Serious Game for Safety and Security Education in the Netherlands

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ABSTRACT

To respond to the increasing demand from government and society for improved performance of the safety and security professionals and supporting educational institutes in the Netherlands, four institutes for higher education, the Netherlands Institute for Safety (NIFV), the Netherlands Police Academy (PA), the Netherlands Forensic Institute (NFI) and the Netherlands Defence Academy (NLDA) joined forces and proposed a common plan for establishing a Virtual Platform for Safety and Security (VPSS). The plan consists of a number of different projects related to the primary processes of the involved institutes: education, research and knowledge dissemination.

This paper focuses on the project to develop a serious game for use in a multidisciplinary educational setting. The development team consisted of representatives from each of the four institutes. Within each institute, representatives worked not only within their respective internal line of management but also within the project's structure. The workgroup was accountable to a steering committee that in turn was accountable to a consulting group consisting of the directors of the involved institutes. Keeping the different levels of management aligned in this complex management structure was the greatest challenge encountered during development of the serious game.

The paper argues that an iterative and prototype based approach works very well to develop a serious game in a complex organisational setting. We start with explaining the rationale of the serious games project. Next we explain our approach: the project was divided into short prototype cycles – rounds we call them – with a focus on delivering prototypes fast. The results and challenges of each round are discussed and finally abstracted to lessons learned. More focus on iterative development approaches and producing prototypes will lead to a better understanding of the product and a closer relationship between developers and clients.

ABOUT THE AUTHORS

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INTRODUCTION

To respond to the increasing demand from government and society for improved performance of the professionals in the safety and security sector in the Netherlands, four institutes for higher education joined forces and proposed a common plan for establishing a Virtual Platform for Safety and Security (VPSS). The Ministry of Security and Justice financially supports the plan. The four safety and security institutes are the Netherlands Institute for Safety (NIFV), the Netherlands Police Academy (PA), the Netherlands Forensic Institute (NFI) and the Netherlands Defence Academy (NLDA). The institutes aim to create a VPSS built upon the existing programmes for education, research and knowledge transfer and supporting (IT) infrastructures. The involved institutes do not have an extended history in cooperation, but share some common interests and - even more important - they are willing to learn from each other and share knowledge. The plan includes the development of a serious game to be used in four different multidisciplinary educational settings.

MOTIVATION

Graduates from the four institutes have to work together when a crisis situation occurs in the Netherlands. If a large industrial fire were to occur, forces from the police secure the area and take measures to inform the public; the armed forces support fire fighters with additional resources and equipment; members of the Forensic Institute lead the investigation to the origin of the fire. In each crisis situation the configuration of the crisis management organisation and the assigned tasks will be different. Therefore, it is very important that the different actors that are actively involved in the crisis work well together because peoples' safety is at risk.

Recent crisis situations in the Netherlands revealed that still many things go wrong. Evaluations indicated that in many cases safety and security professionals had no understanding of duties and responsibilities of other actors (Martens, 2009; Onderzoeksraad voor Veiligheid, 2012). So it can happen that a fireman cleans the scene directly after a fire accident which makes the work of a forensic specialist much more difficult. An obstruction set up by the police often hampers the accessibility of the scene for medical emergency professionals. Military specialists often fulfil specific assigned tasks but are not involved in decision-making processes. These challenges are usually addressed by mutual training exercises and by fine-tuning communication procedures. The serious game intends to address these problems by introducing multiple perspectives on crisis situations, explaining the different responsibilities of the actors involved, within the educational programmes for junior professionals of the four institutes.

The main challenge of the serious game project was not so much the technical part of the project, but keeping the social environment aligned. The workgroup consisted of representatives from each of the four involved institutes. Developing a serious game to be used at all four institutes, despite the many differences in educational programs, approaches and target groups, occurred within a complex management structure. Within each institute, representatives worked not only within their respective internal line of management but also within the project's structure. The workgroup was accountable to a steering committee that in turn was accountable to a consulting group consisting of the directors of the participating institutes.

