Futura: Designing Multi-Touch Tabletop Games for Sustainability

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ABSTRACT

Designing learning games is a complex task that requires collaboration between a number of different types of experts, including knowledge of game design, learning theory, child development, and the specific domain or subject matter of the game. In this paper we discuss the design process for *Futura*, a multi-touch tabletop game intended to support children, between 9 and 12 years of age, to learn about the complexity of sustainable development and land use planning We present a case study of our design process, and discuss design lessons learned through our interdisciplinary collaboration.

KEYWORDS: Games and Learning, Multi-touch Tabletops, Sustainability, Design.

INDEX TERMS: D.2.2 [Software Engineering]: Design Tools and Techniques; K.3.1 [Computers and Education]: Computer Uses in Education; K.6.1 [Management of Computing and Information Systems]: Project and People Management

1. INTRODUCTION

Figure 1 – *Futura: The Sustainable Futures Game*

The rise of Game Studies as a discipline has been paralleled by an increased interest in games for learning and education [1]. Educational games, if done well, promise to couple the intrinsic appeal of strategic play with a learning process: good games – both educational games and commercial "fun" games – leverage ludic engagement into cognitive and emotional engagement with their subject matter [2]. A number of factors must align in order for a game to accomplish this goal: it must present material with a structure and form that supports desired learning outcomes, it must accurately represent its subject domain, and it must be intrinsically fun to play. Often designers of educational games only manage two of these three elements, creating games that are fun, but inaccurate, or games which are pedagogically sound, but boring. The crucial challenge of developing effective educational games is to incorporate each of these components. From a design standpoint, this is an interdisciplinary challenge, requiring specialists with a broad range of expertise. In this paper we present a case study of the design of *Futura*, an educational game intended for children between 9 and 12 years of age, designed to engage the game players in the task of planning for sustainable development [Figure 1]. We discuss how we composed our design team and the preliminary design lessons learned from our collaborative process.

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2. INTERDISCIPLINARY EXPERTISE

We contend that designing an effective educational game requires at least three high-level overlapping areas of expertise. Crucially, these three specialties should be in dialogue with each other throughout the design process. Coordinating these three high-level design perspectives is essential to the creation of a successful educational game.

- **Pedagogical Design and Learning Theory:** There must be some expertise in learning theory, pedagogy and child development, in order to make certain the different aspects of the game are appropriate to the capabilities of the intended audience.
- **Domain Specific Content:** There must be some expertise in the specific subject domain around which the game's learning outcomes are structured, in order to make certain that the game does not inadvertently misinform the players or misrepresent the subject matter.
- **Game Design:** There must be some expertise in game design, in order to make certain that the game is intrinsically pleasurable to play. It should be noted that this final area of expertise is *not* about the technical skills needed for the development of software, but instead about the dynamics of systems of play including: player motivation, rewards, reinforcement schedules, and feedback.

To design *Futura* we assembled an interdisciplinary team of researchers and designers. Our core team consisted of two game designers, a child-centred design specialist, two education specialists, a user interface designer, an artist and UI designer, and a programmer. The leader of our research group had a background in sustainable development, and we also enlisted a second sustainability expert to provide an additional perspective on the content domain. Sustainable development lends itself to a multitouch tabletop interaction. It is an inherently spatial domain, and is a collaborative/stakeholder driven venture that requires real time decision making as a group.

2.1. Design vs. Implementation

The three areas of expertise listed above are what we consider to be "design" level skills. These are necessary to direct the overall structure of the project, however there are additional essential specializations – primarily to do with implementation, such as programming, asset creation, and interface design – which are necessary for the creation of any learning game. For a multitouch tabletop game, additional expertise in camera vision and hardware construction is also necessary. We were fortunate enough to have a core team of experts who also possessed many of the implementation-level skill sets needed to take the game from the conceptual stage to a working design. Our game design team also had experience in music composition and asset creation, our UI designers and programmers were experienced in the construction of multi-touch tables, and our artist was experienced in programming. The result of these shared areas of expertise was that (high-level) design information and (low-level) implementation information often overlapped within the same individual.

