An overview and analysis of the use of simulation training in the Fire & Rescue services and Civil Defence in Europe.

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Abstract — Since more than 20 years Simulation Technologies have been used to educate, train and asses emergency response professionals from Fire & Rescue services to Civil Defence Organisation. It led to different initiatives all over Europe using various technologies and aiming many types of target audiences. This paper aims to start collecting the lessons learned of those virtual simulations projects in order to be able to extract best practise to be shared and spread to all the emergency response community. By using statistics extracted from polls sent in Europe and testimonials from representative virtual simulation training centres as well as results from an experiment, we present a concrete overview of the use of simulation training in the emergency and civil defence in Europe.

1 Purpose

This paper has two mains objectives:
- Collect and analyse data allowing to extract knowledge about the use of Virtual Reality simulation (VR) in Europe such as the number of organisations using it, their target audience, the costs and the return of investment.
- Present the application of Simulation Based Training (SBT) in the training of non-commissioned and commissioned fire officers to develop decision-making competences, through the introduction of virtual reality simulation in the respective training of fire officers in the field of operational command.

This allows us to provide to the European community a white paper on the use of VR-simulation training in the Fire & Rescue Services and Civil Defence in Europe.

2 Introduction

On-going improvements in fire protection and fire safety engineering have drastically reduced the number of fire-related injuries and fatalities. Although this is good news, this development has led to an unforeseen effect: because fire incidents are less frequent, fire officers are gaining less operational experience. This increases the risk of "skill fade" amongst the operational staff and incident command capabilities. Simulation can provide an effective way to tackle this problem.

Virtual simulation has been used in different ways throughout Europe for the past 20 years. One could argue that the most efficient way of disseminating a VR-simulation system via a central spread, and therefore a harmonised approach based on standards, would be favourable. In the civil sector the decision has been made to distribute the systems via a decentralised approach.

This has resulted in a varied range of software systems with derived different education platforms. In contrast to this, the defence sector has coordinated and utilised a common approach through standardisation.
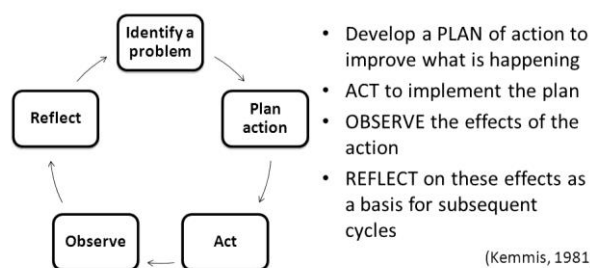
3 Approach – Method

A questionnaire was circulated to Fire & Rescue services and Civil Defence training organisations throughout Europe through various international organisations, as well as visits, interviews and discussions carried out with training organisations in Denmark, France and Great Britain.

An internal study at the Danish Emergency Management Agency (DEMA), Emergency Services College was carried out through a Participatory Action Research method[i], in which they began with an initial diagnosis to identify the main constraints and opportunities for improvement which should be considered in the planning of the VR-training proposal.

Participatory Action Research (PAR) is a qualitative research methodology option that requires further understanding and consideration.

The action research cycle

- Develop a PLAN of action to improve what is happening
- ACT to implement the plan
- OBSERVE the effects of the action
- REFLECT on these effects as a basis for subsequent cycles

(Kemmis, 1981)

Using PAR, qualitative features of an individual's feelings, views, and patterns are revealed without control or manipulation from the researcher. The participant is active in making informed decisions throughout all aspects of the research process for the primary purpose of imparting social change; a specific action (or actions) is the ultimate goal.

4 Results and discussions

The results of the questionnaire mentioned above indicate that though there are many similarities all-over Europe, there is also a diversity in the use of virtual simulation based training within the emergency services area; but with a certain homogeneity in budget, choice of software and target audience.

In reply to the questionnaire 36 organisations from 15 countries responded. A good half of them (52,8 %) are training institutions, the other half operational emergency services – showing that the adoption of virtual simulation based training is getting wider.

