Augmented Board Games - Enhancing board games with electronics

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ABSTRACT
This paper examines Augmented Board Games, the result of using computational power to extend functionality and gameplay in board games. Experimental interaction design has been used as the primary research method, through the use of numerous models and design tools, including social and functional roles, game design patterns, and task analysis. The paper is concluded with descriptions of concepts and prototypes as well as novel game design possibilities within the design space of augmented board games.

Keywords
board games, game design, ubiquitous computing

INTRODUCTION
The increasing maturity of technologies such as wireless networks, micro processors, and sensors, open up new possibilities for board game design. Early examples include electronic chess boards, *Stop Thief*, and *Dark Tower* while the release of *King Arthur* in 2003 shows a continued interest from commercial companies. This new game type, which we refer to as *augmented board games*, is also interesting to research since it offers to expand the understanding of gameplay design and can provide knowledge about how technology and games can be combined in other forms than found in traditional computer games.

We have chosen to explore this genre with a focus on gameplay while taking into consideration the possibilities and limitations put on game design by technology and the social environment in which the games are played. To focus our research we stated three gameplay aspects as prime research interests: minimizing gameplay activities that are not perceived as empowering or emotionally captivating for players; providing game mechanics that without technology would have been impossible, required an umpire, or ruined gameplay due to the effort required by the players; and supporting at least the same level of social environment as non-augmented board games. Further, we decide to not explicitly explore the use of technology for providing purely esthetical augmentation but to note when this became possible as a side effect of gameplay augmentation.

RELATED WORK
As the first step in exploring the design space of augmented board games we studied what games had been created in other research projects. Scanning the fields of game research, interaction

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design, and ubiquitous computing the majority of examples found where heavily focused towards technology exploration, with the game primarily used as a vehicle to showcase the technology in use. Although many examples of augmented games exists (c.f. [2, 4, 8]) these were either traditional computer games using context or location information to affect gameplay or novel game format not based upon board, card or dice games.

Three technology-focused board game examples were KnightMage [13], Battleboard 3D [1], and The Invisible Train [19]. In contrast, False Prophets [14] is an augmented board game developed with specific design goals regarding gameplay. The design goals of False Prophets were largely overlapping with the aspects of augmented board games we wished to study but the work did not document guidelines or methods regarding gameplay design.

GAME DESIGN TOOLS AND METHODS

The identified examples of augmented board games included little or no information on gameplay design methods and theory. Due to this, a survey of more general literature on game design was necessary as understanding how one can design augmented board games was considered a fundamental aspect of gaining an overview of the design space of these games. Besides the analytical insight such knowledge would give, it would be crucial in directing the experimental interaction design so that the concepts and prototypes could explore novel areas within the design space.

The field of game design has in recent years emerged with books [9, 17] describing design methods such as low-fidelity prototyping, iterative design cycles, and user testing. However, they provide few terms and concepts of describing specific gameplay design choices beyond structural parts such as rules, goals, and components and therefore provide limited support for exploring novel gameplay design spaces. Simultaneously designing computational technology and gameplay can also be argued to put special demands on the design process [12].

In earlier research, Game Design Patterns [3], we had explored one approach on how to support gameplay design at a higher level of granularity but this work did not focus upon augmentation of traditional board games. An expansion of the patterns approach [5] included mobile games, and even though not specifically focused upon augmented board games this work provided patterns (e.g. memorabilia, late arriving players, interruptability, extra-game input) that addressed how technology could support the gameplay aspects we deemed most important.

Task analysis

Although game design patterns provided support for gameplay design it did not explicitly explore one of our research foci, how to minimize those activities that are not perceived as empowering or emotionally captivating for players. To explore this we decided to analyze several existing board games to identify the common actions [6]. For the purposes of the study, several board games were analyzed using task analysis (see e.g. [16]). Originally used in human-computer interaction to identify functional tasks needed in a design, we modified the use to identify basic task in games that can be supported or automated with electronics and computational technology.

