BRIDGING THE GAP: Transforming Knowledge into Action through Gaming and Simulation

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Serious Gaming for Infrastructure Design and Management: Prototypes of VENTUM ON LINE and SIM MV2

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1. Introduction

The value of gaming and simulation for education and learning – primary to professional – has long been recognized. Board games, role-playing games and computer supported simulations have widely been used for K12 education, but have also become widely accepted and used for higher education and professional learning. However, a number of important developments in the demand side of the learning market and powerful innovations in the supply side, increasingly challenge us to innovate the (sort of) games and simulations that are being developed and used for higher and professional learning. More and more people become captured by the idea that the technology and concepts used by the entertainment and video gaming industry and the e-learning industry, can be used to develop new simulation-games for education and policy support (Crawford, 2004; Aldrich, 2004; Prensky, 2001; see also www.seriousgames.org). According to proponents of the idea there are several reasons why this will (and should) occur.

First and on the demand side, game developers and users now serve a generation of students and young professionals that have grown up with advanced digital games and simulations and possess the practical knowledge and skills that exceed their teachers. And although for many purposes board games and social simulations will continue to have didactical power, it becomes increasingly difficult to persuade students and young professionals (in our case ‘engineers’) to play and learn from them.

Second, during the previous decades the perspective on learning and education has undergone radical changes. Our dominant view on teaching and learning by class room lectures and literature study, has gradually been replaced, or supplemented by ‘constructivist’ learning concepts – ‘authentic learning’, ‘active learning’, ‘self directive learning’, ‘open learning communities’ and ‘life long learning’ have become prevalent notions in (post) graduate programs. By and large, these concepts imply that students take up an active role in, and are responsible for, their own learning process – inside and outside the classroom, during their formal education and after. Students are increasingly provided with a learning context and are guided and facilitated in their learning process by teachers and instructors. As many will
know from experience, this often implies that traditional ways of teaching are supplemented with case based project work by student groups.

Third and much related to the above, the constructivist-learning paradigm has been accompanied by the implementation of e-learning tools and technologies - e.g. learning content management systems (LCMS) of which Blackboard and WB-CT are commonly known. Early experiences however with constructivist approaches and e-learning tools have led to some discontentment in terms of enhanced learning. This may be due to the poor quality of interactivity – among students, between students and teachers but most importantly between the students’ products and decisions and the world ‘out there’. This is one of the underlying reasons why there has been a steady development to combine e-learning systems with simulation and gaming - both for business and higher education (see for example Dziabenko et al., 2003; www.sig-glue.net). According to some authors, gaming and simulation will bring ‘e-learning to a next level’ (Davies, 2003; Aldrich, 2004).

Fourth and on the supply side, the entertainment and video game industry has induced rapid and major innovations in gaming and simulation technology, concepts and applications. The force of the push and pull factors for innovation in this industry can probably only be matched by the military industry – and it is therefore no surprise that both industries increasingly seem to join forces (www.americasarmy.com). The budgets involved in the video gaming industry however are nowhere in the range of the budgets available for education or decision and policy support. Yet, in terms of technology used (artificial intelligence, internet) motivation and creativity of developers and players, attractiveness of graphics, user interfaces and the wide range of gaming genres and applications we might be able to use elements and components from the entertainment and digital gaming industry efficiently for non-entertainment purposes such as learning and policy support. In this paper we will explore the seriousness of the ‘serious game movement’. We will review a variety of interesting projects and define a number of additional design requirements. We will then describe two prototypes that were designed to meet these requirements.

2. What is the ‘serious game’ movement?

The opportunities and benefits of using digital games and simulations for ‘serious purposes’ are now increasingly being explored in partnerships between industry, universities and public organizations. ‘Serious Games’ is a relatively new but sensitizing concept which we will use here to denote a variety of loosely coupled initiatives that are presented under the same or other headings (also social impact games or simulation based e-learning). Serious games and simulations initiatives try to use the technology and concepts of the game (and e-learning) industry for non-entertainment purposes in particular (higher and life long) education and public policy (support). A website (www.seriousgames.org) is dedicated as a portal for initiatives on
serious games in particular to enhance productive links between the electronic game industry and projects involving the use of games in education, training, health, and public policy.

Like the entertainment industry, the United States seems to be leading in the field of ‘serious games’. Various programs and networks have been initiated by leading game-designers such as Ben Sawyer (from Digital Mill, www.dmll.com), the Woodrow Wilson International Center (www.wilsoncenter.org), MIT (‘Games to Teach project’) and are supported by institutions such as Alfred P. Sloan foundation (www.sloan.org). There are also a couple of interesting examples and initiatives of serious games and simulations for higher education and policy support in Europe (Maharg, 2001, 2004; Dziabenko et al., 2003; www.unigame.net). Marc Prensky (Prensky, 2004) and others like the Education Arcade consortium (i.e. MIT, and several game designers funded by Microsoft) (www.educationarcade.org) mainly focus on serious games as education tool - elementary school to university. Other institutions such as www.watercoolergames.com focus on games that go beyond entertainment and education purposes and have introduced new gaming concepts such political games (about issues such as terrorism), ‘advergaming’ (for advertisement) and, ‘newsgaming’ (to support newscast).