Having introduced the motivation and challenges involved, we will explore how a serious game can be developed in a complex management environment. We begin with our methodology, follow with an examination of the first three rounds of our iterative process, and conclude with lessons learned.

METHODOLOGY

Literature Review

How do the four institutes define a serious game? According to popular literature like Wikipedia a 'serious game' is fluid and encompasses any game that does not have entertainment as its sole or primary purpose. From this definition it can be derived that the application of serious games ranges from games created by military organisations for training purposes to educational games for children or even exercise

regimens such as Nintendo's WiiFit. During the literature review we narrowed the definition of serious game to: "a serious game is a rule-based system with a variable and quantifiable outcome, where different outcomes are assigned different values, the player exerts effort in order to influence the outcome, the player feels attached to the outcome and the consequences of the activity are optional and negotiable" (Juul, 2003).

Benefits of the application of serious games are many and diverse. For example, a meta-analysis of Egenfeldt-Nielsen identifies increased motivation and interest in the subject as well as more effective learning (Egenfeldt-Nielsen, 2007). Although the benefits of the application of serious games in an educational context are quite clear, some literature points out that the educational effects of serious games are often overrated (Tobias & Fletcher, 2011). Much attention is paid to the development of serious games as a means to learn design skills (Kafai, 1996; Kiili, 2005). In addition, we found a large number of overviews of information technology tools used to teach design skills (e.g. Game Maker).

However, these overviews tend to focus on the development of a serious game when the requirements are clear and not subject to further discussion. The literature gives many examples of how serious games could contribute to (higher) education (Nadolski, Hijden, Tattersall, & Slootmaker, 2006), but the topic of developing a serious game in a complex institutional context is not documented abundantly. The structure of the complex institutional setting in this project is that the serious games must be built under uncertain conditions. The requirements and especially their interpretations have to be renegotiated constantly.

One of the publications that inspired our development methodology applied game design principles to an organisational setting (Bree & Lat, 2011). Van Bree & Lat point out that an iterative development methodology is very suitable to study social dynamics that – to some extent – can be used as a methodology for game development in a complex organisational setting. It is emphasized that iterative approaches are very helpful to provide a shared understanding of an information problem. User-centered design offers a rich tool box for iterative approaches (Maguire, 2001).

Approach

To overcome the challenges of our complex organisational setting, we used an iterative three-step development model based on the toolbox and suggestions of Van Bree & Lat. The findings of Step 3 provide input for Step 1 and so on (see Figure 1).

- Step 1: Understand and specify the context of use;
- Step 2: Produce prototype;
- Step 3 Evaluate prototype.

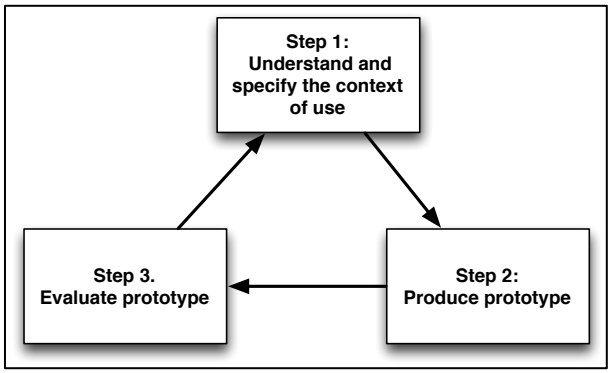

Figure 1. Development process

The workgroup consisted of two representatives of each involved institute. Most representatives were subject matter experts with educational responsibilities within their institute. During the development process the level of participation fluctuated somewhat. All representatives have other obligations besides this project. The limited budget was approximately 120k euro. During the project we focussed on common interests. The project leader of the workgroup made the preparations for the group sessions. He tried to focus as much as possible on the development of content for the serious game and tried to avoid discussions on organisational, political and management issues. The project leader also took notes about the sessions to document the social dynamics process (Foster, McAllister, & O'Brien, 2005). This was done in such a way that it was not intrusive for the process. The notes serve as data to derive lessons learned to stimulate further cooperation.

