Reference Task-based Design of Crisis Management Games

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ABSTRACT

Serious games are an effective tool for giving players a hands-on, immersive experience of crisis situations. To simplify the design of such games while ensuring their relevance, we propose a design method that is based on reference tasks. The feasibility of this approach is demonstrated by the improved design of the serious game "Disaster in my Backyard" that has been played during ISCRAM Summer school 2013. The design incorporates humanitarian logistics, search-and-rescue and coordination tasks. We also present the lessons learned from this instantiation of the game and give an outlook towards future research, such as the evaluation of tools for crisis response and management through the use of serious games and reference tasks.

Keywords

Disaster Management, Training, Serious Games, Game Design, Humanitarian Logistics, Evaluation, Information Management

INTRODUCTION

In the past few years, a growing number of people have become members of volunteer communities that aim to support crisis response and management via the Internet, e.g. the Stand-by Task Force or the Humanitarian OpenStreetMap Team (Ziemke 2012). These digital humanitarians form a "crowd" that provides various services, such as building situational awareness from social media or generating maps from obtained satellite imagery, while using information and communication technology created for example by researchers or IT developers (e.g. MicroMappers). According to evaluations, the efficacy of past deployments of digital humanitarians could have been improved by a better understanding of the situation faced by the responders and their workflows (Crowley and Chan 2011). We argue that improving such understanding among researchers, tool developers and volunteers can help to design better tools, processes and resulting information products that fit the needs and requirements of professional responders and decision makers.

In addition to the various methods that scholars currently employ (Rodríguez, Quarantelli and Dynes 2006) we suggest that serious games are a particularly valuable method[1], by immersing players in a realistic situation similar to those faced by professional responders and also familiarizing them with the tasks that comprise professional workflows. This draws on Abt's (1987) understanding of games, stating that "reduced to its formal essence a game is an activity among two or more independent decision-makers seeking to achieve their objectives in some limiting context", where players may "cooperate to achieve a common goal against an obstructing force or natural situation that is itself not really a player because it does not have objectives". The context of humanitarian crisis response and management resembles such a situation. Responders cooperate to make and implement decisions under limiting circumstances, in order to save lives and alleviate suffering.

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[1] The existing literature gives various examples for the use of serious games, e.g. for training and learning purposes, the exploration of ideas relating to policy and strategy, or as an environment for experimentation (Aldrich 2003, Geurts, Duke and Vermeulen 2007, Marsh 2011).

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Serious games, exercises and scenarios are closely related terms, especially if a serious game makes use of a suitable scenario to exercise certain skills. According to Potter and Farry (2009), there is a lack of "support or general guidance for designing effective scenarios; either for crafting them around the desired exercise objectives or designing them in a coherent manner". This conforms to our findings, showing either very general design approaches (see, for instance, the step "Write scenario" in Whitworth, Smith, Hone and Macleod 2006) or specific instructions for parts of the game (e.g. the five steps for debriefing in Thatcher 1990). The creation of a whole ecology of serious games that is able to address different targets and skills, as suggested Di Loreto, Mora and Divitini (2012), would benefit from better guidance in the game design process, focusing on specific workflows and pertaining elements of the environment.

The objective of the research presented here is to provide better guidance, specifically tailored for the building of an improved understanding of the disaster management context in which information management and decision support systems are provided. In this paper we propose a design workflow that may be used to create serious games more easily. We demonstrate the applicability of the design workflow with an instance of the serious game "Disaster in my Backyard" in the ISCRAM Summer School 2013 and share lessons from that instance. A summary and outlook on future work conclude the paper.