3. DESIGNING *FUTURA*

Figure 2 – Interacting with *Futura*

Figure 3 – The *Futura* Game Screen

Our design and implementation process took place over a four month period, from concept to prototype. Our initial mandate for the design was to create an educational application for a multi touch tabletop that would engage children of a specific age range. The application we designed, *Futura*, is a three player collaborative simulation game intended to teach children about the challenges and issues surrounding sustainable development. The goal of the game is to provide facilities for a continually growing population, without destroying the environment in the process. Each player is responsible for one of three human needs: food production, shelter, and power generation. Players must learn how to coordinate their play and communicate with each other if they want to succeed at the game as well as understand the impact of their individual choices on the simulated environment. To interact with the system, players use their fingers to drag "facilities" off a bar at the edge of the table they are standing at, and place them on the world map (Figures 2 & 3). Facilities cost money, which slowly replenishes over time. Each facility supports a certain number of people, and causes a certain amount of environmental damage. Players must learn how to balance these two elements to win the game.

3.1. Pedagogical Challenges

We identified 9 to 12 year olds as the age group that we most wanted the game to appeal to. From a learning theory standpoint there were several core challenges that we grappled with. In order to keep the interface age appropriate we needed to develop a set of easily learned interface metaphors that communicated complex game simulation details with a simple and coherent system of icons. However, an overly simple interface ran the risk of not providing players with enough information to understand the complex relationship between their actions and the systemic consequences within the simulation. It was also important to provide players with the ability to dig deeper into in-game didactic information about sustainability, without taking them out of the game, or interfering with the experience of the other players. Our goal with the game was to not just expose the players to this information but to allow them to use it actively in a simplified version of the real life process of land use and development planning. This provides players with opportunities to learn how complex the situation is and to reflect about what went wrong and right as they replay the game.

3.1.1. Interface Metaphors

We used a simple color-coding system and several repeated icons to communicate the core interface information. It was important that we communicate "local" feedback to each individual player about her personal performance and contribution, while also communicating global information about the state of the world, which is an aggregate of all three players' contributions.

Figure 4 – Global Environmental Status Feedback

Figure 5 – Local Environmental Status Feedback

Figure 4 shows the global feedback mechanism: an anthropomorphic tree which changes color and facial expression to reflect three levels of environmental damage. Figure 5 shows the three local feedback icons, a tree used to show each player what her individual contribution is.

Figure 6 – The three game map environment states

We reinforced the global feedback by changing the color picture of the world map (see Figure 6) along these same lines, and by changing the background music as the environment changed conditions.

3.1.2. Didactic materials

To provide players with information about the game elements and to allow them an opportunity to dig deeper into issues surrounding sustainability, we created "info cards" for each facility and for each player role. These cards provide players with a combination of game-play information and information about the environmental impact of the facility in use. (Figure 7)

Figure 7 – An example of a Facility Info Card

To access the info cards, players hold their finger down on the associated facility on the info bar. This interaction had the benefit of providing players with feedback that the system had recognized their touch. The player role info cards provide broad information about the importance of their role in society, and about their game goals. These are accessed by holding a finger down on each player's role icon (Figure 8).

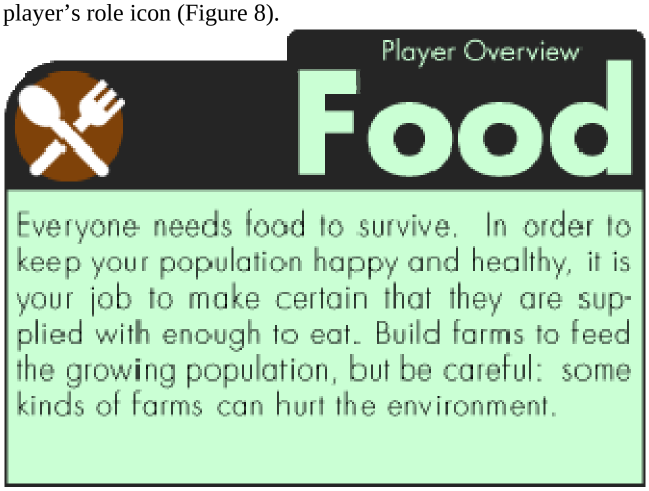

Figure 8 – The Role Info Card for Food Production

3.1.3. Events and end game states

The final important piece of information that was crucial to communicate to our players was the final outcome of the game, the role that their choices played in this outcome. To do this we implemented two different feedback systems: in-game events, and an end-game summary.