The board games analyzed where mainly board games categorized as belonging to the German school of board game design, i.e. games whose design is focused on game mechanics rather than

game theme. Based upon a participatory study of gameplay in these games, as well as studying the printed game rules, tasks were identified that concerned manipulating the game state. To make it possible to relate tasks to technology that support or automate those tasks, and to do this so that these relations are applicable for new game designs, a general set of tasks was needed. This was created by generalizing all the identified tasks based on how players interface with the game state. This set was found to be able to describe user tasks on several levels of granularity and could be used as building blocks for a grammar for the interface between players and the game state. The identified set was:

- Take OBJECT from POSITION
- Place OBJECTS on POSITION
- Give OBJECT to PLAYER/NON-PLAYER
- Find OBJECT
- Perform SKILL BASED ACTION
- Randomize
- Compute EVALUATION FUNCTION
- Select OPTION from SET OF OPTIONS
- Order PLAYER to perform TASK

The set was complemented by a survey of available technology including sensors, actuators and communication systems. The individual technologies were analyzed for their feasibility of supporting each task so that future developers have a list available that describes what technology is available to support or automate a certain task.

SOCIAL INTERACTION

Game design patterns and a method of identifying technologies that could support or automate tasks provided tools for experimental interaction design but no models or concepts for social interaction during gameplay. However, in parallel work we have developed guidelines for supporting *social adaptability* [7] which provided several dimensions for the design space of augmented board games. In particular, a categorization of events affecting the social environment, social roles, and functional roles within games were identified as starting points for unexplored areas of the design space of augmented board games.

DESIGN EXPERIMENTS

Before focusing on augmented board games we had created *MyTHeme* [12], an augmented card game that automatically builds stories depending on the cards played by players, which can be seen as an initial design experiment. However, this work was initiated based on specific a gameplay idea rather than structurally exploring the design space of augmented board games. Since developing MyTHeme we have identified several different perspectives (i.e. social roles, functional roles, technical devices, game design patterns, and augmenting existing board games) that allowed us to have a better understanding of the design space of augmented board games. This not only allowed us to place existing design within the design space but enabled us to identify specific subspaces of the design space for experimental designs. By performing design experiments within several of these subspaces we could then exemplify the possible variety of augmented board games. As the overlying design method we choose to implement Jones's method [10] of divergence, transformation and convergence.

The first phase, divergence, can be described as the creation of several alternative design concepts which by their difference act as markers in a design space and help visualize what other designs are possible. Each identified perspective was used as a starting point for the different concepts. Several novel game concepts were developed including: *Autognome*, a game built around a computer controlled vehicle; *Traps 'n' Treasure*, built on the game design patterns Social Interaction, Imperfect Information and Possibility of Betrayal; and *Figure Battle*, wirelessly connected miniatures allowing trade and battle replays.

The possibility of augmenting two existing games was identified: *Augmented Kingdoms* [11], where augmentation could help players calculate the current scores, a non-empowering "Compute EVALUATION FUNCTION" task; *Settlers of Catan* [18], which could be augmented to make it easier for newcomers to follow the rules.

In the transformation phase the various game concepts are refined and more thoroughly documented their characteristics. The game *Knights' Errant* went through a slight theme change in order to appeal to a wider market and was renamed *Wizard's Apprentice*. The game Traps'n'Treasure was identified as not using computation as an integral part, and a new game concept, *Black Box*, was created by trying to make computational power an integral part of the original game concept. The concept of *Anthills* shifted from being focused upon different functional roles to being able to support players coming and going without interrupting the overall gameplay, although the functional roles were retained.

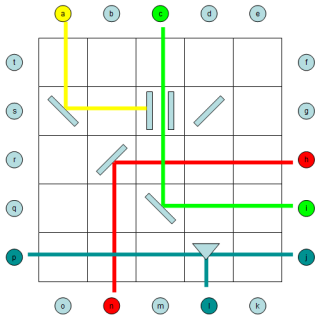

Figure 1: Concept image of the inner workings of Black Box, a game focused on reflecting virtual light. Players cannot see the configuration of the game board manipulate the location and orientation of the mirrors.

In the last phase, convergence, the refined game concepts were compared to each other with regard to their coverage of the design space. Out of the concepts developed, three were selected for implementation: Wizard's Apprentice, Anthills, and *Augmented Diamond Hunt*.