Design approach

When developing a serious game as an exercise, generally two elements are important: *planning* and *delivery* (Gagné and Driscoll, 1975). Planning involves the definition of objectives (purpose) and the design of activities, while delivery is the presentation of these activities to the players. Following this general structure, we propose a design workflow that starts with the definition of the purpose of the game during planning; the interaction, options and environment during delivery; and ends with the evaluation of the game after its execution. The individual steps of the workflow, as depicted in Figure 1, can be related to the roles of game designers who are responsible for *planning* and *delivery*; the game managers who are responsible for the *execution*; and to the "players" and to the game "environment". To illustrate this structure, think of a PowerPoint presentation: content creation is planning, slide creation is delivery and the actual presentation is execution.
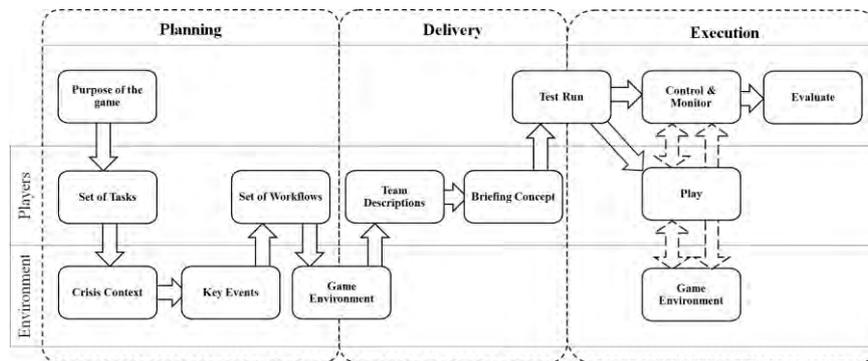

Figure 1: Game Design Workflow (Source: Own Figure)

In a very first step, the game designers define the *purpose of the game*, e.g. to give newcomers in crisis response and management an immersive experience of a crisis context, requiring them to plan and implement a search and rescue operation under high uncertainty and time pressure, and for collaboration between multiple teams that can access only limited resources, like communication infrastructure. When the purpose is set by the designers, they may proceed to determine which tasks are appropriate for the players to handle, thereby also defining the scope of the exercise. To do so, the designers may draw on tasks from existing process reference models, as they exist for humanitarian logistics (Blecken, 2010). As Blecken (2010) puts it, these process reference models are intended to serve as solution schemes or generic recipes for certain classes of decision problems for the accomplishment of practical tasks, defining, e.g., interdependencies, roles and responsibilities of actors in the humanitarian supply chain. These reference tasks and their descriptions enable the designers to quickly select building blocks for in-game workflows that are relevant to their respective discipline, as seen in the exemplary game design below.

When the purpose of the game is decided and it is clear which tasks the players shall handle, designers may select the appropriate *crisis context* for the game environment, e.g. a flood in Western Europe. Proceeding further to design the environment, the designers define the key events ("stages") of the game[2].

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[2] This relates well to event-based exercise design; see, for instance, Fowlkes, Lane, Salas and Oser (1994).

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For instance, (1) the exemplary flood above is announced by an early warning system, (2) the local municipality decides to evacuate a village, (3) the flood hits and remaining locals have to be rescued and (4) complicating factors such as riots, loss of facilities and additional hazards appear[3]. Next, the tasks are meaningfully combined into in-game *workflows*. The designers use these workflows for guidance while they further flesh out the game, creating a situation that can be "solved", e.g. by rescuing affected locals. The workflows are only intended to simplify the planning stage and to lead to a consistent game design. Thus, designers should also expect players to deviate from the workflows and think of ways to guide the players in these cases, e.g. by introducing a non-player character who acts as a guiding expert. These workflows should not be confused with the approach players take, as the serious game does not dictate teams to undertake certain actions or decisions.

With the knowledge of key events and in-game workflows, the description of the *game environment* can be completed, e.g. by key locations, important information to gather, but also the locations of affected people, materials etc. According to Muehl and Novak (2008), when serious games are used for learning and training purposes, the model of the simulation should be as realistic as possible, in order to best prepare trainees for real-life situations. However, a full simulation would require a great amount of resources, while a paper-based version may not be realistic enough to provide valid results (Callahan 1982). Designers will have to balance realism with convenience when designing the game environment and its interaction with players through workflows, as shown in Figure 2. Knowing the exact game environment and the in-game workflows, the *team descriptions* can be fleshed out: starting location, mission statement, and initial resources and so on. In a next step, the expected players are analyzed to develop an appropriate *briefing concept*.

