# SCIENCE & SECURITY Issue 31

CASRA NEWSLETTER

Since 2012, we have been publishing newsletters in which we present results from our research, address trends, and provide information for security practitioners.

The first article of this issue describes the Airport Checkpoint Effectiveness Simulation (ACES), a software we developed for comparing different airport security checkpoints regarding security effectiveness.
The second article presents insights into the relaunch of CASRA's X-Ray Tutor (XRT), the state-of-the-art training and testing platform for X-ray screening. This includes a new user interface that will be available by the end of the year.

We hope you enjoy reading these new articles and as always, 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.

With best wishes,

Dr. Diana Hardmeier
Director

Prof. Dr. Adrian Schwaninger
Chairman

## TOPICS IN THIS ISSUE:

### RESEARCH PUT ACROSS

**AIRPORT CHECKPOINT EFFECTIVENESS SIMULATION (ACES)**

The past few decades have seen continuous technological advances producing new equipment that can be integrated into airport security checkpoints. This equipment aims to improve security, convenience, and affordability in air travel. The integration of new technology into airport security processes to optimize benefits is, however, a complex question. CASRA has developed the Airport Security Effectiveness Simulation (ACES). With this software, different airport security checkpoints can be compared regarding security effectiveness.

### SECURITY IN PRACTICE

**XRT PRODUCT RELAUNCH: NEW, ENHANCED USER INTERFACE**

In 2020, CASRA released XRT4, the new computer-based training and testing platform for supporting X-ray screeners throughout their whole competency life cycle, from pre-employment evaluation to initial and recurring training, to testing and certification for different technologies. At CASRA we embrace the continuous need for evolution as an opportunity to analyze where we stand and define how to further improve our product. We have now been working on designing a new user interface for our platform that we will be launching before the end of the year.

# AIRPORT CHECKPOINT EFFECTIVENESS SIMULATION (ACES)

Text: Yanik Sterchi

The past few decades have seen continuous technological advances producing new equipment that can be integrated into airport security checkpoints. This equipment aims to improve security, convenience, and affordability in air travel. However, how to integrate each new technology into airport security processes to optimize benefits is a complex question. Regulators aim to set standards that maintain security while allowing airports to adjust according to their individual needs. CASRA has developed a software prototype named ACES (Airport Checkpoint Effectiveness Simulation) to compare different checkpoints regarding security effectiveness.

## BACKGROUND

How well a checkpoint can detect and avert threats not only depends on the capability of the implemented equipment but also on how they are integrated into the overall screening process. Therefore, regulation prescribes both the type of equipment that can be used as well as the combinations and processes that are allowed. Thereby, regulation must navigate a challenging trade-off: On the one hand, limited options for the checkpoint design provide more control over the security level they provide. On the other hand, rigid regulation reduces flexibility for airports to adjust for their individual needs and slows innovation with the potential to increase security as well as convenience and affordability. In an ideal world, regulators could define the overall level of security that a checkpoint must provide and airports together with manufacturers would have all the freedom in how to achieve it. But this will not be fully feasible in the foreseeable future as the overall security level is very costly to assess accurately e.g.

through covert tests. There are, however, continuous efforts by many regulators to move towards this so-called outcome-based security with the aim to increase flexibility and innovation for airports and manufacturers.

ACES was developed as part of a research project that developed different tools to assist with checkpoint evaluation and optimization. It is a software prototype that focusses on evaluating and optimizing the security provided by the checkpoint. To make it useful for practice, several regulators started testing the tool and provided feedback during the development of the prototype.



Figure 1: Threat scenario menu of ACES

## INPUTS AND OUTPUTS OF ACES

ACES is intended for regulators or other security experts with knowledge about the alarm rates of screening equipment and want to find out what level of security is achieved when multiple pieces of equipment are combined to a checkpoint. For this, the user can create a list of screening components and processes. These components are then available to create a checkpoint by

combining them into an integrated process. For this, the user chooses with which components the process starts, e.g. with X-ray screening for baggage and a WTMD for passengers. The user then defines the follow-up components in case there is an alarm or not, e.g. a pad-down in case of a WTMD alarm and random quota for an ETD regardless of the WTMD outcome. The user can also create a list of threat scenarios for which the probability of detection should be calculated. Each scenario is defined as the combination of a threat and its concealment, e.g. a bomb made of C4 hidden in a bag. The scenarios can be organized into different categories, tagged with user-defined attributes and weighted with regard to their importance. Finally, the user must input the alarm probability for each combination of component and threat scenario. This certainly requires expertise from the user and profits from access to confidential information. For technical components, minimum detection values or empirical findings from component testing can provide estimates. For screen-

ing processes that depend on the performance of security officers, estimates can be derived from human-factors studies, certification, and covert testing.

