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Balancing Play, Meaning and Reality: The Design Philosophy of LEVEE PATROLLER

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Abstract

Most serious games have been developed without a proper and comprehensive design theory. To contribute to the development of such a theory, this article presents the underlying design philosophy of LEVEE PATROLLER, a game to train levee patrollers in the Netherlands. This philosophy stipulates that the design of a digital serious game is a multiobjective problem in which trade-offs need to be made. Making these trade-offs takes place in a design space defined by three equally important components: (a) Play, (b) Meaning, and (c) Reality. The various tensions between these three components result in design dilemmas and trilemmas that make it difficult to balance a serious game. Each type of tension is illustrated with one or more examples from the design of LEVEE PATROLLER.

Keywords

computer-based simulation, design philosophy, digital games, serious games, flood risk management, game design, levee inspection

Affordable computer systems and the arrival of advanced game technologies have made it possible to use high-quality digital environments for games with a purpose other than pure entertainment: to develop digital—as opposed to analog—serious games (Abt, 1970; Bergeron, 2006; Michael & Chen, 2006; Sawyer, 2002). The interest in the use of digital game technology has resulted in a steadily increasing number of digital serious games, such as HAZMAT: HOTZONE (2006), TACTICAL IRAQI (2006), and VIRTUAL U (2003). Although created in carefully controlled university environments,[1] many of these attempts have not published their underlying design

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philosophies. This makes it difficult for the emerging field of serious game design to establish general principles and theories.

The need for underlying design and learning theories is important, as Shaffer, Squire, Halverson, and Gee (2005) point out:

> This interest in [digital serious] games is encouraging, but most games to date have been produced in the absence of any coherent theory of learning or underlying body of research. We need to ask and answer important questions about this relatively new medium. (p. 111)

The need for such underlying theories has been confirmed by the numerous digital serious games that have been produced and used so far. They are not as compelling as their entertainment counterparts, have many design flaws, but most strikingly, the learning content is frequently not well integrated into the game (Aitkin, 2004; Brody, 1993; Egenfeldt-Nielsen, 2005). For example, in many games, players can only continue playing if a number of educational questions are answered or are continually bothered with educational texts that are irrelevant to playing the game.

This knowledge gap in digital serious games does not mean that practitioners cannot rely on an existing knowledge base. They could for instance profit from a body of knowledge on analog serious games (Crookall & Arai, 1995; Duke, 1980, 2000; Geurts, Joldersma, & Roelofs, 1998; Greenblatt, 1988), or they could derive insights from research on game design patterns (Björk & Holopainen, 2005; Falstein, 2002). As well as these two knowledge sources, designers could rely on the insights of techniques and approaches derived from the entertainment game design communities (Costikyan, 1994; Crawford, 1982; Rollings & Morris, 2003; Salen & Zimmerman, 2004) or from attempts to understand digital games better in the first place (Aarseth, 1997; Bogost, 2006; Juul, 2005) to why they are suitable for serious purposes (Aldrich, 2004; Gee, 2003; Prensky, 2001).

Despite being insightful, these sources are either not focused on digital serious games and/or are not focused on game design. This means that in game design theory, a gap exists

a. between digital and analog serious games,
b. between entertainment and serious game design, and
c. between an understanding of (serious) games and the design of serious games.

Although some success stories do exist (Blunt, 2006; Kato, Cole, Bradlyn, & Pollock, 2008; Sidor, 2007), the incoherency in, and even the simple absence of, theory prevents practitioners from learning from each other and subsequently from developing more successful digital serious games.

One way to bridge the gap in game design theory is to reflect deeply about the design—to think about the underlying design philosophy in the same vein as is done in the design sciences generally (Moran & Carroll, 1996). In our opinion, this approach is particularly lacking from the field of digital serious games. To take a step forward into this desired scientific practice, this article presents the underlying design philosophy of a serious game named LEVEE PATROLLER (also see Harteveld & Bidarra, 2007; Harteveld, Guimarães, Mayer, & Bidarra, 2007). In addition, this philosophy will be a small step forward in establishing a theory of serious game design, a theory that will guide developers in creating entertaining as well as meaningful serious games. This particular game, which has been developed by an interdisciplinary team involving Delft University of Technology, Deltares, a research institute for delta technology, and the Dutch water boards, concerns training levee patrollers. As the term "serious games" is used as a catch-all phrase similar to "virtual reality simulation" (Crookall, 2006), it needs to be emphasized that the discussed design philosophy may not be suitable for every serious game.

Despite this warning about the extent to which our ideas can be generalized, during the development of LEVEE PATROLLER we found that the design of a digital serious game is a multiobjective problem in which trade-offs need to be made in a design space that is defined by three equally important components: (a) Play, (b) Meaning, and (c) Reality. When developing a successful serious game, designers must balance these three components. This may be hard to accomplish, as various tensions can arise within and between two or more components.

The fourth and fifth sections of this article elaborate on this design philosophy by discussing its general idea and specifying the core components and their tensions, respectively. Subsequently, the sixth section provides nine examples from the development of the game to explain this philosophy further. Each of these examples represents one of the potential tensions that may arise during the development of a serious game project. However, we first explain in the following sections why we decided to develop a serious game for this seemingly unique field and how the game has been designed.

The Need for a Serious Game About Levee Inspection

The Netherlands is a unique country in the sense that more than half of the country lies below sea level. Natural and artificial barriers called levees (or dikes) protect the habitants and their goods from being washed away. The failure of a levee would have a considerable societal impact, because the Netherlands is a densely populated country and is an important economic center for Europe, with its many distribution channels, ports, and industries.

