

Towards integral security concepts for government buildings through virtual facility reconstruction

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Abstract. This paper presents VASCO, a Virtual Studio for Security Concepts and Operations. It is based on an innovative multifunctional ICT platform that enhances security design and strengthens security measures for government buildings. VASCO enables security professionals to virtually reconstruct government buildings, their surrounding environment and overlay their existing security means. The security community can validate actual solutions and search for the best practices by simulating diverse types of threats in high-resolution, realistic though virtual environments. Responding to an emergency, which involves a multitude of affected stakeholders and actors necessitates the involvement of a number of state owned agents and organizations. The need for making decisions using a common operational view, sharing information, exchanging data and planning coordinated actions is prerequisite. VASCO is a solution aiming to provide an important leap from present-day security planning methodologies and tools, to more sophisticated and efficient security solutions.

Keywords: 3D representation, security management plan assessment, Building security, collaborative environment, multi touch screen interaction, Threat Response Planning, Risk Assessment

1 Introduction

Over recent years the demand for public and private building security continuous to grow [1]. To fulfil this demand, there is a rapidly expanding supply of security technology products [2]. As a result, security related solutions are considered by a growing number of property owners and tenants, facility managers, construction professionals and government agencies. The growing demand for more secure facilities, in conjunction with recent advancements in Information and Communication Technology (ICT),

necessitates the continuous evolution of existing security management plans (SMP) for civic facilities [3].

The security needs of a building must be determined as early as possible, as part of the facility planning and designing phases. Terrorism, crime, biohazards, workplace violence and many more threats expose, not only property but, human lives to risks [4]. As crime concerns increase each year, security professionals from both the public and private sectors are being called upon to address these concerns by incorporating security into the design and construction of all building types.

A comprehensive SMP focus on the protection of three main security pillars [5]. Focusing on the protection of each pillar separately will enhance the protection of the building, however greater efficiency is achieved when all pillars are planned and assessed together. Security professionals should be familiar with applicable codes and industry standards, understand the nature of threat assessments, risk and vulnerability analysis, methods of reducing liability exposure, and other preventative strategies. This is in line with 2007/124/EC, Article 4 "Specific Objectives" 3a and 3b.¹

In this paper, we argue that virtual reality can overcome the obstacles which come with all these requirements, can enable collaborative planning and threat assessment, and thus expand the network of security experts. The proposed innovative ICT platform aims to enable security professionals and facility administrators to jointly formulate, test, and adjust security concepts and measures in a virtual environment [6]. Our solution provides a cost-effective and risk-free environment for a holistic view of a public building, broken down into three phases: (a) risk assessment and analysis phase, (b) emergency response planning phase and (c) test and effectiveness assessment of phases (a) and (b) for a variety of threats.

The rest of the paper is organized as follows. The next section focuses on highlighting related work in the building security theme. Section 3 lists the user requirements, the 3D visualisation enhancements and the solution requirements that drove the development of our solution. The solution, called VASCO (Virtual Studio for Security Concepts and Operations), has been designed as an ICT collaborative platform aimed to support the validation, testing and optimisation of existing SMPs. Section 4 describes the innovations and advantages that VASCO offers the security community. Finally, a discussion about the solution and recommendations for future work are touched upon in the last section.

2 Related work

There are certain technology trends which will be introduced to explain the model of assessing security plans using interactive displays, GIS data and 3D representations of an urban environment. The necessity to ensure the integrity of building assets against loss, damage or other disruptions gives rise to the need for using advanced technology solutions for assessing security risks (including the risks associated with terrorism) and their impacts on service delivery [7].

¹ <http://eur-lex.europa.eu/legal-content/BG/TXT/?uri=celex:32007D0124>

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The idea of using a GIS layer for studying and analysing a security plan has matured over time. Since 2002, GIS provide a range of geospatial tools and analysis methods. Work by Rauschert et al [8] aimed for collaborative emergency management processes utilizing a GIS layer. However, the restricted range of users and lack of efficiency in task-solving was a decisive limiting factor.