Wizard's Apprentice features two very different modes of play and the technology is both to hold a hidden game state and to update the player who plays the wizard about the other players' actions and present what tasks are available to the apprentices. The effects achieved through augmentation would have introduced menial tasks, e.g. by using an umpire who manipulates the game state through an extra representation of the game state.

Anthills is a party game using a game board containing sensors and actuators to display the possible actions of individual tokens and effects of performed actions, giving room for a flexible

energy based action system. This, together with a public display, provides a team based game handling fluctuating team sizes and spectating. Regarding gameplay, this provides a high level of interruptability as players can come and go as they like. The intention of this setup is to enable people to enter already ongoing games and minimizing negative gameplay effects of leaving the game early, and even to allow for non-players to initiate single actions within the game without becoming players.

Augmenting Diamond Hunt [15] makes it possible to avoid game configurations which resulted in poor gameplay flow, e.g. finding the diamond required to win within the first turns of the game. By letting a computer control the values of the token it also became possible to personalize the tokens (which before had been identical to allow random setup through shuffling).

Figure 2: Left, each game token was sculptured as a thematic object holding an RFID tag inside. Right, initial play testers.

THE DESIGN SPACE OF AUGMENTED BOARD GAMES

Through our design experiments we have identified interesting possibilities within the design space of augmented board games. All though not yet explored in detail, we believe that these can provide fertile ground for future research and design. The possibilities described below do not define the dimensions of the design space but rather describe subspaces, which in many cases overlap. These concepts can add to board games without turning them into computer games. They can also point out unexplored paths of computer game design. Some of them may qualify as game design patterns although not all of them since not all these possibilities directly relate to gameplay.

Being able to, at least partially, locate the game state in computer memory enables *Manipulable Hidden Game States.* In BlackBox, this allows for gameplay focused on manipulating a complex game state with only indirect feedback. Using this feature it is possible to *Fine Tune Gameplay Flow in Real Time*, providing non-detectable dynamic handicap systems or supporting a certain gameplay arc, e.g. guaranteeing no early wins and extending the uncertainty of outcome in the Augmented Diamond Hunt prototype. Another possibility is, depending on which output modality is used, the game can ensure *Guaranteed Common Game State Information* i.e. making sure all present players are given the same information.

Using technology it is possible to shift the responsibility of valid actions from the players, enabling actions which otherwise would demand players to interrupt gameplay to evaluate the possible effect on the game. This includes handling the effects of temporally distributed play

sessions caused by late arriving/early leaving players, which in turn can *Support Player Reentry* as for example done in Anthills and Wizard's Apprentice. As exemplified by Anthills, an augmented system can guarantee a significantly higher level of objectiveness allowing people not playing the game to activate certain events in the game, i.e. *Non-player Initiated Game Event*. Another form of objectiveness can be achieved through the use of sensors, allowing physical actions to be part of gameplay without requiring human interpretation. Although not necessarily requiring evaluation, *Automated Chronicling* shows how for example MyTHeme can allow players and non-players to experience narratives based on the gameplay.

The computational powers to manipulate large game states can *Support Complex Tasks* that would otherwise severely decrease gameplay quality. This can either be achieved through handling the execution of game events which do not provide interesting choices, or produce interesting experiences, i.e. *Automate Menial Tasks*. In Augmented Kingdoms this is achieved by automating the numerous additions and multiplications required to calculate score after each round. Another way to support complex tasks is to provide overviews of large of complex game states.

Depending on the players skill following the rules of the game can be considered a complex task, and the system can support players not loosing face by subtly indicating potential rule violations. An example of this way to *Support Rule Abiding* is the use of magnets in the Augmented Settlers of Catan concept.

CONCLUSION

In this paper we have described characteristics of the design space of augmented board games, game concepts exemplifying the variety possible inside this design space, and models and design tools to support further exploration. Although work still remains to provide further prototypes and observe gameplay we have identified novel gameplay areas not easily identified in other types of games. This not only shows the merit of the new game type but may also expand the understanding of game design in general.

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