Although levee failures are rare—estimates of the failure rate are once every 1,250 to 4,000 years—the National Institute for Public Health and the Environment calculated that flood risks remain much higher than the risks of all other possible disasters added together (ten Brinke & Bannink, 2004). It can be expected that flood risks will increase in the near future due to global warming and continued urbanization. In addition to this, experts recently pointed out that more than 70% of the levees in the

Netherlands do not fulfill the safety guidelines (Adviescommissie Water, 2006). The considerable societal impact, high risk, future developments, and lack of maintenance all indicate that levees are critical to the Netherlands and that appropriate measures need to be taken to prevent major disasters from happening.

Preventing such flood disasters is, in addition to the national government, primarily the task of the Dutch water boards, which are the institutional organs in charge of water infrastructure and levees. Every water board has a number of people who inspect the levees regularly or in cases of emergency. These people are referred to as "levee patrollers." The measures taken to safeguard the Netherlands from flooding include levee reinforcements, spatial planning policies, political and administrative reorganizations, and the improvement of the emergency response agencies that deal with the crises directly (Hoogewoning & Linck, 2006). Ensuring that levee patrollers are trained represents part of the latter.

A trained levee patroller should be able to recognize the symptoms of failure and communicate relevant findings to the central field office in good time. The field office can then issue further directions or initiate procedures to take corrective measures. Recognizing the symptoms of failure requires an understanding of failures, and communicating correctly requires knowledge of the protocols that need to be followed. Levee patrollers need to receive the right type of training to perform this duty, especially given the fact that failures are rare and difficult to notice. A layperson would only observe a failure when it is too late to correct it. Without experience and without knowing what to look for, failures similar to the one in Wilnis or even worse may occur again (see Figure 1).

Traditionally, levee patrollers were trained using role-playing techniques and lectures. Although these methods are certainly useful, patrollers experienced no actual levee failures. For this reason, a number of water boards started looking for alternative methods. Based on an analysis of the possibilities, it was concluded that a digital game seemed the most promising option. Digital games technology makes it possible to create safe, compelling, and realistic virtual worlds (Gee, 2003; Prensky, 2001). More important, it enables users to experience dynamic and multidimensional objects. In other words, game technology could give patrollers an entertaining as well as a meaningful training experience with levee failures without any consequences in the real world.

The Design of LEVEE PATROLLER

LEVEE PATROLLER can be described in game jargon as a "single-player 3-D first-person game." This means the game is solely played by one user from the perspective of the player character. Another term that applies is "simulator." Despite the inclusion of many game elements, it follows reality closely like most simulators. In technological terms, it was implemented using the commercial game engine "Unreal Engine 2." In practice, it can be considered a "total conversion mod" (Postigo, 2007), as all digital assets have been created from scratch and the same can be said of the game-play elements.

Figure 1. A Levee Failure in Wilnis, the Netherlands
Note: This levee breach was caused by the drought in the summer of 2003.

It is not surprising that in the game, the player's role is that of a levee patroller. In the main menu, players have three options. They can do as follows:

a. choose "training" to familiarize themselves with the controls and procedures,
b. start a "complete exercise," in which multiple scenarios with increasing difficulty have to be completed, or
c. start a "single exercise." If the latter is chosen, a scenario generator is presented that allows the player to configure a scenario by choosing a region, the weather, the number and type of failures, and the type of responsibilities (see Figure 2).

The basic purpose of the game is to find every failure and report it. Upon finding a failure, the player has to fill out a report and, depending on the state of the failure, return to the location to see if it has worsened. If not, the central field office should be told that the failure has stabilized. If so, the office should be told that it is worsening and that, depending on the severity, measures need to be taken. The game ends whenever the player has found all failures and either correctly reported that they are stable or has taken the appropriate corrective measures. The game also ends when a player fails to find a critical failure, in which case a levee breach occurs that will flood the whole region.

Figure 2. The Scenario Generator

At the end of a scenario, a score is given from 0 to 100%, which is based on several criteria, such as the number of correctly reported failures and the accuracy with which failures are diagnosed. A scenario is completed sufficiently on two conditions:

a. a player has to achieve a satisfactory score of at least 55%, and
b. no levee breach has occurred.

The second criterion is independent of the eventual score. Therefore, a player with a final score of 90% could still receive an insufficient assessment.

The learning goals of the game focus above all on the recognition of failures and the procedures of levee inspection. The game was designed to be used in workshops during which playing the game is combined with a lecture on levee inspection or in workshops that focus completely on the game. In both types of workshops, we consider the presence of an experienced facilitator important, as only playing the game will not yield an effective transfer of the learning goals (Egenfeldt-Nielsen, 2005).

In workshops combined with a lecture, the facilitator debriefs participants beforehand by explaining a failure type with reference material and pictorial 2-D cross-cuts of levees. Subsequently, participants are assigned to play a scenario involving this failure type to gain some experience. After such a scenario, the facilitator discusses the failure as it appears in the game and relates this to reality. The same procedure is followed for other failure types. However, the regular scenarios were too long for this workshop setup. For this reason, mini scenarios were added to the game, in which participants have to deal directly with one quickly developing failure.

Unlike the combination of workshop and a lecture, for which the single or complete exercise is now only used near the end of the workshop and only if there is enough time left, the other workshop uses these options from the beginning. In these game workshops, the facilitator's role is to assign specific scenarios and semi-structurally debrief each assignment by discussing the results of each participant.