ACES then calculates the overall probability of detection for all selected checkpoints and all threat scenarios. The results are displayed as a graph that allows dynamic grouping and filtering for different threat categories or types, or the results can be exported as a csv file. Because ACES also allows the user to copy a checkpoint and quickly make changes to the equipment or processes, different variations of checkpoint designs can be compared quite easily.

The overall probability of detection is likely the most important metric when evaluating the security level of a checkpoint. But it is certainly not the only relevant aspect. This becomes especially obvious when looking at random quotas. If a certain threat were only detected through explosives trace detection (ETD) and the ETD is performed on a random selection of 15% of all passengers, then said threat would have a detection probability of below 15% (specifically, of 15% times the detection probability of the ETD). The main contribution to security by quota alarms is not detection but unpredictability and deterrence. The looming and unavoidable risk of a quota ETD assures that also even if a threat could only be detected by an ETD, that threat would not be guaranteed to go undetected. To cover this aspect, ACES also calculates the unpredictability in the screening process in form of the entropy (a measure of uncertainty from information theory; Shannon, 1948) for each threat scenario. To assist with checkpoint optimization, ACES also allows you to identify which screening component might profit most from improvement by calculating for each component how much the overall detection would improve if its probability of missing a threat were cut in half.

There are a few limitations to keep in mind. As ACES is only a prototype, the tool does not come with an installer and does not offer the performance and stability of fully developed software.
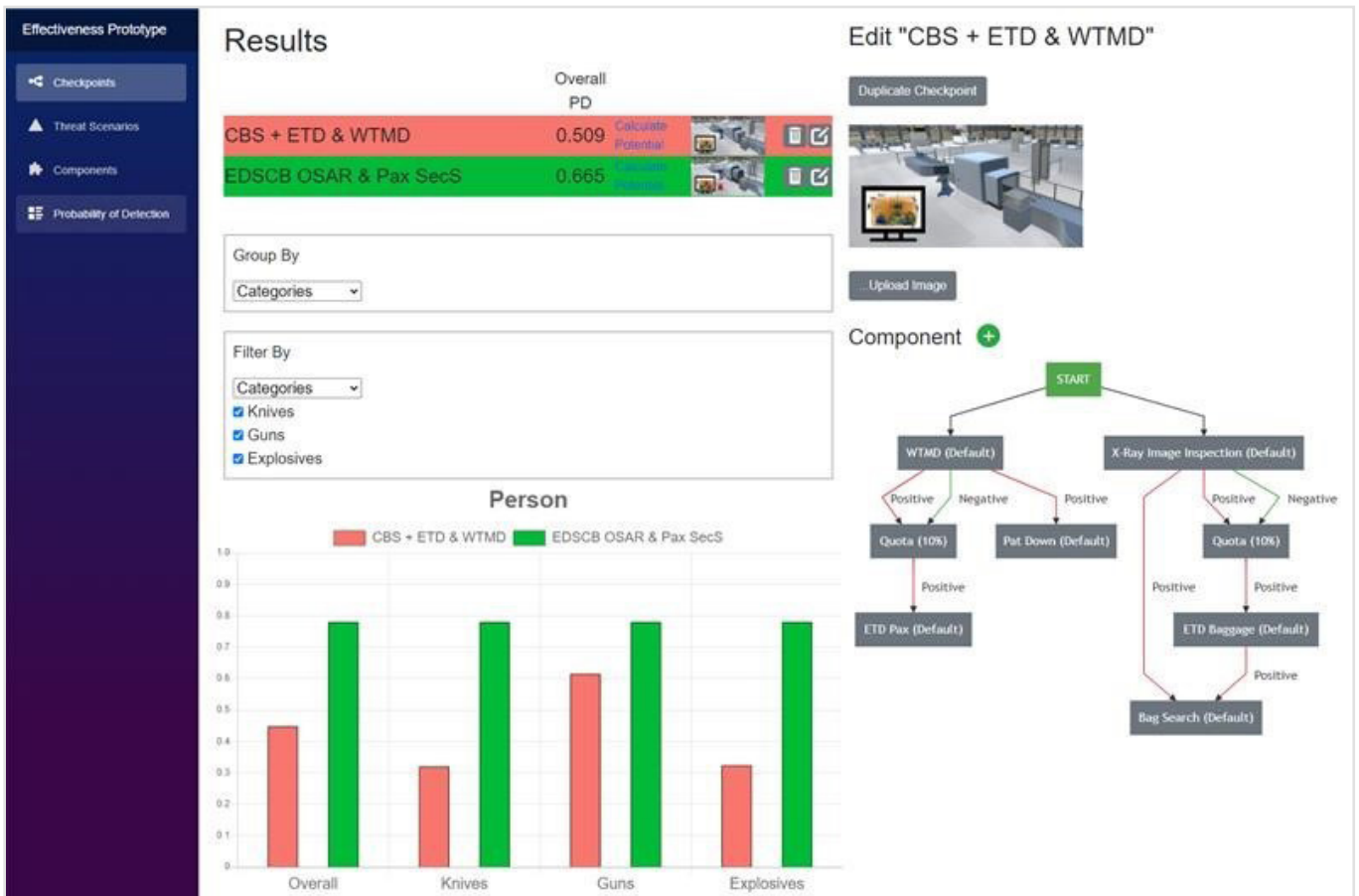