Furthermore, the workgroup used system development methods such as focus groups, brainstorming, mind mapping and storyboarding to produce results and stay focussed on the content of the serious game.

Planning

The kick-off meeting of the workgroup was used to agree upon a more specific time schedule. We agreed to focus on development of (working) prototypes and set a number of deadlines (see Table 1). The workgroup tried to minimize group sessions by combining different activities. For example, we used one day to do both: evaluate the prototype and develop new specifications (combining tasks #2 and #3 as well as #4 and #5).

Table 1. Planning serious games project

#	Activity	Deadline (end)
1.	Round 1: Paper-based prototype	Jan 2012
2.	Evaluation of prototype 1	Feb 2012
3.	Round 2: Selecting technology	Mar 2012
4.	Evaluation of prototype 2	Apr 2012
5.	Round 3: Working prototype	May 2012
6.	Evaluation of prototype 3	Jun 2012
7.	Round 4: Developing an integral scenario	Aug 2012
8.	Testing prototype 4	Sep 2012
9.	Completion of serious games project	Oct 2012

As indicated in Table 1, at time of writing this paper, the serious games project was still on-going. Therefore, the remainder of this paper will describe the serious game development process during the first three rounds of the 3-step iterative process. We conclude our paper with lessons learned.

Round 1 answers the question: What do we need? Round 2 identifies the required technology. Round 3 focussed on answering: What content do we need? Each round is related to the previous round and delivers more specific results than its predecessor.

ROUND 1: PAPER-BASED PROTOTYPE

In the first group session (one day) we discussed the main goals of this project and the context of use of the serious game(s). We ended the day with an initial paper-based prototype. In a second group session (half a day) we evaluated the paper-based prototype. The project leader planned and chaired the session. Each institute contributed to the open discussion; a total of six people participated in the session. We added an external experienced serious games consultant to guide the discussion about game content and gameplay. The consultant drafted the first paper-based prototype. The results were achieved by applying the brainstorming method.

Step 1: Understand and specify the context of use

To make the serious game applicable for all four educational programmes we had to find common ground. Based on the findings of our literature review we structured the discussion by answering the following four questions.

- Who are our target groups?
- What are our learning aims?
- What is our game concept?
- What is our game content?

Who are our target groups?

Making young professionals (junior officer level) familiar with the different actors in a crisis situation can improve cooperation when they reach senior level. Our goal is to provide these (junior) officers a general understanding of what other actors are doing and why. This understanding should contribute to better communication and coordination during crisis situations. The workgroup acknowledged this to be a long-term achievement, because the junior officers first have to gain substantial experience before they can play a leading role in a crisis organisation.

Our challenge was to overcome the differences in the several methods of training and education at the four institutes. For example, the NLDA and the PA focus primarily on initial education and offer a bachelor degree program whereas the NIFV and the NFI focus more on the education of security and safety professionals who have already gained experience in the field.

Based on these observations we formulated the following list of target groups:

- NLDA: Regular students following one of the three scientific bachelors at the Faculty of Military Sciences to become officers after graduation.
- NIFV: Security and safety professionals who follow special courses for specific roles within crisis organisations such as Leader Command Place Incident (responsible for handling the crisis at the scene), Leader Regional Operation Team (responsible for handling the crisis when a larger area is affected and more municipalities are involved), information manager COPI, and information manager ROT;
- NFI: Mostly security and safety professionals with a forensic background or professionals with forensic interests such as judges in training and prosecutors;
- PA: Bachelor students of the Police Academy who follow an educational programme on crisis management.

What are our learning aims?
Because of the previously described differences between the four institutes it was difficult to formulate learning aims. There was, however, a common agreement that security and safety professionals working together in a crisis situation should at least understand the duties and responsibilities of the other actors involved. From this we derived the following learning aims.

- All students, regardless of their parent institute and specific knowledge, should have knowledge of how a multi-disciplinary crisis management organisation is configured and what tasks, processes, roles, information and command structures are relevant.
- All students, regardless of their parent institute and specific knowledge, should be able to identify the factors that contribute to the crisis situation and relate them to the configuration of the crisis management organisation. This aim should enable students to evaluate the multidisciplinary effort and formulate lessons learned to prevent the crisis situation from happening again and improve collaboration in new situations.