So far, the game has been successfully used in more than 20 of these workshops. It is expected that more workshops will be given in the future and that the game will become an essential part of the training of levee patrollers, including at the water boards that are not currently using the game. For the near future, we are thinking about the idea of letting patrollers continue to play the game at home after a workshop, something they are demanding but have not yet been allowed to do, because the game is still in an early phase of deployment.

The Design Philosophy of LEVEE PATROLLER

Although philosophical issues relating to design have been considered rather limited in the design sciences in general (Love, 2000), it is important to distinguish a "design philosophy" from a "design methodology." The latter is preoccupied with the methods and techniques of design, whereas the former focuses on a deeper understanding of what design is, what it characterizes, and how theory could contribute to design. Such a deeper understanding will eventually lead to better designs, as common ground between practitioners is established. To take a step forward into the scientific practice desired for digital serious games, we have reflected on the underlying design philosophy of LEVEE PATROLLER.

Before we elaborate on this philosophy, it is necessary to explain the difference between serious games and entertainment games. In our view, serious games differ fundamentally from their entertainment counterparts in that the applications have been designed with a specific meaningful purpose in mind. Serious games need to educate players or bring forth valuable insights that go beyond the "magic circle" of the game, whereas entertainment games need to entertain players while they are inside the game world. To put it in economic terms, serious games are about achieving "positive externalities" (Png, 1998, whereas entertainment games are an almost completely internal affair.

This does not mean that entertainment games are meaningless. Games, like other media (McLuhan, 1964), have a profound effect on society at large in, for instance, our attitudes and ways of acting (Beck & Wade, 2004), and can be seen as cultural expressions in their own right (Bogost, 2006; Jones, 2008). Players of these games will also definitely learn something, whether hand-eye coordination skills, visual-spatial skills, or an idea of how ancient Rome may have looked (Gee, 2003. However, all of these potentially meaningful effects beyond the game experience were not intended by the developers. Their main objective was to make an enjoyable, engaging, and challenging experience. In other words, they aimed to make the game fun (Koster, 2005). All the other achievements are unintentional side effects.

From the above, we can conclude two important and interrelated notions that are relevant to our design philosophy. First, for entertainment games, everything should serve to make the game entertaining. For serious games, on the other hand, the game should be entertaining as well as meaningful and valid. In game theory, engineering, and the social sciences, this contrast between entertainment and serious games can be seen as a single-objective problem versus a multiobjective problem (Deb, 2001). Single-objective problems always have a single optimal solution, whereas this does not exist for multiobjective problems. For multiobjective problems, a "Pareto Optimum" has to be found. This is a solution whereby at least one objective is better off without making any other objectives worse off. To find these solutions, designers have to make trade-offs between these frequently conflicting objectives.

Making these trade-offs is a difficult task, not only due to the conflicting objectives but also because it is necessary to take the constraint of harmony into account, an essential characteristic of good games according to game designer Brian Moriarty (Salen & Zimmerman, 2004). Games are systems, and without harmony, which stresses that elements of the system need to be in balance, the game becomes frustrating, unchallenging, and ultimately no fun to play. Although in practice entertainment game designers also need to face several trade-offs to balance their games (Rollings & Morris, 2004), the point we wish to emphasize is that this balancing process is more difficult and important for serious game designers. The latter have to take into account a variety of interests of equal importance, whereas entertainment game designers simply have to focus on one specific issue of whether it makes the game fun or not.

The second important notion is about how a game relates to reality. Although many entertainment games, like SIM CITY 4 (2003) or CIVILIZATION III (2001), correspond to meaningful topics, such as spatial planning and history, respectively, their designers created them with the goal of developing a fun—but not a valid—game about a serious topic. As such, the connection of these games to reality is lost or at least arbitrary (Shaffer, 2006). They can still be useful for learning to think about certain aspects in reality as some studies have shown (Adams, 1998; Squire, 2004). However, because the aspects are not appropriately embedded, it would be difficult for an effective transfer from a game to reality to occur. For this to happen, the game should have been built around teaching players to think in a way to solve problems in reality, not in the game. Shaffer (2006) refers to this as having the right type of "epistemic frame" and continues to explain why, in fact, a different design philosophy is needed:

> [T]he focus of a game matters in the end, and in the most extreme cases, commercial games can give dangerously inaccurate portrayals of the way things work in the real world. (p. 177)

Of course, serious game designers run the risk of creating a “dangerously inaccurate portrayal” as well. If this happens, players may deal with situations in the real world incorrectly, which could have enormous consequences if they concern business decisions or crises. Nevertheless, the initial intention of serious game designers and the resulting process of game design are aimed at preventing this from happening by emphasizing the importance of meaning and reality. This is what distinguishes serious games from entertainment games from a design philosophical point of view.

The Play, Meaning, and Reality Components

During the design of LEVEE PATROLLER, we concluded that the multiobjective problem set could be defined along a design space of three core components: (a) Play, (b) Meaning, and (c) Reality (see Figure 3). The term *design space* is used as introduced by Simon (1969), who gave a cognitive science account of design, involving a search in a space (Moran & Carroll, 1996). It could be defined as a “problem space + solution space + design process.” This means that the design process binds a design problem, selected from a world of possibly related problems, to its solution, selected from a world of possible designs (Krishnamurti, 2006). The design space thus involves an imaginary place from where the design is created from. For serious games, this place evolves along the lines of the three previously mentioned core components.