Figure 1: Results page of ACES

CASRA

The user also should be aware of the assumptions behind the calculations of the overall probability of detection and unpredictability (in case of interest we can provide a document describing these assumptions). Lastly, it can be challenging to estimate the alarm probabilities for each component and screening process as they are often tested for different categories or types of threats.

Despite these limitations, ACES can be a helpful asset in managing the security in passenger screening. The tool was provided to government agencies from four different countries. By providing an easy way to rearrange checkpoints and estimate their security level, ACES supports these regulators moving towards outcome-based security.

## REFERENCES

[1] Shannon, C. E., 1948. *A mathematical theory of communication*. The Bell system technical journal, 27(3), 379-423.

# XRT PRODUCT RELAUNCH: NEW, ENHANCED USER INTERFACE

Text: Sara Bracceschi

## BACK TO THE LAUNCH OF XRT4

It was only a few years ago, in 2020, when in the 23rd issue of the CASRA's newsletter we proudly presented our new testing and training solution XRT4. The new computer-based training platform was developed with the aim of supporting X-ray screeners throughout their whole competency life cycle, from pre-employment evaluation to initial and recurring training, to testing and certification for different technologies.

XRT4 provides training and testing for single view, dual view and 3D CT images, incorporating, in addition to generic X-ray simulators, X-ray system specific user interfaces, in order to mimic the operational environment. Theoretical modules can be integrated, as well as the possibility, through XRT4 Expert, for the customers to upload own X-ray content, in order to further customize training and testing modules. The numerous features of XRT4 were then presented in detail.

Like the predecessor, XRT4 incorporates an individually adaptive algorithm, which performs a systematic assessment of the trainee's performance and henceforth displays the X-ray images for analysis based on the individual's experience and areas of improvements.

New features, adaptations, and enhancements that our customers and partners have become used to in XRT4 have been the result of scientific studies on visual cognition and human factors in X-ray screening.

XRT4 has provided us with the opportunity to introduce to the market a state-of-the-art application but the migration to the new platform, just like any change, brought about some level of effort. Six years later, we are proud to share that 93% of our customer base has successfully migrated to XRT4, either as a hosted or as a locally installed solution.

The field of computer application is, however, an ever-evolving one, driven by either advancement in technology, changing user needs, and emerging trends. Henceforth, as XRT4 reaches its full maturity as a stable product, we ought to look ahead and consider how to move forward to ensure a radiant future for the X-Ray Tutor platform and for the X-Ray Tutor's users.

At CASRA we have embraced this continuous need for evolution as an opportunity to analyze where we stand and define how to further improve our product. With the XRT users at the core of such investigation, we have been focusing on how to improve our customer's user experience, and have been working on designing a new user interface for our platform that we will be launching before the end of the year.