In the context of learning methods and learning outcomes the first aim is focussed on the transfer of knowledge while the second aim is more focused on the development of analytical skills. The workgroup agreed that both aims should be achieved by the serious game and should guide us in the development process of the game.

What is our game concept?
After identifying the target groups and learning aims the workgroup explored game concept possibilities. After considerable discussion, the game concept converged to the idea of students assuming the role of a 'god' character that is confronted with events, questions, dilemmas and/or challenges that they should solve in a dynamic crisis situation.

Example. *The player receives a message about a fire accident. The player must configure the correct crisis organisation, mobilize the correct safety and security actors and start the correct processes. Afterwards, the player receives a score. The event escalates and the player has to decide whether or not to change the configuration. Based on the player's actions the fire accident will progress in a certain direction with certain consequences. This is repeated a few times until a final score is achieved. The decisions of the player are logged and are input for a group discussion in which the teacher critiques student performance.*

The workgroup decided that the game should be played within one hour and should offer different safety and security accident situations and scenarios. By using development methods such as brainstorming and mind mapping the workgroup was able to develop a (draft) storyboard for the game.

What is our game content?
The question about content was strongly related to the question, which case (i.e. crisis situation) and scenarios should be developed. We defined a case as a factual or fictional event that we will describe. The scenario is the path or questions that lead the player through the game process (i.e. a case will/can be the basis for several scenarios). Each institute was able to propose a relevant factual multidisciplinary case. Due to the tight schedule of the project we had to choose a case for which information was readily abundant.

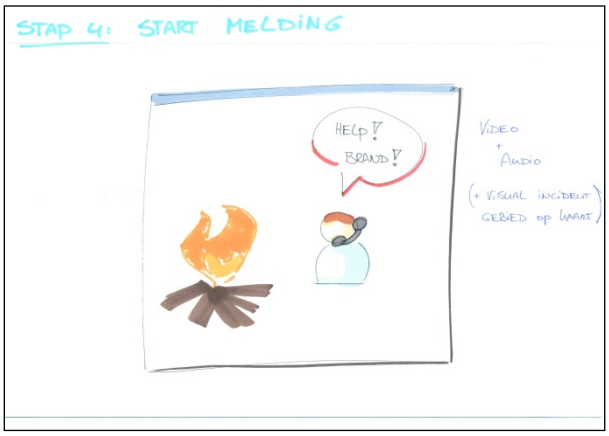

Figure 2. Paper-based prototype 1

Step 2. Produce paper-based prototype 1

The paper-based prototype consisted of 13 'screen shots' (an example is shown in Figure 2). The screen shots were the basis for subsequent discussions that enabled us to formulate our requirements more clearly.

Step 3: Evaluate paper-based prototype 1

During our discussions about the paper-based prototype we learned a lot. Firstly, we decided that we did not want a photo-realistic representation of a crisis scene; a more cartoon-like representation of the crisis scene seemed preferable. The members of the workgroup were afraid that by making the serious game too realistic the interest of the students would shift too soon to the scene instead of the abstract questions beyond it: the configuration of the crisis management organisation and constituting processes.

Secondly, we realized that we had to make some technological choices soon. Do we want to develop a

game from scratch or do we want to use an existing game environment? These decisions have an immediate effect on the project's budget, costs for availability and maintenance during the post-project period, and possible limitations to game development in terms of functionality and gameplay.

Thirdly, we realised that it would be valuable for each of the participants to develop a case specifically aimed at the needs of their own institute. It would make discussions with management about the value of the project for their own institutes senseless, because everyone is (also) building something that is tailor-made for a specific course or program.

ROUND 2: SELECTING TECHNOLOGY

During the second round the focus was on the game technology. Again, the workgroup followed the three phases of the development process shown in Figure 1.