The first component, Play, represents the world associated with digital games. This world consists of the technology behind games, such as artificial intelligence and computer graphics; the criteria for developing good games, such as engagement, fun, and immersion; and game elements, such as rules, challenges, competition, and scores. Moreover, this component is grounded in fields such as computer science, human–computer interaction, and of course game design. Basically, the Play component is the most important to entertainment game designers.

Meaning, the second component, represents another world. This component incorporates aspects such as communication, learning, and opinion. It is related to the learning sciences, psychology, and semiotics. The theories derived from these sciences can be used to guarantee that knowledge is acquired or a specific message is received, instead of clicked away to continue playing, as occurs in many poorly designed serious games (Egenfeldt-Nielsen, 2005). For example, criteria for this component concern reflection, transfer, and relevance.

Finally, the third component, Reality, represents the real world and its model representation in a game. It is grounded in the disciplines related to the subject matter. For LEVEE PATROLLER, this consists of soil engineering, water management, and levee

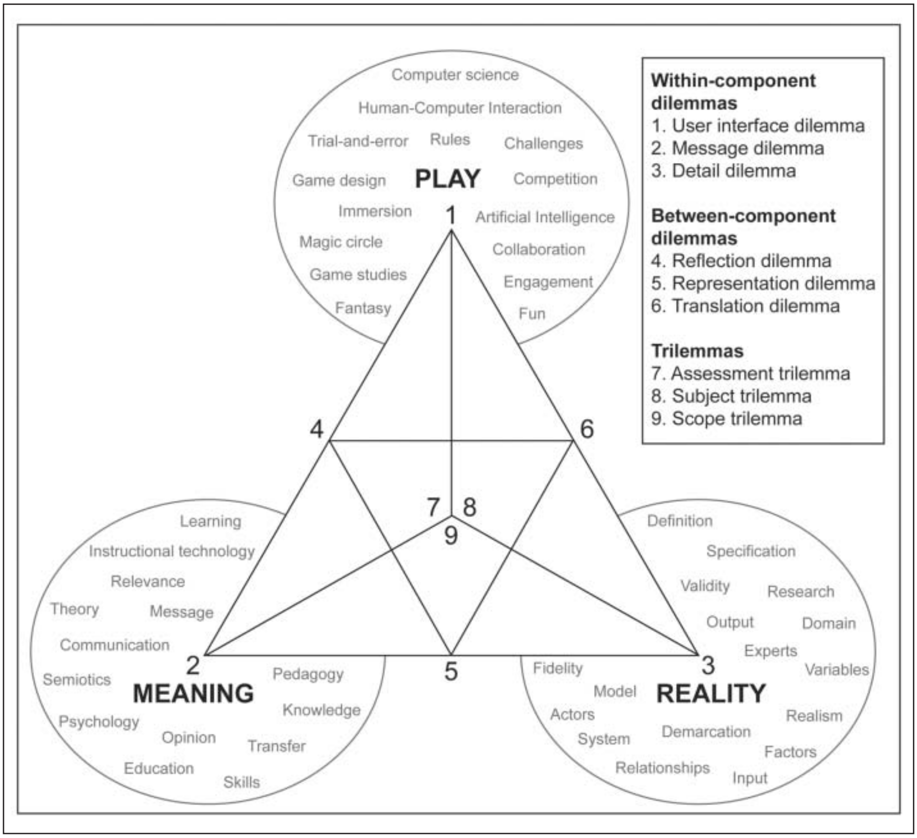

Figure 3. The Design Philosophy and the Various Tensions

inspection, whereas for VIRTUAL U (2003), this is management, public policy, and higher education. Further aspects of this world relate to the determinations of the subject, such as factors, variables, definitions, and so forth. The criteria of this component include fidelity, realism, and validity.

In our experience, all three components are equally important in designing a digital serious game. Such a game should be fun and engaging, but this should not occur to the exclusion of the message and the validity. Learning by playing does not occur automatically. It needs to be carefully considered. Similarly, attention is required to think about how reality is translated into a game. If not, a game is created that nobody wants to play, which does not achieve the positive externalities it was designed for and/or may disseminate information that is useless or even harmful in practice.

Besides the realization of the existence of the three equally important core components, we also experienced that several tensions exist within and between the three components during the design of LEVEE PATROLLER. The tensions can be categorized as follows (also see Figure 3):

- *Within-component dilemmas*: In some cases, a situation may arise in which the designer is confronted with a dilemma, a choice between two alternatives that seem equally desirable or undesirable, which is restricted to one of the components. The user interface, message, and detail dilemma are examples of a within-component dilemma of the Play, Meaning, and Reality components, respectively.
- *Between-component dilemmas*: In other cases, a dilemma may arise between two components. Such tensions are a result of the different worlds of each component. This causes each component to have a different *Weltanschauung*, a certain perspective, on how to accomplish a good serious game. When two of these Weltanschauungs conflict, between-component dilemmas emerge, like the reflection, representation, and translation dilemma.
- *Trilemmas*: If a designer faces a tense situation in which all three components play a significant role, we speak of a "trilemma." The next section discusses the assessment, subject, and scope trilemma, to illustrate this category.