Other advancements were introduced through the work carried out by Bader et al [9], who introduced the concept of smart furniture in command and control centers. Again, technology limitations in 2008 were a limiting factor for the hand gesture recognition system, while the interaction of users was limited. Nevertheless, the convergence of both GIS data and large interactive displays eventually took place. The latter came to be with uEmergency [10]. The user interface as a component in emergency planning was presented in 2012. A horizontal, large scale interactive display was implemented to assist end users from the security field to rapidly raise operational awareness using a simulation game and Google Maps as its GIS.

Following from the above, the concept of using a GIS background, large size interactive displays and simulations for emergency and security planning only came together very recently. TIPEXtop constitutes a holistic integration of the aforementioned technological innovations [11]. The concepts of “Role-based collaboration”, “Around-the-table interaction”, “Geo-spatial representation”, “Annotated design” and “Design history” were used to promote user interaction and foster exploration of alternative security practices.

Another component that was introduced into the security assessment toolbox was the use of 3D maps. The CRIMSON² platform [12], which was developed by VASCO partners in 2004-5, was based on the then revolutionary idea that crisis managers could use a 3D map to visualize their threat environment. As mentioned, the technological “maturity” a decade ago did not allow for many ways of organising information, other than geographically related data. However, the work performed did provide the rudimentary means to build and run scenarios, allowing for media reports to be inserted into unfolding crisis scenarios.

An advancement of the above solution was the development and delivery of the INDIGO project³ [13], again by the same consortium. INDIGO is an innovative IT-system that integrates 3D-mapping, simulation tools and a highly effective method of information display made available to security professionals. The solution was developed to display a strategic representation of a crisis situation that is as complete and as easy as possible to understand. To succeed, this graphically displayed operational information was projected on a 3D map.

² CRIMSON: The Crisis Simulation System, G.A. SEC4-PR-110500, PASR 2004

³ INDIGO: Innovative training and decision support for emergency operations, G.A. 242341, FP7-SEC

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3 Solution framework

As the potential of CRIMSON and INDIGO platforms became evident, managers at the strategic level for government facility protection were involved. The challenge for a next generation security assessment solution will be to provide added value to the public safety and security agencies by enabling them to share security concepts and measures and promote their local or remote interaction. It is envisaged that the development of such a system will further promote the information sharing between security community members [14].

By introducing a method to quickly build a 3D reconstruction of a facility and its proximate environment, strategic and operational managers can work together to understand and assess complex situations. The resulting 3D rendering of any building will illustrate the threats that manifest as a unique security incident. Additionally, it will allow security professionals to mobilize forces outside and inside a facility and interact with the facility's SMP. This 3D representation can be considered as the most accurate and intuitive tool for responding agents as it produces output that is readily used and eliminates the need for mental calculations, path-finding, etc. All locations, assets, actors, simultaneously occurring events and conditions can be represented and visually fed to security experts and expedite their introduction to the security challenges they will face.

3.1 User requirements for 3D reconstruction use in security

VASCO envisions to be of great assistance to security experts who have been tasked with protecting government and public buildings. VASCO's potential end users are (a) security teams responsible for the protection of government assets, (b) interdisciplinary first response teams (e.g. police, fire brigade, ambulance services, etc.) who most likely interact with the buildings and their occupants upon request and (c) security planners responsible for optimizing the security plans of government facilities. Additionally, the project inspires to promote and enhance the interaction and collaboration between all security stakeholders of a facility.

To facilitate and promote the interaction between security professionals and an innovative ICT platform, a fast learning curve should be offered to end users. The faster the end users learn to operate and exploit the advantages of a security suite, the sooner they will include the solution into their daily workflow of security tasks. The platform should enable both collocated and remote users with different security needs and interests to collaborate and cooperate, either around a multi-touch screen or interact remotely using an additional ICT platform and a secure network connection.