For instance, your local Red Cross group can be expected to react differently to a flood and search-and-rescue context with new IT tools than a group of university students who are curious about new technology but have never given first aid to anyone. Concluding the planning stage of game design, the game is played in a *test run*. This would preferably happen in the actual physical game location but could also happen virtually with a map, a game script, game descriptions and other materials.

Following planning, *execution* consists of the players *playing* the game while the game managers (which could be the designers) simultaneously *monitor and controlling* the game. By monitoring the moves of the players, which can be supported by real-time tracking systems or expert systems, the managers are able to dynamically adjust the difficulty of the game (control). When the game script has ended, the managers should *evaluate* the game quite quickly, in order to preserve as many fresh impressions as possible. This can involve feedback sessions with the players but also within the managers' team. A follow-up evaluation may capture long-term impressions and effectively supporting learning by including a debriefing with players (Thatcher 1990).

EXEMPLARY GAME DESIGN FOR DISASTER IN MY BACKYARD 2013

Disaster in my Backyard is an augmented reality game employing mobile technology and various information flows. The *purpose of the game* is to give players an immersive, first-time experience in crisis response and management, in order to improve the alignment of their preconceptions about crisis contexts with reality. They experience challenges related to the search and rescue of affected people ("victims"), coordination and material supply. The *set of tasks* consists mainly of tasks from Blecken's (2010) "Reference Task Model for Supply Chain Processes of Humanitarian Organizations" (RTM). It includes tasks such as "Identify needs and number of beneficiaries" or "Request goods". Because the RTM merely links to coordination and search-and-rescue activities but does not define them in detail, the tasks for coordination and search-and-rescue operations were derived from additional reference material, i.e. the guidelines and methodologies of the International Search And Rescue Advisory Group (INSARAG) and the United Nations Disaster Assessment and Coordination (UNDAC) teams. The *crisis context* is a flood in Western Europe, which fits the series of Summer School courses that the game is embedded in. The *key events* of the game are structured into six stages, ranging from the introduction of the context to the players via increasingly challenging stages with new tasks and up to a final state, in which the players ideally feel like they are in control of the situation. The *set of workflows* matches all stages and includes, for instance, the continuous assessment of the situation and the collection of specific information about local needs, resources and capacities, as the example depicted in Figure 2.

In Disaster in my Backyard 2013, the *game environment* is set up to support the immersion of players into an augmented reality, creating the required realism while being cost- and resource-effective (Meesters and Van der Walle 2013; Azuma, Baillot, Behringer, Feiner, Julier and MacIntyre 2001). For instance. search and rescue operations are simulated using *victim profiles*, QR-codes and an app on a mobile hand-held device. Facilities and the status of the urban environment are partially represented using *markers*.

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[3] Potter and Farry (2009) describe a set of complicating factors that can be used in this step.

The game environment furthermore includes a coordination center, dynamic information inserts (e.g. tweets and emails) and in-game characters (e.g. local citizens and a government official). Notably, the game includes real-life, professional responders who act as non-player characters, adding realism to the game and aiding evaluation.
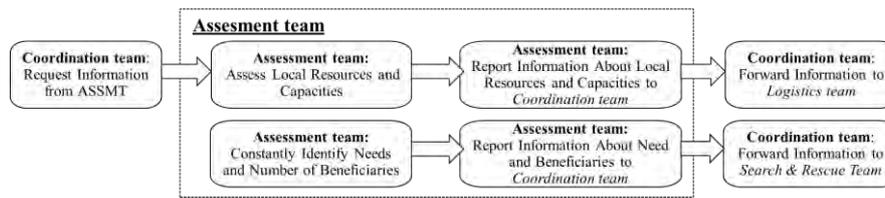