The tensions between the components mentioned above do not mean these components can never be united. Actually, at times, they can even reinforce each other. Another point to be made is that while some of the tensions are restricted to two or even one component, the other components cannot be neglected. Ultimately, the game has to be a consistent and coherent whole. Every component is therefore somehow involved in each type of tension. The final point to be made is that the way the components and their tensions are considered is dependent on the project. Games that aim for training in operational procedures, like LEVEE PATROLLER, require a high degree of realism due to the importance of specific actions, while other serious games use metaphors or fantasy settings. This does not mean that these latter games completely neglect the reality component; they have simply traded off realism, one of the many criteria, for other objectives.

Solving Design Dilemmas and Trilemmas

In this section, we discuss nine examples of various tensions from the development of LEVEE PATROLLER to illustrate the design philosophy. These examples are illustrative for two more reasons. First, we had to deal with far more tensions during the project. In fact, we believe that game design involves a large degree of "solving dilemmas and trilemmas." Second, these tensions could be exemplary as message, reflection, and translation dilemmas can be considered stereotypical types of tensions that may occur in almost any serious game-related project.

1. The User Interface Dilemma

To play and enjoy a game, a user must master the controls. The more complex the controls are, the steeper the learning curve becomes, and the less likely that every user may enjoy the game. On the other hand, a simplification of the controls limits the gameplay possibilities and may result in frustration. With two buttons, fewer fighting combos become possible than with four, and using the keyboard only would be annoying in a 3-D environment, because it would not be possible to examine every angle easily. This within-component dilemma between usability and gameplay is what we call "the user interface dilemma."

For LEVEE PATROLLER, the most obvious controls would have been to use the mouse and keyboard, because we decided to create a 3-D first-person game. In these types of games, the mouse is used to look (and aim) and the keyboard to move. We liked this configuration, as looking around is an important task for a levee patroller and walking is obviously necessary to explore a region.

Unfortunately, this configuration is difficult to master for those who did not grow up with digital games, since it requires the ability to use the mouse and keyboard at the same time (Prensky, 2001). As an alternative to the combination of keyboard and mouse, the keyboard or the mouse could be used individually, but this would restrict and frustrate the gameplay. Another alternative would be to use a joystick. Although this certainly simplifies the interface, it still requires its user to perform parallel tasks. Otherwise, the same disadvantages would apply as with the mouse or keyboard on their own. Furthermore, using a joystick would require an extra purchase by the users, and possible interface problems may arise because joysticks are not standard PC equipment.

A test with the mouse and keyboard showed that, although levee patrollers had trouble mastering the controls, they did persevere, and more importantly, they enjoyed it. This led us to decide to choose gameplay over usability within the world of Play. With a keyboard and mouse, the game experience could be enriched, but at the expense of having a steep learning curve.

2. The Message Dilemma

In determining the message of a serious game, it may turn out that it has multiple learning goals. If these goals are incongruent with how the message is transferred to the player, designers face a within-component dilemma between the conflicting learning goals. This "message dilemma" forces a designer to prioritize the goals, since in the end, it is necessary to create a single experience:

Note: The pictures depict a failure called "sand boils" in-game and as 2-D cross-cut, respectively. The failure is caused by the creation of a pipe underneath a levee. This cannot be seen in the game. Only signals on the outer side can be seen, like water and soil outflow.

An example from LEVEE PATROLLER may clarify this dilemma. To transfer the procedural skills, it is best to stay as close as possible to the perspective of the patrollers themselves. To educate the user about the behavior of levees, on the other hand, it would be better to centralize the levees and not the patroller. A levee patroller only sees the outer side of the levee and not the inside, which means the emphasis on procedural skills leads to only seeing the tip of the iceberg (see Figure 4). Centralizing the levees, however, is difficult to reconcile with teaching about procedural skills.

We eventually decided to emphasize procedural skills. To balance our choice, players need to diagnose the failure of a levee. To make a correct diagnosis, players can access a handbook from their inventory, which describes the signals and failures textually and visually with 2-D cross-cuts (see Figure 4). Furthermore, as explained earlier, the game is designed for use within a workshop in which instructors explain failures more thoroughly.

3. The Detail Dilemma

Today's digital game worlds can look quite realistic. It is, however, unclear how detailed the environment needs to be. On one hand, detail ensures the recognition of objects. On the other hand, a surplus of detail may actually distance players from the objects or discourage them from relating the virtual objects to what they resemble in reality. Cartoons work well because the nonrealistic characters enable its readers to project themselves or others onto it (McCloud, 1993). However, at the same time, if an important element is missing, a user may dismiss the experience as invalid. We experienced the latter in one of the test runs. Patrollers indicated that the proper embankments—a critical detail, according to them—were missing along the levees.

The amount of detail necessary corresponds closely to the criteria of fidelity, realism, and validity. Players have to perceive the experience as real, and the represented objects need to resemble the real ones structurally as well as process-wise (Peters, Vissers, & Heijne, 1998). In dealing with this, a tension arises between adding and omitting detail. The way we solved this "detail dilemma" within the Reality component was by working closely with experts and levee patrollers. Using their comments and suggestions, we were able to achieve a certain balance. Furthermore, we applied the trick of making certain objects detailed and others not, to create an illusion of realism (see Figure 5).

4. The Reflection Dilemma

Games should immerse the players in their world (Murray, 1997). If this happens, players forget the real world and focus on the world that is unraveling on the screen in front of them. Although a desirable quality in a game, immersion may detract from the potential meaning, as it hinders reflection on the experience. Reflection is a critical aspect of the learning process (Egenfeldt-Nielsen, 2005; Kolb, 1984), and designers therefore have to consider how they could enhance this in their games.