Initially the users should be introduced to security goals and objectives specific to the building and the threats they will be challenged to address. A scenario storyboard should provide a short narration of the mission: what to protect, against what, who shall be involved and in what way, which impacts to mitigate and how, what factors to consider and what data from is available from the SMP. The aim of the storyboard is to offer security experts a concise but explanatory visualisation of their mission.

During the security assessment of a government building, any changes or annotations shall be stored and maintained for future reference. The inclusion of such a feature will allow the platform to be used also for after action de briefings, comparison of security methods and assessment, and as reference material for training sessions. The inclusion of a scenario database serves a dual purpose; first, as a knowledge transfer mechanism where the enhancements in existing security plans are documented and disseminated within the security community; second, as a benchmarking tool where different simulations for a number of security approaches will be compared against a selection of security parameters.

Documentation and plans related to the government building, memorandum of actions (MoA), and standard operating procedures (SOPs), should all be accessible from the platform. Stakeholders from both public and private sectors should be involved and collaborate on themes of pro-activeness and prevention, preparation, and response. Apart from cooperation between diverse national entities, users have indicated their preference to include attacker-defender functionality aiming to involve different security divisions either on national or international level. The initial VASCO user group members were 13 EU organisations (Ministries, universities, first responders, public authorities, and private organisations) from 4 EU countries.

3.2 3D reconstruction visualisation vs representation

A digital mock up (DMU) facility is the cornerstone of the SMP. It is an accurate 3D representation of the facility (building and perimeter) to be studied. The virtualised environment should include proximate urban elements (e.g. roads, other buildings in the area, transportation routes). Over the past decades, the 3D representation of buildings was a complex and time consuming process as is shown in Fig. 1, and the final output was a realistic, yet rigid representation of the building, without including the nearby urban environment.

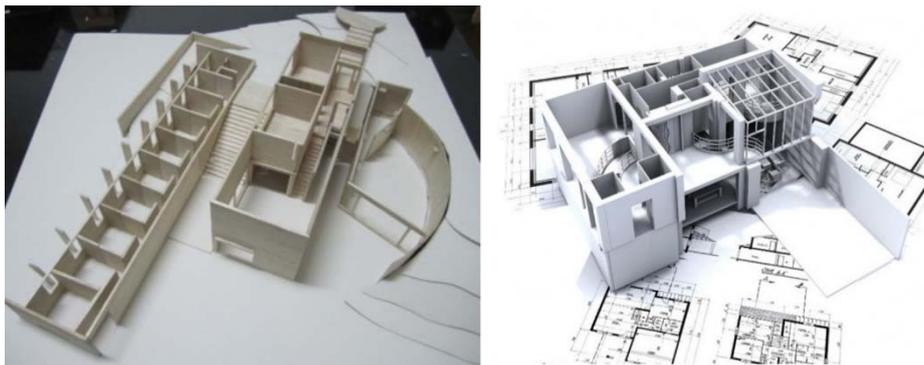


Fig. 1. Manual 3D building representation

To advance the 3D representation, different approaches were used for the outdoor and indoor areas. The VirtualGeo⁴ technology, a 2D/3D Geographic Information System (GIS), is implemented to provide the visualization of the external view and the surroundings of the buildings. Additionally, the reconstructed environment should also provide the indoor view of a facility.



Fig. 2. Legacy building representation and 3D representation with the surrounding environment

The benefits of the computerised 3D building reconstruction over that of the legacy reconstruction are shown in Fig. 2. The DMU includes a realistic representation of the 3D environment and it is optimised for modifications, changes, visualisation from different viewing angles, with varying environmental conditions. The works of [15]-[17] were used for constructing and representing the facility's interiors. Above all, users can insert security elements (any item that is part of their security toolbox) like cameras, entrance barriers, fences, alarm sensors in the DMU and simulate the impact of their addition in the building's security. Moreover, the users using a multi-touch screen will be offered the option of focusing on certain areas of the virtual environment using different viewing angles, visualise the line of sight, and toggle between 2D and 3D representations.