Figure 2: Exemplary workflow for the assessment team

Final *team descriptions* are created for the teams (i.e. coordination, assessment, logistics and search-and-rescue) and translated into a *briefing concept*. The briefing concept includes preliminary training in courses that precedes the game, e.g. a lecture about humanitarian logistics and a workshop about how to use the IT tool GDACSmobile to support assessment, and a short introduction in the first minutes of the game (crisis context, safety instructions, rules and game workflows and applications). The *test run* was done off-site due to prior knowledge of the game location and led to minor modifications of the game design. While the game was *played*, the designers monitored the players from a room next to their coordination center. During this time, the designers made use of several (pre-defined) options to increase or decrease the difficulty (Meesters and Van der Walle 2013). As the game was played until late at night, the *evaluation* was done in the next morning with a presentation of the game results, a feedback session with the players and a feedback round among managers.

LESSONS LEARNED FROM DISASTER IN MY BACKYARD 2013

The game design workflow has led to an improved design that includes multiple teams with different tasks requiring coordination, maintained a high standard of realism and shortened the planning stage, while delivering consistent results. Due to an improved scenario design, the efficient use of dummies and the extension of the game with additional tasks relying on augmented reality, the game was lighter on resources than previous versions. Players have noted that the game has provided them with an improved understanding of the difficulties faced by first responders, which enables them to design solutions that are better suited to the needs and requirements of professional responders. Beyond noting these positive aspects, several lessons can be learned and applied in future design and deployment of serious games.

From the very beginning of the game design process, the designers have to be highly aware of the players' backgrounds, especially when mixing newcomers and professional first responders. Specifically the gap between existing knowledge and expertise and the desired learning effects (*purpose of the game*) has to be large enough to provide challenges to the teams and small enough as not to discourage them. This gap should be considered in every stage of the design process.

As suggested by Potter et al. (2009) the set of key events included options to dynamically adjust the game's difficulty with complicating or mitigating factors, depending on the teams' progress and motivation. The game was designed to induce high levels of stress, and more often than not we had to make the game easier. Players generally took more complicated rather than simpler approaches to tackle the challenges they faced. However, we found it difficult to adjust to the way the players used (or rather: did not use) the technical tools that were at their disposal. According to the players' feedback, they were overwhelmed by the environment and struggled to keep up with rescuing victims, so they did only use tools that they understood perfectly. This leads to the conclusion that preliminary training has to be considered more strongly in the briefing concept, e.g. by including a short radio communication workshop or a more extensive GDACSmobile tutorial.

Another lesson relates to the mission statements for briefing, which need to be very clear and concise and include a description of the available channels of communication.

During the game, players became creative and started using parts of the environment to solve tasks in a way that was not intended by the designers, e.g. by taking equipment from buildings that were not meant to be entered in the game. While innovation is generally welcome and may lead to valuable insights, it should not disturb the flow of the game too much and, more importantly, it should not put the safety of players at risk. Consequently, within a large environment it makes sense to carefully develop and communicate proper restrictions. It should be easy for the players to distinguish between usable and non-usable items, e.g. by clearly tagging all in-game tools, such as wheelchairs. The players should also be aware what each tool is intended for.

CONCLUSION

In this paper, we proposed a workflow for designing serious games that makes use of reference tasks to simplify and speed up development, while leading to a consistent and realistic outcome. The feasibility of this design workflow was demonstrated by the improved design of the serious game "Disaster in my Backyard" that has been played during the ISCRAM Summer School 2013, adding tasks from humanitarian logistics to the search-and-rescue and coordination tasks from a previous version of the game. Eventually we presented the lessons learned from this instantiation of the game, naming several actionable points that may improve the next version of the game, which shall be played in ISCRAM Summer School 2014, also to evaluate GDACSmobile.