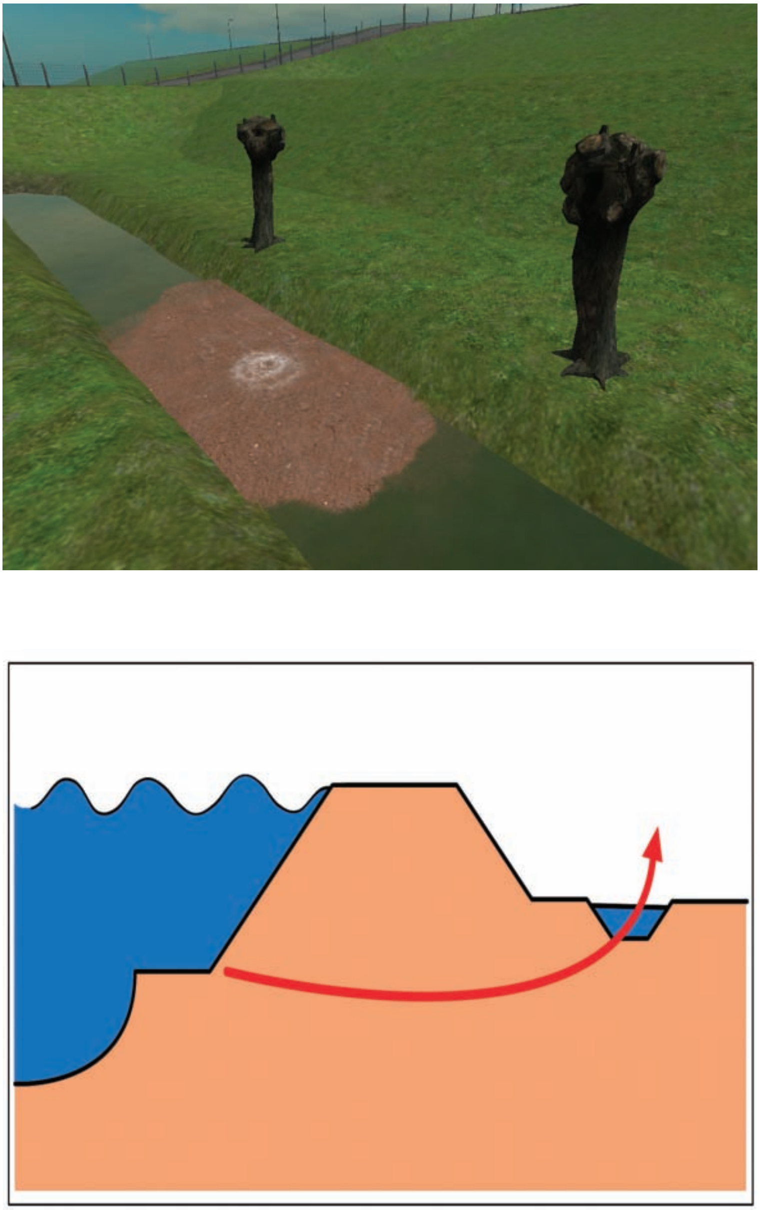

Figure 4. Reconciling the Message Issue

Figure 5. Detailed Objects Mixed With Plain Objects

Reflection-on-action (Schön, 1983), deliberation after the action, can be achieved through a thorough debriefing. Reflection-in-action, deliberation during the action, is more difficult to establish, and apart from being difficult, it is also questionable whether it is desirable. To be able to reflect, the flow of the game has to be interrupted, and this affects the game experience negatively (Sweetser & Wyeth, 2005). So again, we faced a dilemma but this time between two components: between the Play component that aims for an immersive experience and the Meaning component that aims for a reflective experience.

Eventually, we chose to prioritize the Meaning over the Play component. We tried to create reflection-in-action in two ways:

a. by pausing the game whenever a player enters a menu, and
b. by asking about the severity of the failure.

By integrating the latter step subtly into the conversation between the player and the field office, we minimized the disruption to immersion.

5. The Representation Dilemma

To improve understanding but also to simplify processes, games make frequently use of powerful metaphors, such as the "medikit." This is an object that can be picked up to improve the player's health. Although potentially powerful, players need to understand these representations and be aware of their restrictions. Otherwise, the metaphorical representations will be ineffective when the time comes to apply the acquired insights in the real word. On the other hand, sticking closely to reality, the game may become restrictive, annoying, and less versatile. This dilemma between the Meaning and Reality components forms the "representation dilemma."

To avoid making the inspection too easy, we developed landscapes for LEVEE PATROLLER that would be comparable to a region of 200 × 200 meters. This is far less than the areas levee patrollers normally have to patrol, but even using this limited area, it takes approximately 10 minutes to inspect every levee in these virtual regions. As we wanted players to return to failure locations to see if they have worsened, players would thus spend a large part of their time walking. Besides being tedious, it constitutes a waste of precious time—time that could be used to educate the player.

One solution would be to implement a much used game functionality derived from the "Star Trek" series: teleportation. Many on the development team had trouble envisioning this, because it seemed awkward to use a science fiction method within a realistic game. Solutions were sought to create a more believable way of transportation, like making it possible for a player to get into a bus or use a bicycle. In the end, we decided to keep it simple and choose the Meaning component over the Reality component. After finding a failure, the player has to mark the location by putting a marker into the ground. Later, the player can teleport to the marked failure by accessing a map and clicking on a "mini-marker" that represents the failure.