3.3 Solution Requirements

A solution for assessing the SMP for government buildings should facilitate the creation, simulation, and analysis of scenarios to explore effectiveness of tactics, technologies, and procedures in a range of environments, including the effectiveness of physical, cyber, and human behavior. The scenarios are a sequence of events used to validate the security mechanisms in place [18]. An example is a bomb threat followed by a fire within the perimeter of the facility. This scenario will trigger (i) the building evacuation plan, while (ii) a fire in the designated assembly point will disrupt the pre-determined evacuation route. Scenarios can be rehearsed with variations like changes in tactics,

⁴ <http://virtual-geo.com/en/>

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weather and daylight conditions, addition of threats, or changes on the locations and capabilities of security means.

The evaluation of scenarios via table top simulations, will support the development of policies and optimize the operational SMP for the facility. Furthermore, simulations can be used to document and justify relevant security decisions. Lessons learned from scenario rehearsals will provide value added knowledge to security planners for government buildings. Only the final plan needs real-life testing to verify the expected outcomes and validate the simulation results.

An ICT solution offers cost savings in the following manner: using DMUs, security experts can contribute to building security without visiting the site (or) with minimum site visits. Moreover, a virtual environment will promote the collaboration of experts from different agencies to contribute and validate the plans. Lastly, interactive scenarios with teams or individuals operating in “defender-attacker mode” will (i) test the SMP against a wider range of threats and (ii) provide competitive and valuable experience to security professionals.

4 The VASCO

A literature review on state of the art⁵ crisis management systems and interviews of end users highlighted a need for sharing information, but also emphasized the need to have a system tailored for operational efficiency among every public facility stakeholder. Focus group interviews revealed that additional information should be shared among several organizations involved in a crisis, and above all parties should have access to the same and amended information sources and review identical security plans.

The VASCO project designed a tool to support the creation of a common operational picture that fits both training and operational purposes, as encouraged by [19]. The goal of the VASCO system is to support information exchange among members of the security community and promote the concept of the common operational picture.

⁵ Internal deliverable of VASCO project (SEC-2013.2.1-1 - Evidence based and integral security concepts for government asset protection – Capability Project. G.A. 607737)
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4.1 Virtual Environment for Security Analysis

VASCO’s relevance and interaction with an existing SMP for buildings is depicted in Fig. 3. This closed loop process, aside from a holistic optimization on security, will also allow security experts to study the impact from a potential failure of certain security elements or functions related to physical, human, and cyber-attacks or any combination of them for any security planning phase.

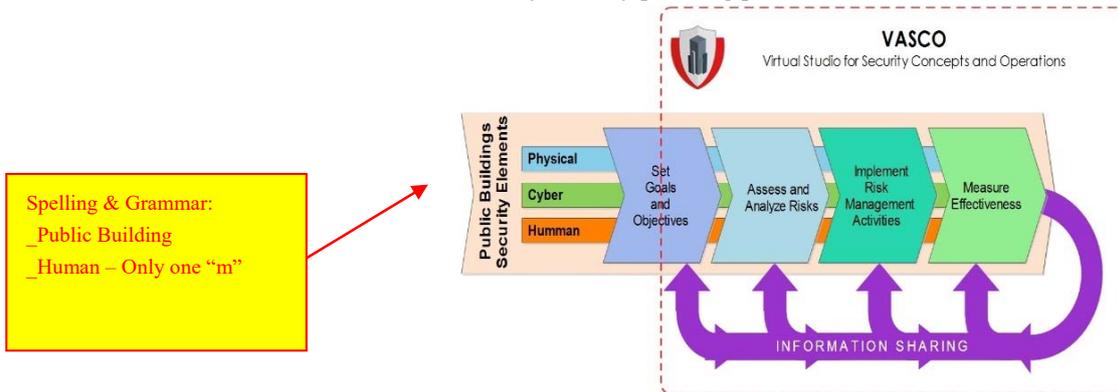


Fig. 3. VASCO application field in Public buildings security

Starting from the defined security goals and objectives that should be listed in every government building SMP, security experts using the virtualization environment can:

1. Analyze and asses a range of risks
2. Implement different approaches for managing and controlling exposure to risks
3. Simulate the effectiveness of their actions using a variety of security measures

At any time during the facility’s security assessment, the participants can assess the impact of their proposals and compare the effectiveness of their security plans throughout all the phases shown in Fig. 3. The resulting facility SMP will enhance the initial security goals and objectives.

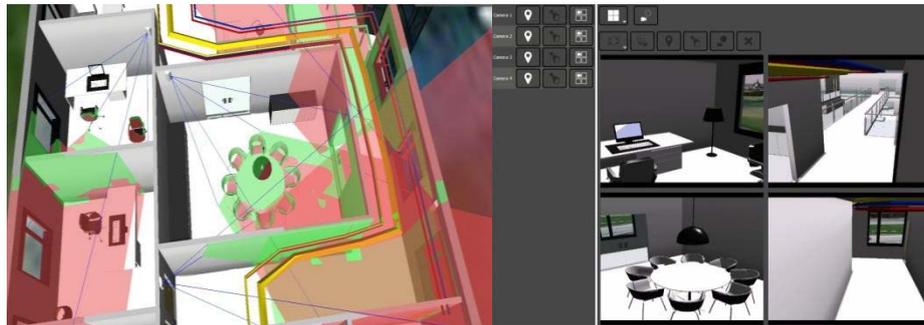


Fig. 4. Left: The visibility coverage of multiple security cameras enables end-users to acknowledge the hidden zones. Right: The virtual “operational control center” offers the possibility to see through all the virtual cameras

Security professionals using the VASCO studio can accelerate and facilitate the threat assessment and placement of security equipment and surveillance means that will assist the preparedness plans and mitigation strategies for the building in question. Using 3D representation of a building, security reviewers can first visualise and then decide on the following:

- The selection of surveillance camera types (image sensor specifications and lens characteristics) that could provide broader supervision
- Place the surveillance cameras at optimal points around the building and its perimeter
- Identify surveillance vulnerabilities in the perimeter and indoor locations (where necessary) by using the line of sight functionality
- Map and then eliminate any blind surveillance zones around and within the building and its perimeter
- Plan alternative detection means like unattended sensor networks, passive infrared detectors (PIR) for the areas identified above, or enhance possible vulnerable areas by adding an additional security layer
- Proper placement of the security personnel and reaction forces within the facility
- Assessment of evacuation routes for combination of threats and various types of incidents

4.2 3D Visualization Benefits

The reconstruction of any building, including its surrounding environment, using advanced computer graphics, can first of all provide a short but accurate introduction to security professionals of what they are meant to protect and what they should consider using actual parameters in a full scale approach. Interdependencies of the facility under study with parts of the critical infrastructure or with other buildings is visually represented. The passive use of the physical environment to reduce crime (or Crime Prevention Through Environmental Design) is very accurately represented if reconstructed using real world data. Furthermore, the concepts of natural surveillance, natural access control and territoriality are integrated and displayed using 3D representations.

Using the rendering capabilities of VASCO, security professionals can validate the performance of CCTV cameras placed anywhere in the virtually reconstructed environment, and view the surveillance security screenshots (**Error! Reference source not found.**). Moreover, security experts can move inside the digital mock up (DMU) of the building and focus on areas that will be eventually be affected by a potential threat and extrapolate how this will affect the existing SMP. Security experts can relocate the threat to consider how changing the threats location will affect the required response actions. By providing the ability to virtually move around the facility safeguards that Submitted to: Third International Conference on Information Systems for Crisis Response and Management in Mediterranean Countries (ISCRAM-med 2016), October 26-28, 2016, University Carlos III of Madrid. Madrid, Spain

security personnel can assess their exposure to threats, and to identify the conditions and factors that might affect or jeopardise the security measures already in place (Fig. 5).

