Tankwar - Tabletop war gaming in augmented reality

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ABSTRACT
Table top games involve social interaction that is impossible in computer games, yet computer support can offer valuable features to game designers. By developing augmented table top games with video see-through augmented reality, we are exploring the possibilities of face to face computer supported games. We discuss the role of social interaction in both table top and computer gaming, introduce our augmented game AR Tankwar, and present the results from initial evaluations.

Keywords
Augmented Reality, Tabletop games, Strategy games, Collaboration

1. INTRODUCTION
Before computers, game playing was almost universally a social activity played between two or more players, sometimes with spectators. There are very few examples of solitary games away from the computer, and these are mostly puzzle and solitaire card games. However, in computer games[1] single player is the default.

Game designers have long stressed the value of social interaction as an important part of game play, and as a recipe for successful game design [5]. The surge in popularity of massively multi-player online role-playing games in recent years shows that industry has begun to take notice of this. However, the medium of PC or game console is not well suited to social interaction between players. Communication is limited to mediated channels such as text and sometimes voice, while the intensely interactive and fast paced nature of most computer games leaves little time for social interaction.

On the other hand, table top games[2], are intensely social. In addition to interaction stimulated by game play, players commonly indulge in idle chatter, meta-game discussion and more in depth conversation about topics raised by a game.

We do not suggest that single player games are a bad thing - certain games, such as those that rely on fast paced action and narrative, are best played this way. Such games often rely on rapid interaction or immersion, such that social interaction simply interrupts the player's experience. Other genres of computer game are however much more suited to the introduction of social interaction.

Our particular interest is in strategy and role-playing games (RPGs). Both of these are based on table top games, and have been enhanced by the addition of, amongst other things, computer simulation, artificial intelligence, and graphics. Though these enhancements are certainly valuable, the game's social attributes have been lost in the process of adapting them for computer. We aim to construct games that occupy a middle ground - that retain their social characteristics while gaining the advantages of computer enhancement. In this paper we present our work on the AR Tankwar project, an attempt to build an augmented table top war game using augmented reality.

2. SOCIAL INTERACTION IN GAMES
In this section we discuss in more detail the types of communication that go on during games. Based on our informal observation, we then discuss the communication that goes on in different types of games.

2.1 Types of interaction
There are several types of in-game communication. By extending a model proposed in [16], we offer some terms to better understand and describe it.

- Stimulated communication is communication that is part of the game itself. Examples include calling 'Snap' when a pair of cards is seen, announcing an accusation in 'Clue', or requesting payment of rent in 'Monopoly'.
- Strategic communication is discussion of game play and actions. It occurs during the game, and includes the discussion of tactics by allies, the dispersal of misleading information to enemies, the issuing of commands to subordinates, or even the bluffing behaviours of players of Poker.

[1]Computer games are taken to mean console games, PC games, and to a lesser extent, arcade games.
[2]For example board, card, war and role-playing games.

- Meta-game communication is about the game. Players may argue the rules, comment on each other's play, and discuss preferred strategies. It differs from strategic communication in being about the game in general, rather than about a game in progress.
- Audience communication is not limited to non players. It includes communication by those not directly involved in some part of the game. It may include jeering, applause, calls of support, and suggestions.
- Natural communication is 'out of game'. It is not stimulated by the game, nor does it have any formal game effect. It is the background interaction between players as people outside the game. It may consist of idle chatter, gossip and banter.

We suggest that as communication becomes more difficult or limited, natural communication disappears early, followed by meta-game, then strategic. Stimulated communication is necessary for game play, and thus never disappears completely. However, it can be restricted to the most formulaic of messages, and thus is representable by game tokens rather than actual human to human communication.

Audience communication is a special case as it requires observers who have time to comment on a game. Face to face games in a social situation may attract spectators who are happy to watch, and although their contribution to a game experience is purely social, it can be important to its enjoyment.

2.2 Computer Games

A typical computer game player sits facing a screen, their whole attention focused upon it. They may look away rarely, if at all. Some players will further isolate themselves by wearing headphones. Such a setup is appropriate for single player games, as it permits greater immersion and focus. It may also be appropriate for multi-player games where other players are remote. However, there is no scope for social interaction except through the computer.