However, despite the success of the concept, the question can be raised how serious the ‘serious games’ are and (how) effective they are for higher learning and policy support? In the next section we will consider some of the strengths and weaknesses of the concept and projects by briefly reviewing a variety of examples (see Table 1).

3. How serious are the serious games?

3.1. Serious digital games

VIRTUAL UNIVERSITY (www.virtual-u.org), and NITROGENIUS (www.serc.nl) are interesting examples of single user digital games with a serious subject and learning purpose. VIRTUAL UNIVERSITY uses an existing but modified game engine of a commercial game (i.e. CAPITALISM) while NITROGENIUS was developed from scratch. The game-concept DAEDALUS' END also uses an existing game engine (i.e. TROPICO) but has a multi user environment (Zhan & Shrestova, 2002). VIRTUAL LEADER (Aldrich, 2004) is another single user digital game based upon a tailor made 3D game engine and sophisticated AI. The game is used for professional training about leadership and management in companies.

From a serious game concept we can observe that these games have a serious subject but are still entertaining. To some extent the games are quite complex, use state of the art gaming technology and have characteristics of an open ended game; On the other hand, in order to be useful for professional learning or real policy support they do not adequately reflect the social and strategic complexity of real world decision making. Another major disad-
vantage is that they are quite costly to develop while the content is not very specific or adaptable to other contexts.

3.2. Serious web based single player games

FIX YOUR COMMUTE (FYC) (fyc.heraldnet.com) and US OIL POLICY SIMULATION (US OIL) (broadcast.forio.com/pro/oil/index.htm?FD_rand=1659) are interesting examples of web based single user games with serious content and objectives. FYC is a flash based game that revolves around road-based infrastructures. It does give some insight about infrastructure policy but also does not add much to social complexities. US OIL uses off the shelf technology (i.e. Forio Business Simulation) so that the development time and costs can be reduced but strategic and political complexity is also low.

The advantage of both games is that anyone with Internet connection can play them. The current state of the web-based game only requires about 10 or 20 minutes to play one cycle of the game. In other words, web technology reduces the resources needed to develop and play the game and can therefore diffuse serious games to massive number of players. The downside is that as long as they do not include elements of multi user role play, the social and strategic complexity of these games is even lower than the above examples and the opportunity for debriefing and evaluation are even less.

3.3. Serious groupware games

UNIGAME (www.unigame.net), ARDACALLOCH (www.ardcalloch.ggsl.strath.ac.uk) and THE UTILITY COMPANY (TUC) are examples of simulation based e-learning systems that provide a re-useable simulation and gaming architecture that is relatively independent from the game content. They are all used for e-learning in higher education. TUC uses standard groupware (similar to blackboard and web-ct), which includes video taped interviews with employees that students can watch to perform a consultancy assignment (Bos & Gordon, in press). UNIGAME is an Internet based learning content management system that allows university teachers to develop and manage their own simulation (game scenario) (Pivec et al, 2003). The underlying architecture provides chat, e-mail and video conferencing services as well as features to make the game motivational. ARDACALLOCH has a similar structure but also includes a map of a virtual town including virtual companies (Maharg, 2001, 2004). The advantage of the aforementioned systems is that the technical architecture and the content are separated so that new games can be developed and implemented relatively easily. Teachers can be involved or even develop and manage the games themselves. Furthermore, these systems do reflect the strategic and social complexity of real world system. The downside of these systems however is that they do not include simulators so there is a risk that students will reach a ‘negotiated nonsense’ because there is (no long) term and dynamic feedback of (quantitative) consequences.
4. What could make serious games more serious?

The serious game examples described above do not generate learning or policy support per se! As indicated above, many of the so-called serious games have a number of weaknesses and barriers to learning and policy support. In short, the underlying complexity of real world systems – e.g. the messy entanglement of technological and political issues, the strategic behavior of stakeholders, the political wheeling and dealing, the ambiguity, mistakes and manipulation - are largely neglected. All in all, for serious games to become truly ‘serious’, more awareness and better understanding is needed on how higher education and policy making come about. We define the following requirements to make serious games and simulations even more serious:

1. Context and content should lead design – not the other way around!
   Serious games and simulations need to be (more) specific about the advanced learning objectives or policy support they aim for.

2. In order to be relevant for university and professional learning, serious games need to reflect and address the multi disciplinary and-or interdisciplinary and constructive character of such learning.
3. In order to be relevant for decision support, serious games need to address the messy - ill structured and multi actor problem context. In many cases, this means that technical and political aspects are entangled.

4. Serious games should be tailor made or adaptable to varying contexts and objectives. In order to be able to reach and address the actual decision makers and professionals, serious games need to have a high level of realism and concreteness.

5. In order to enhance learning and improve decision-making, serious games need to address issues that for a longer period of time will stay or rise on the decision-making or political agenda.