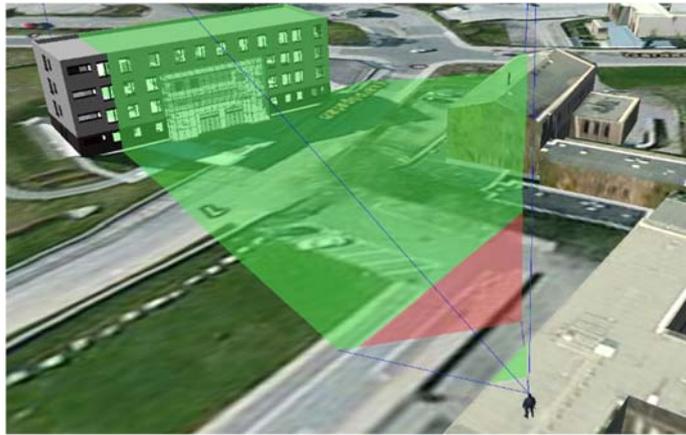


Fig. 5. Outdoor visibility representation

Aside from the description above, in which VASCO is used as a security planning tool, it can greatly benefit tactical security teams as a training or as an on-scene briefing tool. An accurate floorplan can be shared with responders via their smartphones while they are approaching a response scene. This enables them to know exactly how the building is laid out, where the personnel is usually located, while it ensures that all involved teams share identical information and have a common understanding of the threat. The blueprints of the facility can be annotated with the latest intelligence. Entry points can be marked, and the locations of existing forces can be shown, if desired. The assailants' location can be identified and marked as well.

As a training solution, virtualisation may promote knowledge transfer of successful security practices, disseminate lessons learned within the security community or highlight security compliance to international, national or industry operational security frameworks. The need for site visits is minimised and virtualisation ensures that all security stakeholders will have an accurate and updated understanding of the facility by virtually exploring the reconstructed environment.

4.3 Demonstrated Security Advancement

A number of workshops were conducted during the solution development phase, as part of VASCO's concept validation. Security experts were introduced to solution capabilities and then they were challenged to design a building's SMP and validate it afterwards. The security professionals valued having the option to create a digital replica of a building with the immediate urban environment which surrounds it.

The use of a building's virtual replica and of its proximate environment offers a safe setting in which security issues can be thoroughly assessed. Introducing numerous types of threats of varying impact in the virtual environment allows users to better grasp the potential consequences. Workshop participants confirmed that VASCO allows users to test actual approaches and pursue best practices by simulating diverse types of threats in a high-resolution, realistic environment. As such, it may provide an important leap from present-day security planning methodologies and tools, to new integral security concepts. Flexibility in choosing diverse viewpoints was well-received. Users welcomed the possibility of hiding or viewing any combination of building features to obtain unobstructed views of the areas of interest.



Fig. 6. Left: Third floor exclusive view of property elements (furniture) Right: Second and Third floor combined view of stairs, inner walls, doors and windows

One feature unanimously seen as innovative, of high value and unique was the ability to identify the field of view and the areas covered from any vantage point, which the users recognized a useful tool for placing security personnel and relevant equipment (Fig. 5). Seeing from the perspective of, for example, a sniper, a security camera, a police car or a helicopter selectively placed in the environment was a very welcome capability, which is almost impossible to attain outside of a virtual environment.

4.4 Perspective of the VASCO solution

Security practitioners and designers showed interest in using VASCO for a variety of purposes and at different levels of security planning. End users agreed that the added value resides in promoting interdisciplinary collaboration and allows professionals to visualize the environment they are asked to secure, enabling a more efficient and meaningful design and assessment of security measures. Furthermore, they have recommended two new functionalities that can elevate the performance of the developed solution.