## REASONS FOR USER INTERFACE (UI) RELAUNCH
### THE PRODUCT ASPECT RELAUNCH

As we strive to ensure that XRT remains a leading state-of-the art and modern application, we have completed a review of the platform, assessing how its look and feel can be revised and improved for our customers, in order to provide an enhanced experience.
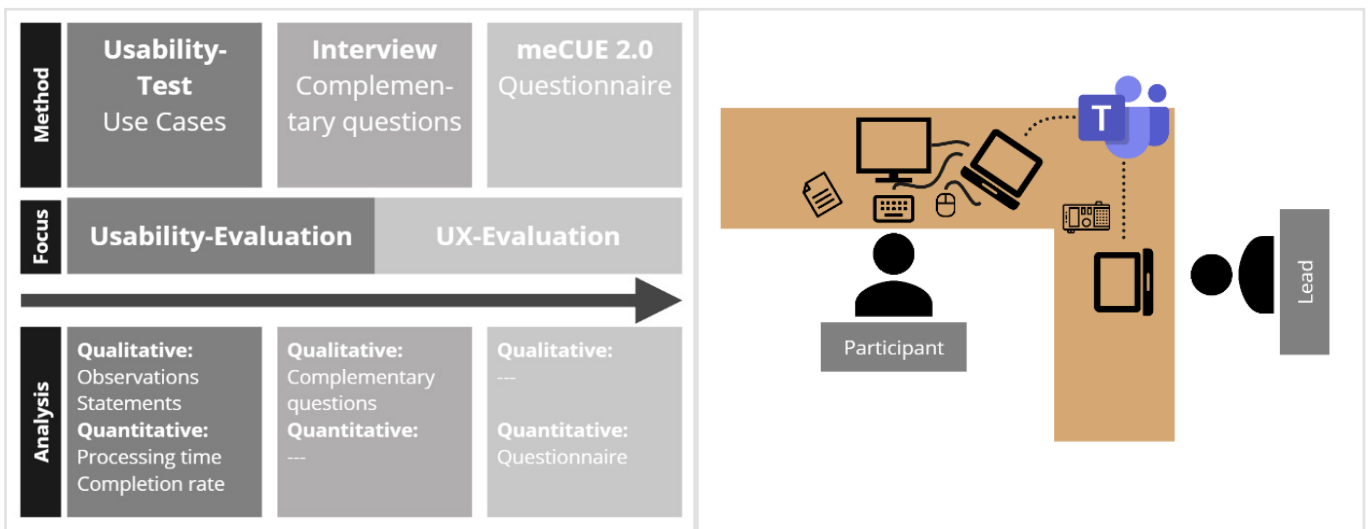
In such an effort, we have conducted



Figure 1: Study settings and set up

research on user experience (UX) and user interface (UI) design to gain insights on how to further improve usability and user experience. The results have been incorporated in the new UI and UX design, which in keeping with its predecessor's general look, will fit seamlessly with the existing product.

are developing. As such developments unfold, from a technical standpoint, behind the scene, we intend for the different platforms to lie upon a shared, unified solution that is based on the latest technology. And on the front end, for our customers, we'd like to ensure that the UIs of the different applications have as

change overwhelming.