6. The Translation Dilemma

Quite often, it is difficult to translate reality to a game environment, because a game ought to be a coherent and consistent whole, whereas reality is the opposite. For instance, many clients have differences, even internally, and this means that designers will frequently face a "translation dilemma" about what to incorporate into the game. Through prioritizing the Play component by standardizing everything, the game may lose its connection to reality and clients would not feel affiliated with it, which would render the game useless. By prioritizing the Reality component, meanwhile, the game becomes a game that nobody is able to play.

For LEVEE PATROLLER, the clients are the Dutch water boards. From the beginning, we decided to involve only 6 of the total of 26 water boards, as too many stakeholders would undoubtedly slow down the design process. After an interview round, we quickly discovered it was not going to be easy to come up with a universally acceptable game for the following two reasons:

- *Regional differences*: Each water board has its regional specifics (e.g., differences in the types of levees and potential failures).
- *Organizational differences*: Each water board organizes the inspection of levees differently, particularly in the way responsibilities are given to levee patrollers.

To overcome this between-component dilemma, we built in some flexibility with the scenario generator (see Figure 2) and created fictitious landscapes that contain a mix of several landscapes. Nonetheless, it was impossible to escape from standardization. The game's procedures cannot be adjusted, for example. Therefore, we tended to pick the Play over the Reality component.

7. The Assessment Trilemma

Every serious game designer will face the problem of implementing an assessment. It is difficult to decide how to determine the performance of a player, especially on aspects from reality that are hard to quantify, and to make this performance visible in a transparent yet motivating way. Assessment is unrealistic by nature, since it is always subjective and controversial but highly relevant to reflecting on the game experience. From a Play perspective, scores need to be straightforward and somewhat ludicrous to motivate the players. A score of 10 points is simply not as impressive as one of 10,000 points, while the first is much easier to trace than the second. Taken together, an "assessment trilemma" emerges between all three components.

For LEVEE PATROLLER, we first decided to somehow arbitrarily decompose levee inspection into indicators and assign scores to these. We quickly discovered that the scoring system would become too complicated compared to most games, but sticking to a more straightforward system would make it less transparent and incomplete. To incorporate the Play component, we implemented a system in which points were visibly multiplied with a certain weight and aggregated to a single score. The reason for implementing the multiplications was to be able to prioritize certain criteria above others for the aggregated score. This aggregated score is a conversion of the total number of points to a percentage. The choice for a percentage was made, as a score of 90% sounds more impressive and conclusive than one of 90 points.

To increase the transparency and the motivation still further, we made it possible to access the scores at any time and included a comparison between the points achieved and the total number possible for each indicator. At first, we were convinced that the player should not know the number of failures at the start of a scenario. It would go against the Reality component to inform the player that, for example, five failures are located somewhere and that these have to be found. Besides this, we thought it would be exciting to explore a region without anticipations. We were wrong. After some tests, we noticed that players lost interest in inspecting, because they did not know if they had found every failure. The eventual scoring system did not make the game much more realistic; it did become much more exciting and insightful instead.

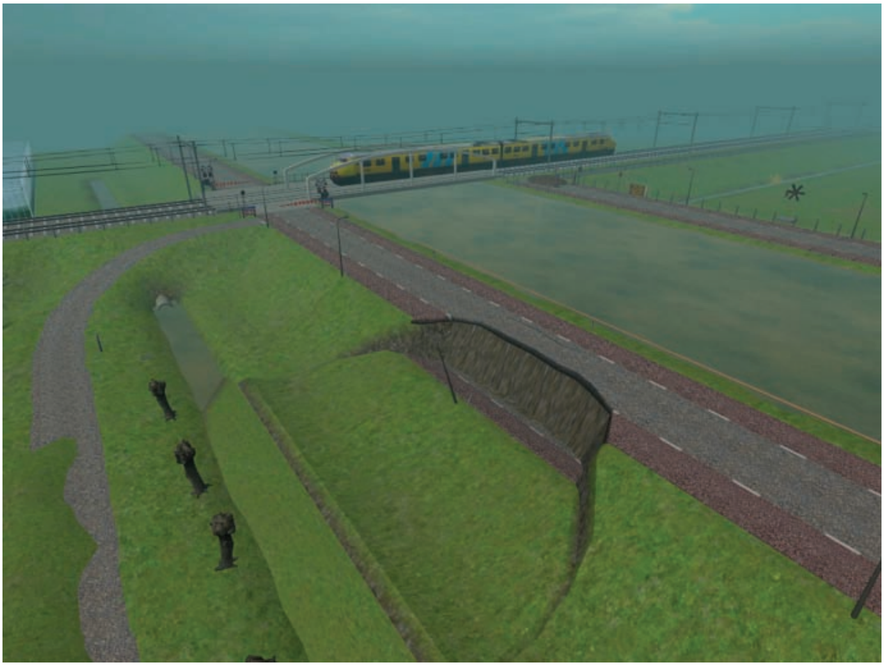

Figure 6. An Example of a Levee Failure

8. The Subject Trilemma

The story of VIRTUAL LEADER (2007) shows that it can be quite a problem to implement the subject of a game (Aldrich, 2004). The tension may differ for each project, but for LEVEE PATROLLER, it concerned a trilemma around the main subject of the game: the levee failures (see Figure 6. From a Play perspective, uncertainty is a key in this. By not knowing where and when a failure will appear, the experience becomes exciting and replayable. Another requirement of this component is that the failures should follow a generic model. Otherwise, failures cannot appear at any location. More important, without a generic model, it would become difficult to link the failures to other game elements, such as scores and game phases.