First, a knowledge management repository and an associated functionality to promote training that will foster knowledge transfer within the VASCO security community. Best security practises for a range of government facilities can be narrated and stored as training material. Initially users can query the database using a subset of the fields shown in Fig. 7 while - as the number of scenarios in the database grow - the query shall support more complex searches. The use of VASCO is in full compliance with the EU legislative and regulatory framework for data protection based on the uniform approach of the EC Directive 95/46/EC⁶, the recent 2016/679⁷ and the national legislative and regulatory framework for data protection of each project member country.

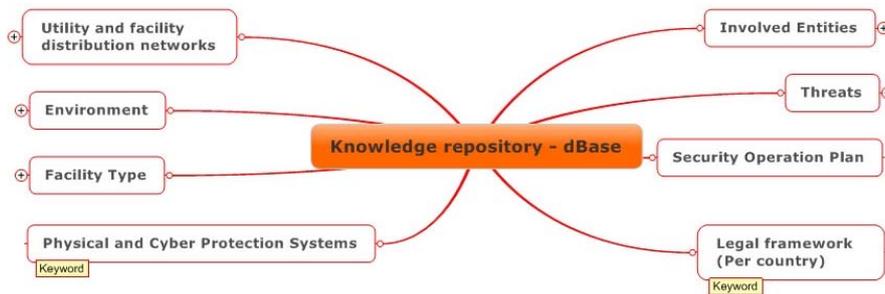


Fig. 7. VASCO Knowledge repository concept

Second, by adding the functionality, which allows the injection of news and introduction of challenges, under certain criteria, the use of VASCO is elevated. Experienced security professionals can author a scenario using a timeline. They can plan a complex security situation in a detailed manner, involving members of security communities from different organisations and with different objectives (Fig. 8). Starting from a request to respond to a trivial security incident, a complicated situation will evolve in a controlled environment, where the efficiency of measures and security plans will be assessed. Thus beyond the facility’s SMP assessment, a cross-functional collaboration exercise might highlight not only security weaknesses, but also possible interworking issues across different agencies, which require improvement.



⁶ <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31995L0046>

⁷ http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:JOL_2016_119_R_0001

Fig. 8. Security scenario editor

A step further in VASCO's development could incorporate an analytics engine, allowing the system to search for weaknesses in the security design in an automated manner.

5 Conclusions

This paper has presented a cutting edge collaboration platform, which enables security professionals from both the public and private sector, and from different agencies and departments to jointly plan, design, formulate, test, adjust and optimise the SMP of public buildings and facilities in a virtual setting. Government buildings which are used to host essential services and functions that are vital for our societal, economic, security and health functions are growing both in size and complexity. Since this expansion occurs within a security situation of growing security threats, supporting the interdisciplinary collaboration across different security communities is a highly recommended approach.

Multidiscipline security-related professionals with focus on facility security were enthusiastic about VASCO's novel solution capabilities, agreeing that digital mock up units offer advantages compared to current security design practices. It should be noted that the interviewed teams possess a diverse background with respect to their security culture and the different operational and legal frameworks they operate in. All of them recognized the versatility of the system, and shared thoughts on how they could use it in various ways, including: designing of security plans, risk assessment, mission planning, (on-site) briefings for tactical teams and after-action reports.

Throughout the state of preparation for a threat of variable impact, severity and urgency, VASCO would bring immense added value to the security forces, as it gives them the opportunity to examine and extensively test different security approaches for the same situation by varying specific influencing factors. In addition, VASCO would enable end users to store relevant information, reconstructing past cases and developing new test cases, establishing thus a large Knowledge Base for public building security design which may support comparative future studies. The envisaged platform allows the maximisation of the security protection level of any given public building, by running a number of threat and risk scenarios while at the same time allowing security experts to gain knowledge and experience, optimizing the relative security management plan of the facility.

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