In light of such experience, the new UI is a first step towards other changes and updates to come over the next few years. CASRA is committed to bringing its customers with it throughout this journey, instead of meeting them at the des-
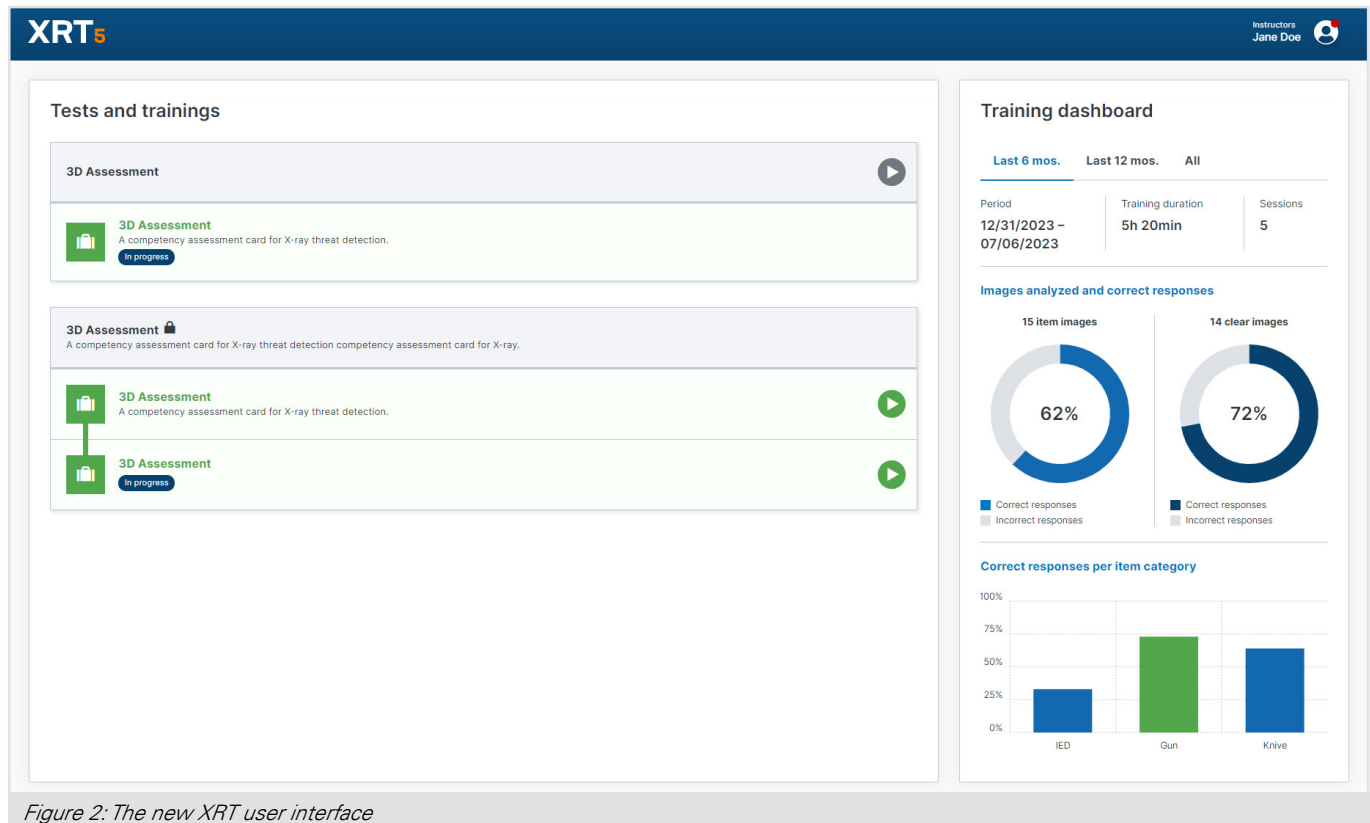


*Figure 2: The new XRT user interface*

In addition to that, prior to the UI relaunch, the new proposed design has been scientifically validated in a research study conducted by the University of Applied Sciences and Arts Northwestern Switzerland (FHNW), as described in the section below.

As our name says it, Center for Adaptive Security Research and Applications, our focus is developing security applications based on research findings. Most of our customers know us for our computer-based application XRT4 for training and testing X-ray screeners. However, XRT is one of other applications that we

much of the same look as possible. It is also in light of such goal too, that we are redesigning the XRT software, starting with the new UI.

## THE CUSTOMER ASPECT

Despite the tremendous innovation that the XRT4 platform yielded in the field of remote X-ray image analysis training and certification, the transition from its predecessor XRT3 was not as seamless as we would have hoped for our customers. The radical look, feel and the several novel features, as much as needed, called for a somewhat long transition phase. Some customers found the complete

tination. Which is the reason why we are approaching the product relaunch as a phased approach, announcing today the new UI relaunch, which we will roll out before the end of 2024.

## THE RESEARCH BEHIND THE NEW UI

In keeping with CASRA's *raison d'être* as a research center focused on improving the human-machine system performance in X-ray screening, the relaunch of the XRT platform, including the new user interface (Figure 2), is introduced as a result of scientific investigation on the new XRT5 UI design that was proposed

by the external consultants and experts.

More specifically, the new UI that all our customers will be able to use in just a few months, derives from a usability and user experience study carried out at the University of Applied Sciences and Arts Northwestern Switzerland (FHNW). At the core of the study lies the most recognized literature on the topic of usability testing and UX, namely, the ISO norm of ergonomics of human-system interaction which, particularly in its part on interactive principles, provides guidance on the requirements that a system should hold [1]; Breiner's Psychology of Design [2]; and Jakob Nielsen's Ten Usability Heuristics [3], who is considered the godfather of usability testing. It is upon such literature that the findings and consequent recommendations for enhancing the XRT platform were based.