Reality, however, is messy. Failures are hard to categorize, in particular because multiple failures types commonly happen at the same time. In addition, failure types are so diverse that it becomes almost impossible to randomize failures. In fact, this is undesirable in any case, since some failure types only occur at certain locations and those types that can occur at different locations vary in how they develop at each location. As for the phases of a failure, these differ enormously. Some never lead to a levee breach. What makes things worse is that failures are surrounded with ambiguity. Little information exists and experts disagree on many aspects. All of this makes it undesirable to create a dynamic image of a failure that fits a generic model.

The need for randomness is to some extent congruent with the Meaning component. To make sure that players would learn from the game instead of learning how to play the game, failures should be placed randomly. If a player knows that a failure will occur at a particular location, a player will simply remember that location and its solution and apply this. However, the message needs to remain meaningful, which means that randomization should be somewhat limited and exceptions should be made from the generic model. If not, the learning content would be oversimplified and the insights acquired would be of limited use. From this perspective, it was also desirable to allow players to experience each phase of a failure to ensure the creation of a mental model of the development of a failure (whereas in reality, preventive measures can be taken in the initial phases of a failure). Finally, the provision of a clear message about the failures was needed to ensure that the learning content is comprehensible.

Finally, we decided to incorporate randomness, but with some of the restrictions of the Reality component in mind. In practice, this means failure types can occur at 4 to 8 different locations out of 28 within a region. It must be emphasized that the decision was also made to not include every type of failure in every region. For the other decisions, we disregarded Reality more or less. We chose to fit all failures into a generic model with some exceptions, only allowed players to take measures in a critical situation, and simplified the failures to provide a clear message to the player.

9. The Scope Trilemma

In addition to how the subject itself is represented, the delineation of aspects related to the subject pose a tension that may also result in a trilemma. In choosing the scope, it should be kept in mind from a Play perspective that it needs to have an added value for gameplay. Take, for example, the measuring of the symptoms of a levee failure, such as the length, width, and depth of a crack. Apart from the question of whether the game world is able to produce sensible measurement results, measuring is a tedious process that slows down the flow of the game, especially if it needs to be done frequently. From this perspective, it would be better to leave it out and focus on more interesting gameplay elements.

The water boards and experts thought differently here. They explicitly wanted a system in which it was possible to make exact measurements. Measurements are important, as they indicate the severity of a failure, and for this reason, measuring constitutes a relevant part of the inspection process. In addition to this, patrollers all too often make rough estimates of signals, and this is a practice that is discouraged by the use of water boards.

The meaning component also had a bearing on this. On one hand, it would be good to make players aware of the role of measuring. On the other hand, it would be unnecessary to enable players to measure in the game. This would have no added value in terms of learning. A possible suggestion from this take was to retrieve measuring information automatically when a player is close to a signal. This, however, is not a

Figure 7. Information About the Height and Distance Between Two Markers

solution that the famous game designer Sid Meier would consider an "interesting choice" (Costikyan, 1994).

We solved this trilemma with an unrealistic system to make the measuring visible in a game-like sense while ensuring that the focus would not be on the details of the measurements. This balanced compromise between each component was reached by enabling players to put two markers into the ground to retrieve information about the distance and height between them (see Figure 7). Although some measurements remain impossible to accomplish, such as measuring the depth of a crack, and even though we had to implement some tricks to make the measurement results sensible, the system enables players to measure interactively. To de-emphasize the measurement details, players can choose in the reports between large ranges of options to indicate the distance and height.

Conclusion

We have described a novel design philosophy for digital serious games. This philosophy was derived from the design and development of LEVEE PATROLLER, a game conceived and developed in the Netherlands for the instruction of levee patrollers, a professional group that plays a crucial role in national security. It asserts as follows:

a. That the design of a digital serious game poses a multiobjective problem in a design space involving three equally important components, each with its own Weltanschauung and a set of criteria:
    1. Play (e.g., engagement, fun, immersion),
    2. Meaning (e.g., reflection, relevance, transfer), and
    3. Reality (e.g., fidelity, realism, validity); and
b. that it is fundamental to balance these three components.

Furthermore, we observed in designing LEVEE PATROLLER that creating a well-balanced digital serious game is difficult, since various tensions between the three components will arise during the development of the game. These tensions can be categorized into design dilemmas within and between components, and design trilemmas, in which all three components play a significant role. We illustrated the tensions by discussing each with one or more examples from the game's development. In other serious game projects, similar or different tensions may appear. By using the design philosophy outlined above, it becomes possible to understand why and what kind of tensions have emerged. The subsequent understanding may help designers to develop a better game.

Although the design philosophy discussed may already be useful for current and prospective designers, further research is needed to validate and extend it. It is, for instance, necessary to understand to what extent the philosophy can be applied to other types of games, how it relates and sheds light on other game design theories such as the game design patterns (Björk & Holopainen, 2005; Falstein, 2002), and what criteria play a role in each component. As for LEVEE PATROLLER itself, research efforts are currently being made into the effectiveness of this application, as well as efforts to improve the game in conceptual and technical terms.

Authors' Note

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Note

1. HAZMAT: HOTZONE (2006) and TACTICAL IRAQI (2006) were developed at Carnegie Mellon University and the University of Southern California, respectively. Several universities (e.g., Stanford University, University of Kansas, and University of Pennsylvania) were involved in developing VIRTUAL U (2003).

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