Serious games and the introduced design approach provide several interesting directions for future research and applications. While the games designed with the proposed workflow have – so far – only targeted newcomers, we are interested to examine how it can be used to design serious games that train professionals in the use of IT tools or other types of innovation and evaluate their usefulness. This may lead to valuable insights about the factors that influence the adoption of new tools and procedures by professionals. Apart from putting greater emphasis on such evaluations, the design workflow may be extended to explicitly include tutorials that specifically address identified learning opportunities. Another interesting opportunity arises with the integration of virtual players through chat or e-mail, which interact with the physical game environment from afar (e.g. simulating support from a group like the Stand-By Task Force).

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REFERENCES

1. Abt, C. C. (1987). Serious games. *University Press of America.*
2. Aldrich, Clark (2003). The future of learning: An innovative approach to e-learning. *John Wiley & Sons*
3. Alexander, D. (2000). Scenario methodology for teaching principles of emergency management. *Disaster Prevention and Management*, 9(2), 89-97.
4. Azuma, R., Baillot, Y., Behringer, R., Feiner, S., Julier, S., & MacIntyre, B. (2001). Recent advances in augmented reality. *Computer Graphics and Applications, IEEE*, 21(6), 34-47.
5. Blecken, A. (2010). Humanitarian Logistics: Modelling Supply Chain Processes of Humanitarian Organisations. *Haupt Verlag, Bergisch Gladbach.*
6. Callahan, L. G. (1982). Modeling and Simulation of Land Combat. *Proceedings at Callaway Gardens.*
7. Crowley, J., & Chan, J. (2011). Disaster Relief 2.0: The Future of Information Sharing in Humanitarian Operations. *Washington, DC and Berkshire, UK: UN Foundation and Vodafone Foundation.*
8. Di Loreto, I., Mora, S. & Divitini, M. (2012). Collaborative serious games for crisis management: an overview. *IEEE 21st International WETICE.*
9. Fowlkes, J., Dwyer, D. J., Oser, R. L., & Salas, E. (1998). Event-based approach to training (EBAT). *The International Journal of Aviation Psychology*, 8(3), 209-221.
10. Gagné, R.M., Driscoll, M.P. (1975). Essentials of learning for instruction. *Dryden Press Hinsdale, IL.*
11. Geurts, J. L., Duke, R. D., and Vermeulen, P. A. (2007). Policy gaming for strategy and change *Long Range Planning (40:6),* pp 535-558.
12. Gummesson, E. (2000). Qualitative methods in management research. *Sage.*
13. Mann, S., & Nnlf, S. M. (1994). Mediated reality.
14. Marsh, T. (2011) Serious games continuum: Between games for purpose and experiential environments for purpose," *Entertainment Computing (2:2),* pp 61-68.
15. Meesters, K., & van de Walle, B. (2013) Disaster in my backyard: a serious game introduction to disaster information management. *Proceedings of the 10th International ISCRAM Conference.*
16. Muehl, W., & Novak, J. (2008). Game Simulation Development. *New York, 288.*
17. Potter, S., Farry, P.M,. (2009). Supporting the C2 of Training Exercise Management: The design of a Decision-Centered Scenario Management Tool. *14TH ICCRTS.*
18. Rodríguez, H., Quarantelli, E. E. L., & Dynes, R. R. (Eds.). (2006). Handbook of disaster research. *Springer.*
19. Thatcher, D. C. (1990). Promoting learning through games & simulations. *Simulation & Gaming,21(3),262.*
20. Whitworth, I. R., Smith, S. J., Hone, G. N., & McLeod, I. (2006). How do we know that a scenario is 'appropriate'. *11th International Command and Control Technology Symposium, Cambridge, UK.*
21. Ziemke, J. (2012). Crisis Mapping: The Construction of a New Interdisciplinary Field *Journal of Map & Geography Libraries*, 8(2), 101–117.

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