### STUDY SETTINGS

The study overall evaluation process was composed of three methods:
1. Usability testing
2. Interview with the study par ticipants
3. A questionnaire

Each of these methods has either a focus on usability evaluation or on UX evaluation or a combination of both, as you can see in Figure 1, and can generate qualitative and quantitative data.
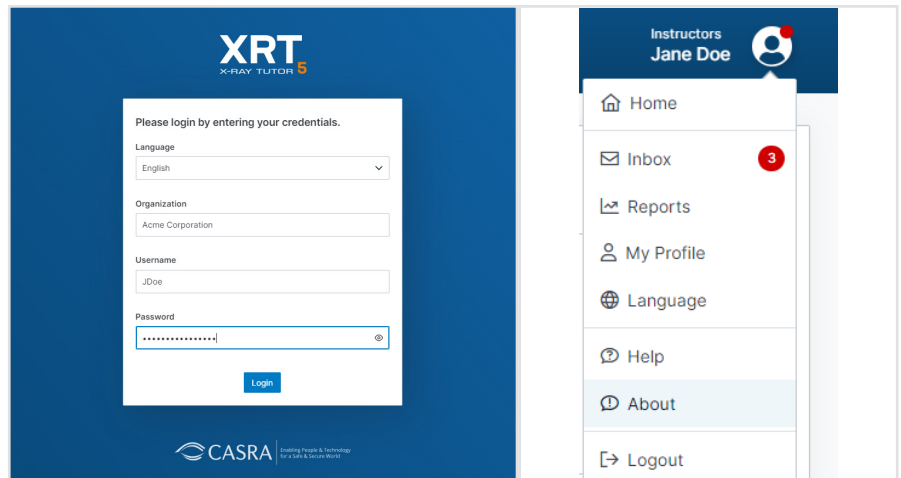


Figure 3: The new Login/Logout page and Menu

The first part of the project focused on usability test and, for that, seven areas of interest were identified by the FHNW's researcher together with CASRA's representatives from our Product Management and Software Development teams. The areas of interest identified aimed at rating the usability and user experience on the current platform and at gathering data on how it can be improved. Specific use cases were generated in order for the participants to be able to rate different features of the new proposed XRT5 UI from the login page to the module status, buttons, colors, as well as dashboard and menu. The second phase of the project comprised interviews with the participants, as some use cases required an oral explanation to complete the task. The interviews were key to gather quali-

tative data from the participants. Last, the meCue questionnaire with its five-module composition and various dimensions, allowed us to focus on the usefulness of the product, the visual aesthetics and also the overall participants' experience with the platform.

### STUDY FINDINGS

As the study on the new design is reaching its completion, the general feedback is very positive. The participants involved in the study find the new UI modern, advanced and very user friendly. The study findings will be turned into recommendations for future development of the XRT platform. But in this first round of enhancements and upgrades, to be completed this year, the focus is on the new UI, as described in the following section.
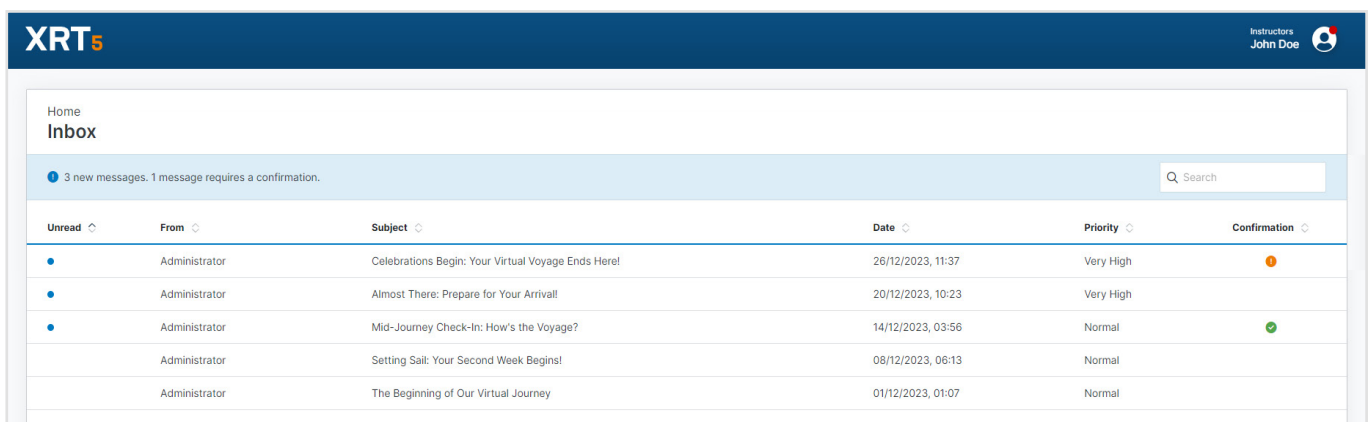