A 50 % of the respondents have started virtual simulation less than 5 years ago and for innovation purposes (80% of the answers). Knowing that those technologies existed since decades, it is reasonable to conclude, that there is an increase in the adoption of VR for training. It can to a certain extend be explained by a generational shift in the trainees.
The exposures to video games in their childhood have – directly as well as indirectly, led to the rapid growth in the use of VR technology. The younger amongst the trainees have shown to be more prone to using the new VR technology – benefitting of a more mature technology.

The emergency services use VR mainly for maintaining their competencies (92 %) training on daily incidents (98 %). The training organized is mainly aimed for their own staff (72%).

The target audience for virtual simulation based training is Subordinate (83 %) Medium (92 %) and Higher command levels (78%). Only 53 % of the organisations are training manual level which could indicate, that there is room for some improvement in this regard.

The study shows that especially one VR simulation training vendor dominates the VR training market, with more than 80 % of the market share; which reflect a to some extent monopolistic situation.

A 53 % of the organisations are spending between €5,000 and €50,000 each year on simulation including software and staff. Most of them are using fixed simulation centres (81 %) and part-time staff (67 %). Only 11 % are utilising remote learning. We see here an opportunity for expansion of virtual simulation based training technologies, as we see that technologies are bridging long distance activities more and more efficiently.

Most of the answers underline that virtual simulation based training is cost effective (73 % of favourable answers) covering most of their pedagogical needs (58 % of favourable answers) and require a balanced staff intensity (66 % of favourable answers). We know that upcoming developments on Artificial Intelligence (AI) will make virtual simulations more realistic and less staff intensive (thanks to AI rendered 3D environments and intelligent agents[ii]).

Speaking about the future, the most anticipated developments referring to the results are Immersive Virtual Simulation (81 %) localized 3D content (78 %) and Remote training (61 %). Almost all the users (88,9 %) plan to invest more money in virtual simulation based training in the coming 3 years. Most of the money (75 % of the answers) will be spent on expanding actual hardware and software.

As discussed previously, the study also reveals that virtual simulation require investment on staff, facilities, hardware and software. In a context of budget cuts in Europe (f.e.: in France[iii], United Kingdom[iv] and Spain[v]) we can conclude that getting to VR for an organization requires some investment efforts that can discourage new adopters.

According to the answers gathered, simulation helps to:
- Reduce training costs (72 % of favourable answers)
- Require less resources than live exercises (82% of favourable answers)
- Replace some live exercises (83 % of favourable answers)
- Allows doing exercises not possible in reality (100 % of favourable answers).

A vast majority of the organizations (94 %) agree that students enjoy VR exercises and find them realistic (89 %).

With reference to the data in this study, most organizations find a real return on investment using virtual simulation based training. The challenge for VR companies is now to tackle the challenge of manual level training and remote learning. Answer those needs will surely help mass adoption of those technologies.

5 Danish participatory action research
In a Danish article about leadership as a profession[vi], on the subject of the tension between education and practice, the analyses have shown that even though the one-on-one training is seeking to simulate and train as close to realistic conditions as possible, it is difficult to include everyday discursive negotiation of the "positions of power" sufficiently effectively and subtly. The emergency services profession therefore need to think about leadership in the emergency services as a cognitive and relational activity, which must be trained in the actual organisational and ordinary setting. The answer to such a challenge can be VR simulation.

At the DEMA Emergency Services College they are currently conducting training activities for crew commanders. In one of such events they collected data on the performances of the trainees and compared these to the subsequent evaluation. In the last step of the action research (reflection), corrections and improvements to the training activity were identified.

In the second cycle of the action research, the steps were repeated, with the formal implementation of the simulation-based training at a course for crew commanders at DEMA Emergency Services College.

The evaluation of the impact of the changes introduced was carried out through a comparative analysis of the learning outcomes, the assessments given by the trainees of the two groups and the evaluation of the team of trainers and VR training operators participating in the training.

The DEMA Emergency Services College is subsequently investigating the possibilities for implementing VR simulation in their training of incident commanders. This initiative call for further research, linked to, what VR simulation means to the trainees' reflective learning processes (metacognition), and what this means to training actual practice – and even in practice after the training has ended.