6. Serious games need to reflect the strategic stakeholder interaction that takes place in real world systems by enabling and supporting social interaction through role play and various forms of human communication (socially and electronically).

7. Serious games however must reflect and support the substantive aspects of decision-making by transparent simulation models. These provide the reality check to negotiated nonsense.

8. The costs and time frames of serious game design need to be fairly limited.

9. Serious games have to be designed and implemented as part of an intervention or learning trajectory that involves more than gaming.

10. Serious games have to provide tools, guidelines and support for debriefing and evaluation.

5. More serious games?

Below we will describe two ‘serious games’ in the field of infrastructure planning that were designed to meet the above requirements (see Table 2). VENTUM ON LINE is a web-based multi player on line role playing game with high quality graphics, animations, visuals and user interfaces. The game has been developed in a partnership between two universities and the company, Ijfontein interaction design. The game will be used for university education for engineers about project management and will also be used for professional training of public administrators and business managers. The game SIM MV 2 was commissioned by the Port of Rotterdam for internal training and learning purposes. The game is a computer-mediated game that uses 2 and 3 D animations of the design and land designation of a new harbour area (2nd Maasvlakte) in the port of Rotterdam. Below we will briefly describe the games.
VENTUM ON LINE

VENTUM ON LINE (www.ventum.nl) is based upon the role-playing simulation-game VENTUM that has no computers but has successfully been used within a university master program and for external in company training sessions. The original game as well as the on line version revolves around the project-management for building an off shore wind farm. Both versions are modeled after actual developments in the Netherlands, i.e. the decision
to experiment with offshore wind energy winning. In the game, groups of students form a consortium by setting initial agreements among the various companies involved. Next they negotiate and agree upon a tender proposal to submit to the national government. After the tender has been granted, the consortium members have to actually design and build the off shore wind farm according to their own specifications. Each company can perform R&D, make decisions for design, can buy information about aspects such as wind speed or wave heights from consultants. Overall, the game is characterized by a high level of uncertainty, distributed information and interconnected decisions. The main challenge for the consortium members is to coordinate their activities and to manage the tensions and conflicts that will arise among them. When all partners have agreed upon their final design they can agree to build. A scenario now shows a video of the actual building of the wind farm and the teams’ final performance indicators. During the game, social interaction can be arranged through the Internet (chat, e-mail) or by arranging face-to-face meeting (in settings where this is allowed and possible). Important parts of the game are parts for registering, information, for communication and to fill in decisions. At the end of the game a streaming video will be showed about the realization of their project.

5.2. SIM MV 2

SIM MV2 is a multi player computer based simulation-game that revolves around the infrastructure planning and land designation in the second harbor area (2nd Maasvlakte) of the Port of Rotterdam. After a lengthy and highly controversial public decision making process, the Dutch national government has recently decided to reclaim from the sea some 1000 ha of new land in the Port of Rotterdam area. During the coming decades, this new land has to be supplied in several phases. The infrastructure (energy, roads, but also docks, jetty etc.) has to be built and future clients have to be found. The planning and decision making process is therefore characterized by a high level of uncertainty, path dependency and strategic stakeholder behavior. Technical and political aspects of the decision-making are highly interwoven and a number of pitfalls are foreseen. Commercial and infrastructure decisions for a period of several decades need to be co-ordinated between different departments of the Port of Rotterdam. Moreover, exogenous uncertainties such as the development of the global and national economy, the relative economic development of the various industrial sectors, future innovations in containerships (their depth) and logistics need to be taken into account. SIM MV 2 uses advanced simulation and gaming techniques to: 1. reach better short and long term commercial results for the 2nd Maasvlakte; 2. increase the insights and knowledge about exogenous and endogenous uncertainties related to infrastructure planning and land designation strategies 3. improve the communication and co-ordination of different departments of the Port of Rotterdam. The simulation-game is played with 8-16 players that the real decision-makers of the Port of Rotterdam. Social inter-
action can be arranged among the players – while various decision makers insert decisions in a distributed fashion (LAN). The underlying simulation model contains a Geographical Information System, a design tool and a 2,5 D visualization of the results.

5.3. Technical architecture

For reason of focus and space, we cannot describe the underlying technical architecture here (see van Houten and Jacobs, 2004). It is important to note however that the architecture uses a Java based simulator (D-SOL) that exists of reusable gaming modules that support various types of (distributed) Internet mediated simulation games with user interfaces programmed in Flash or SWING. The user interfaces of both games consist of multiple screens that support a player in making decisions. Furthermore, the architecture supports the interaction between simulated and human players. Players can view the result of their individual or joint decisions in a 2D and 3D world.

6. Conclusion

Although there are movements from serious gaming industries to use the latest developments from the entertainment industry, there are possibilities to improve the serious games further. In the policy making process of complex problems, the decision-makers have to deal with social complexity as well as technical complexity. This combination of complexity has to be visible in the games intended for academic and professional learning and decision or policy support. The challenge is to design ‘serious games’ with the proper balance between social and technical complexity.

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