Figure 4: The new Inbox look

### NEW UI FEATURES

So here it is the now much anticipated new XRT user interface which we will release before the end of the year (Figure 2). The new UI offers an improved experience in the areas of interest that, at the beginning of this journey, were identified as areas for improvement and modernization, namely: the login/logout process; header with user menu; side navigation; module display and dashboard on home page; language; about, help and my profile sections; inbox; and last, but not least, reports.
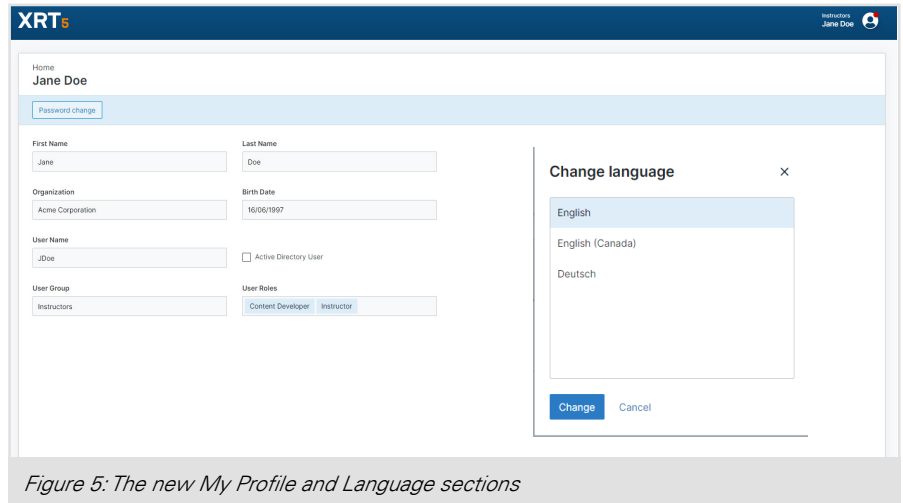


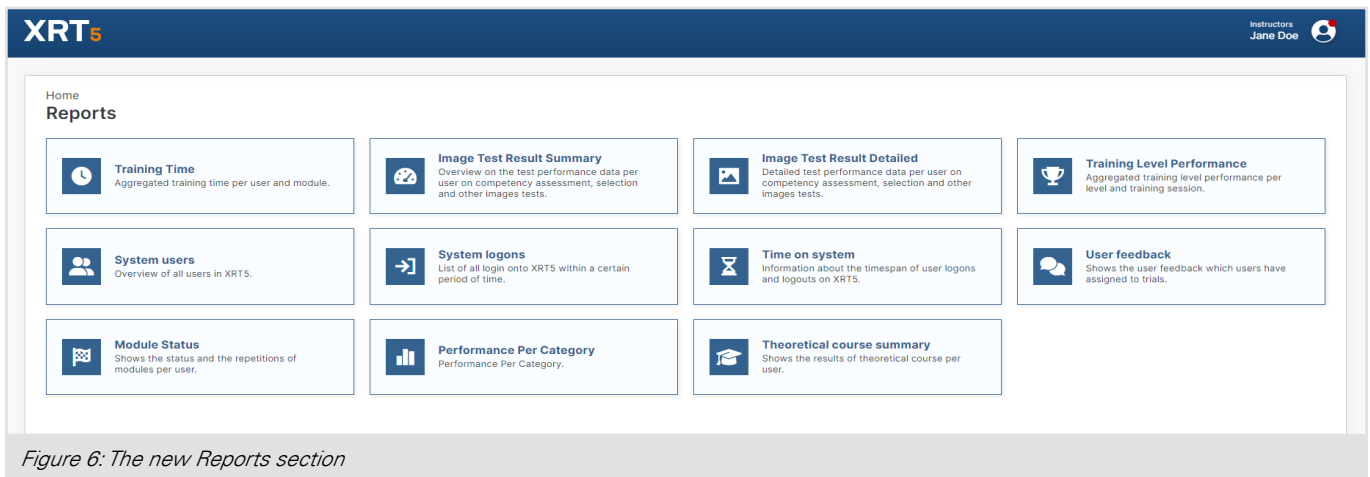Figure 5: The new My Profile and Language sections