As players interact with the game the state of the world and the population are in flux. Periodically, the system samples the state of the simulated world, and presents the players with an event that represents a consequence of their choices in the game. These events might be positive or negative, depending on how players have been performing in the game. (Figures 9 & 10)

Figure 9 - An example of a negative event.

Figure 10 - An example of a positive event.

Upon completion of the game, players are presented with a summary screen that evaluates their contributions to the final world state, and provides feedback about how well they performed. (Figure 11) Possible end-game states include:

- Very Polluted, Unsupported Population (worst outcome)
- Very Polluted, Supported Population (common bad outcome – see Figure 11)
- Moderately Polluted, Supported Population (common better outcome)
- Moderately Polluted, Unsupported Population (uncommon better outcome)

- Unpolluted, Unsupported Population (uncommon bad outcome)
- Unpolluted, Supported Population (best outcome)

Figure 11 - A sample of a *Futura* end-game screen

The short duration of the game supports multiple consecutive playings, which allows players to encounter a range of events and outcomes as they play.

3.2. Domain Specific Challenges

Sustainable development is a complex challenge, and sustainable choices are not always obvious or clear-cut. We wanted to preserve the complexity of this domain, but we also needed to make it accessible to children. We enlisted a sustainability expert to evaluate our game design and help eliminate misinformation, or potentially misleading game mechanics. We collaborated with her to devise a list of facilities and roles that reflected the complexity of development options in the world, but which would be understandable for children. She also researched and prepared a master document of didactic material and details about each of the facilities and roles, so that we had an accurate starting point from which to develop our info cards.

One challenge that arose that was particular to this domain was how to communicate the persistence of both good and bad choices to players over time. For example, when a player builds a Fossil Fuels facility, it generates a set amount of pollution in the moment. However, as the game continues, that facility continues to generate new pollution. Thus, a small number of bad choices can easily aggregate to a significant environmental threat, even after the player has started making better choices. Learning to understand long-term consequences is an important learning outcome for this system, however finding simple ways to represent these within the game remains a significant design challenge.

3.3. Encoding a Pedagogical Message in Game Mechanics

It was important to us that the game be fun to play, and challenging, but also that the learning be necessary in order for players to succeed. We did not want to develop a game where the learning only occurred in breaks from play, while reading the info cards. Drawing on Rieber's work in blending microworlds, simulations, and games [3] we established a set of high-level design goals:

Winning = Learning Outcomes Achieved: This was the central mantra of the game design team. Our goal was to balance the mechanics of the game in such a way that it was only possible to win by understanding the impact of different development choices on the environment. To do this, we needed to make the game challenging, without making it frustrating. This brings us to our next goal:

Losing = Learning Outcomes Advanced: The game is currently paced so that it completes within about 5 minutes of play. This allows players to play and lose multiple times, while observing the impact of different choices and decisions, but by keeping the time investment short, we hoped to reduce the attachment to the outcome that comes from deep sustained play. Instead, we designed the game to foster a trial and error approach that rewarded experimentation. It is also important to communicate to players the difficulties inherent in sustainable development, and the hard choices that developers are often faced with. Often players are forced to choose between a few cheap power plants, with high output and high pollution, versus a single expensive solar panel that only barely meets the needs of the population.

Cooperation and Communication are required for success: To accomplish this we balanced the game so that any one player had the ability to cause the whole group to lose. This meant that learners who had mastered one aspect of the system had incentive to talk to other learners in order to win. By encouraging the players to explain their learning to each-other we provided them with an opportunity to reinforce that learning. To help with this, we designed the game so that there is no hidden information between the players; at any point any player can see how the other players are doing, and how it is affecting the world. It is also possible for players to reach across the table and interact with each other's interfaces, which creates opportunities for negotiation that we see as central to this learning process.

4. Conclusions and Future Work

Futura was exhibited at an Olympic venue during the 2010 winter games in Vancouver. We gathered observational and survey data from over 80 international participants of all ages. While there is much analysis that needs to be done to make sense of this data, our initial observations are encouraging, and indicate that we are on the right track. Our next steps involve resolving some technical issues with the tabletop, and revisiting the UI in order to best communicate the persistent nature of each player's choices. We also have plans for an evaluation of the game as a learning tool, within a classroom and museum setting

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