Step 1: Understand and specify the context of use

In this phase we decided which game environment would be most suitable for the technical realisation of the paper-based prototype (result from round 1). Each institution proposed one suitable game environment. Company representatives presented their products to an audience of the program manager, the steering committee of the project VPSS, and the directors of the involved institutes. We asked each company to answer the following three questions:

- Is the game environment flexible enough to support our learning aims and implement our game concept?
- Are you able to support the development process on both technical and content levels?
- Can you develop and implement the proposed serious game within our budget and time schedule?

The project leader compared the answers. The most important criterion was how the game environment would support the original paper-based game concept. Only one game environment complied with this criterion.

Step 2: Produce second prototype

We asked the chosen company to translate the original paper-based prototype (round 1) into a new paper-based prototype. This 'proof of concept' was developed with the possibilities and restrictions of the game environment in mind. This resulted in a storyboard of 18 'screen shots' that matched our paper-based prototype (an example of screen shot is given in Figure 3). Because it was based on a existing game engine prototype 2 was a much more detailed proposal than prototype 1.

Figure 3. Paper-based prototype 2

Step 3: Evaluate second prototype

As discussed earlier, each involved institute developed a scenario for its own use. This taught the members of the workgroup how to develop a scenario. After this the workgroup developed a general scenario for common use. We decided to take the same case as a starting point for all scenarios: an accident with Apache AH 64 helicopter on December 12th, 2007 (Onderzoeksraad voor Veiligheid, 2009). The Apache crashed on an electrical tower for high power transmission during a low-altitude training mission and caused part of the Netherlands to be without electricity for more than two days.

Each institute was able to define its own specific view on this accident:

- NIFV focussed on how the event was formally escalated: Which actors (police, fire fighters, forensics, medical, etc.) became involved? When and how did the coordination take place?
- PA focussed on how the police operated during the event: How were risks assessed, scenarios developed and acted upon?
- NFI focussed on the forensic investigation: What were the procedural and practical problems while performing the forensic investigation?
- NLDA focussed on explaining the accident. How can the accident be explained in terms of human and technical failure?

ROUND 3: WORKING PROTOTYPE

In the third round each institute is developing a scenario tailored to its educational needs. The prototype of this phase consists of four scenarios based on one case implemented in a serious game environment originally developed for a serious game for majors.

Step 1: Understand and specify the context of use

Each institute selected a specific course where the serious game should be implemented. Lecturers specified the learning objectives in such a way that they could be accomplished within the selected course. For example, the scenario for the course entitled Military Innovation and Technology in the bachelor program for junior officers at the NLDA focussed on analysing accidents. Many different and sometimes opposing approaches are discussed: (Dekker, 2005; Vaughan, 1996; Wiegmann & Shappell, 2003). While playing the serious game the students are confronted with different explanations for the same event.

Step 2: Produce third prototype

In producing the third prototype we identified and specified the roles of the actors involved in the complex network of actors during a large-scale accident. Our aim was to reduce a large number of actors (at least thirty) to seven representative ones. Then we formulated seven controversies in which the seven actors have different perspectives. It was organised in a matrix. We used post-it notes and simple pictures to demonstrate our results.

The structure of dilemmas, actors and perspectives is implemented in the game environment. In Figure 4 we see the actors represented as people. The players decide what they will do in a specific situation by selecting the option 'Yes' or 'No.'

Figure 4. Working prototype (first draft)

Step 3: Evaluate third prototype

The workgroup choose to conduct an 'evaluation walkthrough' because we wanted to learn from each other's experiences. This led to many improvements in terms of consistency of concepts, clarifying dilemmas, sharpening learning aims and user experience. After this session we decided to develop a fifth scenario in the next round (round 4) and improve the interface. The individual and integral scenarios will be tested with students in September 2012 (after the summer holidays).

Subject matter experts and students will test the scenarios from different perspectives – the so-called 'controlled user testing.' First we will provide a lecture and take a test to measure knowledge about the concepts addressed in the lecture. Then we will play the serious game and reflect on the game results. Then we will do the same test to establish whether the students have learned something. A separate questionnaire and workshop will be organised to identify improvements for the game and the course.

