taught to operators as a program, subsequently starting a next training component after finalizing the other. In this program, classroom CT training is often provided in order to take the first steps into 3D analysis. On-the-job training is followed in where operators work in a real operational setting, having to deal with operational interference at hand.

Cheryl ten Brink (CTSN) explains the importance to implement tests after completing training, even if regulations do not require this. "Without a test moment you do not know what information the operator has adopted. In the end you will only be able to notice this during monitoring and coaching in operation".

At last, ongoing coaching and monitoring will help to track progression and stimulate the enhancement of operator performance. Some of the important focus points for these separate training layers are included below.

Computer based training

When taking the first step towards CT operation and specifically CT image analysis, usually operators need to pass a CT exam in order to screen in live operation. Computer based training is developed to create a simulated screening environment with practical exercises to challenge screeners with realistic scenarios and immediate feedback on their decisions, **Michiel Poppink** (Stage Gate 11) defines. He continues: “Data is captured and provided trainers with extensive information on each trainee’s strengths and weaknesses, to improve their screening skills and optimize the training. This feedback helps screeners to improve effectiveness. Trainees can gain hands-on knowledge by screening real 3D X-ray images of typical passenger content, some of which contain hidden IEDs.”

Securitas’ **Jan Cuypers** elaborates on their use of CBT: “In order to best prepare the operators who will be working with CT equipment, we must allow them sufficient time to get acquainted with the new technology and provide them with a real test environment such as 3D simulator software training, currently developed by one of the major players in CBT. Using a CBT that has the same capabilities as the technology that is deployed in the checkpoint and which has a sufficiently large image library, provides the operators with the possibility of training and testing themselves to such a level that they become very confident with using the technology in real life”.

Another advantage of CBT software is “the agnostic character of the system that helps them to stay flexible if an airport or security operator has screening equipment of different manufacturers”, says **Michiel Poppink** (Stage Gate 11). These organizations look for graphic user interfaces that are identical to the CT systems and the same X-ray image enhancement functions. Next to these technical features it is very important to airports to have a flexible system that is easy to adjust to new legislation or procedures.

> “Data is captured and provides trainers with extensive information on each trainee’s strengths and weaknesses, to improve their screening skills and optimize training.

Michiel Poppink
Stage Gate 11

On the job training

Training in live operation with help of active trainers and experienced CT operators. During training on site, the theoretical framework and experience from CBT will be combined. In this practical part of the training different scenarios can be practiced achieving a deeper understanding of the CONOPS. Operators should experience the outcome of the changes on all positions at the security lane and how processes influence one another.

An example of on-the-job training is the direction Eindhoven Airport took in their security trial project. For on-the-job training of existing security staff and new joiners, the airport's security operator G4S selected approximately 10 operators, including team leads well as enthusiastic and eager security staff. "The selection of ten operators was the first group for adopting the new security configuration into current processes. They were provided a train-the-trainer program in order to be fully capable of training and coaching the rest of G4S' security staff on-the-job at Eindhoven Airport" (**Mariëlle Sijm**).

> "The selection of ten operators was the first group for adopting the new security configuration into current processes."
>
> **Mariëlle Sijm**
> *Eindhoven Airport*

Coaching and monitoring

In the final part of the training, it must be assessed to determine whether the learning goals are achieved. Operators should also give feedback regarding their experiences. This feedback is incredibly valuable. Further, an estimation is needed to determine the amount of coaching an operator needs. Coaching and monitoring will follow during their shifts in operation. Recurrence training will provide insights on further developments and insights for the whole staff population. Find out more in-depth elaboration about coaching and monitoring in Chapter 3.

Alexander Dilweg (RTHA Airport) explains their approach in training components, in collaboration with their security operator Trigion. "Before starting deployment, all operators have been trained on the required knowledge for all equipment that was part of the security transition. Trigion was provided full management and control over training its operators. Training consisted of knowledge sessions and were followed by walk-arounds and physical training during the first month after the install was completed. We then opened just one of the new security lanes for passengers, to have operators getting acquainted with the new process. For these two weeks we kept most pressure off the security lanes in order to avoid queuing and to provide an organized process in initial period of operation."

>> Next part: Operator coaching and progression monitorinng

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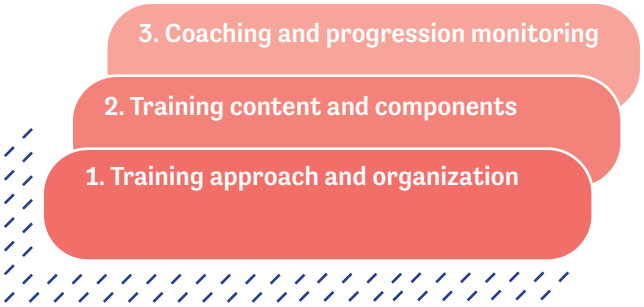

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Point FWD specializes in the guidance on CT implementation into global security checkpoints. On the CT implementation perspective, guidance goes in specific direction of CT implementation approaches, specific equipment training programms and helpful data tools for accurate progression monitoring.

Please get in contact for exploring how Point FWD can be of help achieving success in your CT implementation project.

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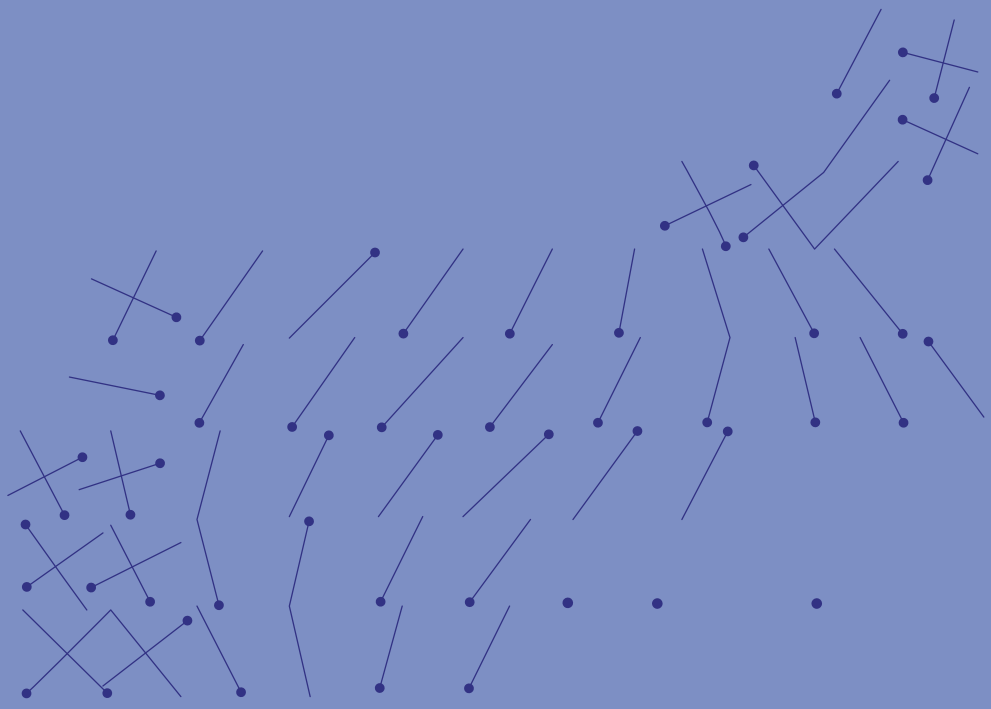

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