Figure 6: The new Reports section

From the Login/Log out page to the new user menu, the XRT feel and look will provide a much more modern and user-friendly experience.

The Inbox section will improve the communication function of the XRT platform.

The My Profile section as well as the language option have been modernized.

The Report section presents a completely new redesign which is consistently displayed also in the Help section.

As we work towards completing the new UI so that our customers can start enjoying it in a few months, we reassure you that this new implementation is done for our customers and keeping our customer's needs in mind. The transition will be smooth and seamless and most
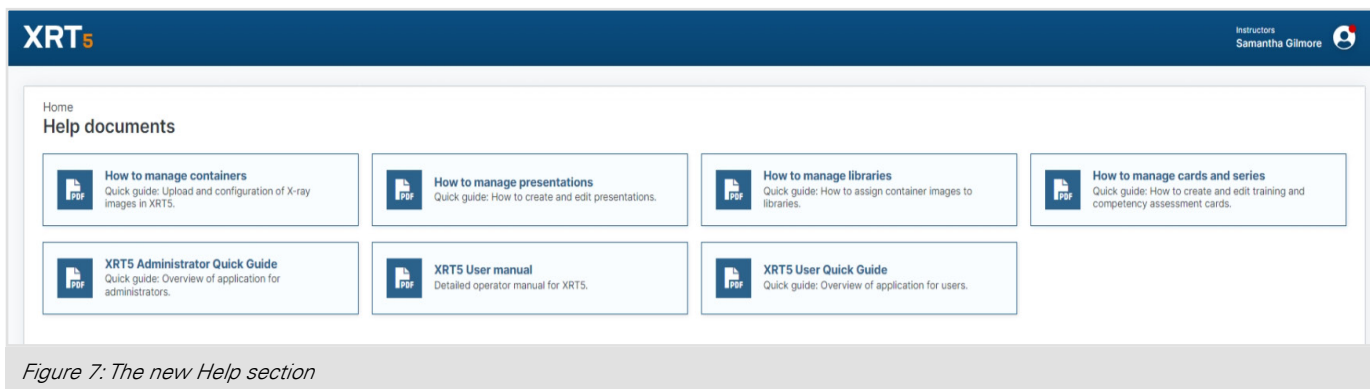


Figure 7: The new Help section

importantly gradual, and we are sure that it will improve their experience with CASRA's XRT application.

## THE FUTURE OF XRT

We believe that any product demands constant upgrade and modernization. For that reason, the full implementation of the new XRT5 UI is in full swing and CASRA has embraced this as an opportunity to enhance the overall XRT platform. Our plan is, however, to undergo a gradual replacement of our current XRT4 over the course of next few years. This means that progressively more parts of the current application will be broken out, rewritten and replaced.

The 2024 release will be focused on the aesthetics of the platform, prioritizing the user portion of the application, the new XRT5 UI. This is the major change our customers will notice. The additional changes, upgrades and improvements will be mostly done on the back end, targeting features such as authentication and identity management, simulators, and ensuring the easy integration of XRT5 with other platforms, just to provide some examples. Those changes, however, will have no impact for users, except an improved, faster and more seamless experience when training or completing tests in CASRA's XRT5.

## REFERENCES

[1] EN ISO9241-110:2020. (Edition 2020-10). Part 110: Interactive Principles.

[2] Breiner, T. C., 2019. *The Design of Psychology*.

[3] Nielsen, J, 1994. *The Ten Usability Heuristics*.

[4] Minge, M., 2018. *The meCUE Questionnaire (2.0): Meeting Five Basic Requirements for Leand and Standardized UX Assessment*.