Metacognition is the awareness and understanding of one's own thought processes, and considered a critical component of successful learning – as well as critical to decision makers who have to make fast conclusions often based on limited information. It involves self-regulation and self-reflection of strengths, weaknesses, and the types of strategies you create. It is a necessary foundation in culturally intelligent leadership because it underlines how you think through a problem or situation and the strategies you create to address the situation or problem.

Metacognitive strategies are what you design to monitor your progress related to your learning, experience and the knowledge you purses and acquire in an interaction. They are an instrument for controlling thinking activities and to ensure that one meets ones goals and can include the following:
- Monitoring whether you understand the situation fully.
- Distinguishing when you fail to comprehend data or information of the situation communicated to you.
- Identifying strategies that help you to improve your comprehension of the situation.
- Adjusting your actions to the situation.
- Maintaining your tactic to ensure you comprehend the situation.
- Establishing a system to assure your tactics fits your goals and objectives.

The results of the trainees' performance and the evaluation made by the trainees themselves led to the conclusion that the training activities, promoted the development of decision-making competencies in the management of operations through the application of virtual simulation based training.

6 Lessons Learned, Future Work

Even though the emergency services do their utmost to train the officers to the best of their abilities, a fair amount of skills and knowledge will be lost over time – this is known as 'skill fade'.

Taking into account that the number of serious incidents have dropped over time, a well-known method to avoid skill fade is substituting the experienced based knowledge you gain from real life incidents, with simulation based training, and thereby train individual abilities and techniques. Quality assurance can be further enhanced by instituting different methods of testing. The study indicated that virtual simulation based training has proven itself as a particularly useful instrument to improve the accumulated risk of skill fade among incident commanders.

The main challenge is now first to be able to share the results amongst the emergency services community helping hesitant or 'not aware organisations' to step in as well, as well as beginning to harmonize – if not standardize the tools and the practice around virtual simulation based training.

7 Conclusions

In Europe the use of simulation for training in the emergency services is still not fully matured. Although tools are getting better and subsequently cover a wider range of population, there is still hesitation in some organisations, because it's still considered a 'revolution' and they have difficulties in measuring concrete effect as well as quantitative and qualitative added value.

Rather than one VR-platform of simulation replacing another, training methods will continue to be used side-by-side with tabletop exercises and full-scale exercises of operational staff as well as incident responders from other sectors. They are so to speak complementary disciplines that offer *specific benefits* for training *specific skills* and *capabilities*[vii].

The VR-systems ability to allow trainees to experience and act in large-scale, complex events, as well as the VR-systems flexibility and cost effectiveness, makes virtual simulation based training an essential tool to achieve and maintain incident command readiness.

Our study shows that 94 % of the students enjoy VR exercises. The fact that they "have fun" participating in a simulation – such as a higher sense of presence, does not necessarily increase the students learning. A study at the University of Copenhagen[viii] presents that adding immersive virtual reality to a science lab simulation

demonstrates that it "… causes more presence but less learning". In other words "liking is not learning".

Since we are still at the brink of designing cutting-edge high-immersion VR shaped exercises, we do not really know whether these new methods can create an increase in processing demands on working memory (overload) and actually decrease the knowledge acquisition, when compared to conventional media. Consequently considerations of the specific affordance of cutting-edge high-immersion VR shaped exercises for learning should be further examined and considered when designing learning content for virtual simulation based training.

Although this study shows a real satisfaction about VR, there is still room for improvement on the manual level as well as with distance/e-learning. New technologies such as Artificial Intelligence (AI), building information modelling (BIM) and Remote access will help at the dissemination of simulation.

8 Authors/ Speaker Biographies

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[a] The Sahana Software Foundation is dedicated to the mission of saving lives by providing information management solutions that enable organizations and communities to better prepare for and respond to disasters. We develop free and open source software and provide services that help solve concrete problems and bring efficiencies to disaster response coordination between governments, aid organisations, civil society and the survivors themselves.

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