LESSONS LEARNED

The aim of this paper is to share our lessons learned about a project in which four institutes of higher education work together in a complex organisational (management) setting to develop a serious game. In order to deal with the complex management structure and to keep the different levels of management aligned we proposed an iterative approach to guide the development of prototypes. The approach applies insights of literature on user-centered design. The development work was organised around so-called 'rounds,' each consisting of three steps. Each round had its specific problems and challenges.

In the first round the main challenge was to find a common goal and approach. It was hard to identify a common interest, because we realized that the four institutes varied widely on target group, responsibilities, tasks, and interests. It was very helpful to analyse the problems of the junior officers in the field. Analysing perspectives of the different actors on recent crisis situations made it possible to formulate the learning aims. Everyone agreed that security and safety professionals should at least understand the duties and responsibilities of each other. An important lesson is that a shared understanding of the problem is essential to guide the development process.

After a short explanation of our literature review and especially the paper of Van Bree & Lat (2011) everyone was willing to follow a creative and iterative approach. Brainstorming for a possible game concept energised everyone. Mind mapping helped us to structure this creative open discussion. Drawing a storyboard visualised the ideas very clearly. The workgroup took its time – one whole day at a secluded location – but at the end of the day a rough draft of the storyboard was ready. An external consultant was present to draw the first sketches and share his experiences with the group. An important conclusion is that visualising abstract ideas with a mind map and a storyboard made the discussion very productive.

Iterative approaches for developing prototypes require much time, because of the collaborative creative processes and user research. Therefore we tried to combine our activities as much as possible. We scheduled half-day workshops in which we tried to complete a round and start the next. This gave team members the opportunity to focus on the serious game instead of other work.

In the second round our main challenge was to specify the IT requirements. The storyboard (from Round 1) was very helpful to identify the requirements and for communication with potential game developers and the higher management of the four involved institutes. For the latter, it was very important that they saw a product in development and not another requirements document. An important lesson here was that the storyboard was very helpful to manage expectations.

Every institute had very different approaches on IT-infrastructure and IT-Governance, so a web-based solution was desired. However, it was very valuable to invite several game-developers to present their vision and game development environments. It enriched the discussion and made technical possibilities and restrictions much clearer.

In the third round our challenge was to develop a 'perfect example' of a scenario (showcase). It would help to convince lecturers and managers that the serious game really can contribute to education. Every institute was willing to work together, but the higher management was very sceptical that it could lead to a product. We decided that every institute would develop a scenario for a specific course. It accomplished two aims. Firstly, it demonstrated that the serious game was useful. Secondly, everyone within the workgroup gained experience in developing a scenario. The workgroup discovered that it was fun to develop a scenario and saw new possibilities to present complex concepts to the students.

The workgroup chose to develop four scenarios based on one specific incident (case). This decision had many advantages. The content is shared over the scenarios. But more importantly it connects very well with our idea that an incident can always be analysed from the different perspective of the institutes. It emphasises the relevance of multi-disciplinary cooperation.

We also discovered that it is vital to have a responsive game developer. Nothing is more satisfying than seeing a scenario implemented and working in the game environment. This is especially important if one needs to discuss and evaluate the scenarios.

Although we have learned many lessons from this development project already, and will learn additional lessons during our fourth round, it is important that we recognize further matters of significance. Firstly, the iterative approach we proposed is applied in a relatively small multi-disciplinary team. It is important that the team is relatively stable so that insights can develop over time. The people have to be able to participate in the meetings and prepare content for the prototypes. Secondly, a crucial phase is on the way: the evaluation of the serious game with real students. The trainer/lecturer (mostly workgroup members) are enthusiastic, but will the students share this enthusiasm? Thirdly, the serious game that is developed does not require technology that has to be developed; it can be built with a game development environment available on the market and updates can be implemented in one single (web-based) environment, which makes the implementation of additional prototypes relatively easy.

In conclusion, this paper is an argument for introducing more (agile) iterative and prototyping methods in system development projects. Our aim was to develop a serious game in a complex organisational setting and explore the application of user-centered design methods. It seemed to work rather well. It keeps everyone in the game – so to say.

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