Most multi-player computer games provide some channels of communication between players. Usually this is limited to text or scripted behaviours. More recently, some action games enable players to talk via microphone. In real-time strategy and action games, players may use this to engage in short strategic communication - announcing their intentions to attack, or suggesting a plan of action. Players of computer RPGs and war games are more inclined to converse in depth, but the channel is still mediated and difficult. Players cannot receive visual cues, cannot point, and may have trouble turn-taking. These problems are common to most CSCW applications, and solutions such as telepointers and video channels have been proposed. We have not yet seen any computer game implementations of these. They may be quite valuable if players must remain remote, however.

Co-located players of computer games can engage in much richer communication. Speech is much clearer, and players are free to move between their computers and engage in face to face communication. However, their task space and communication space are split - they have the choice of looking at a screen, or looking at each other. Thus, communication is not seamless. However, players appear quite willing to indulge in all four types of inter-player communication during play. Spectators may also participate in a such a game, though their attention is usually limited to one player. For traditional computer games, this is the best situation for social interaction.

Most computer games occur in real time - play is continuous and asynchronous. Thus, players must normally be continually attentive to the game's state. Depending on the pace of the game, this may reduce a player's willingness to engage socially, and may result in stilted speech as players switch their attention between game and communication.

2.3 Tabletop Games

In table top games, players face each other across a table. Full face to face communication is possible, as is the presence of spectators. The communication space and task space (the game board) are aligned, so players are not forced to switch between the two. Also, players can more easily refer to the task space by pointing. Compared to this, the mediated communication of remote multiplayer computer games is clearly inferior.

While face to face communication is possible in a co-located computer game, players must move from their own terminals to be able to interact fully with another player. Normally, their attention remains on their own screen.

The rate of play is regulated by the social environment in table top games - play will pause as a player gets a drink, or continue until their turn. Table top games frequently involve turn taking mechanisms, and players will often engage in meta-game and natural communication while waiting for their turn.

Some styles of table top game rely so heavily on face to face communication that they are impossible to reproduce on computer. Character, atmosphere and plot based role playing games rely on the social skills of players and game master, and psychological interactions such as bluffing is impossible through a computer.

3. PREVIOUS WORK

There have been several previous efforts to build augmented table top games, with various motivations.

The Shared Space interface [13] was an early augmented reality game that explored face to face gaming. Players stood around a table on which there were a number of cards. When players turned the cards over they saw virtual content popping out of the cards, and when they put matching pairs of cards together the content became animated. Thousands of people tried the system and found it very easy to interact with. Players were also observed spontaneously collaborating with strangers while playing the game.

In another early project, Zsolt Szalavári's group [15] explored collaborative gaming in augmented reality using Personal Interaction Panels. They implemented casino and Mahjongg applications. Their work focused on providing

private interaction spaces to users in augmented reality environments.

False prophets [10] was a promising augmented game utilising a public tabletop display, handheld PCs, and a tangible interface to create a game that required players to interact socially in the real world as part of game play. However, we can find no evaluations of this game, and so it has served solely as inspiration.

The STARS project of [9] has constructed several games using augmented physical pieces, table top displays, and personal devices. Their work has focused on physical and social interaction between players and has served as an inspiration for some of our initial work.

The Battleboard 3D project was an interesting integration of real Lego pieces with an augmented reality game. They focused on play between children, and found that while children were pleased with the personal viewpoint afforded by head mounted displays, that they had some trouble communicating with them [3].

Hybrid AR Worms was our first effort at a multiplayer augmented reality game, and was based on the Worms series of PC games by Team 17 [1]. Each player controlled a team of worms armed with an assortment of weapons, scattered across a 3D map. Players took turns attempting to win the game by destroying their opponent's worms. Spectators could watch on a projector screen showing various viewpoints of the game. It was demonstrated at several events, and provided us with a foundation on which to build [11].

4. MOTIVATIONS

Our motivations came initially from background interests[3] in both table top and computer games, particularly war and role playing games. More formally, we have developed a simple model for considering different ways in which players are engaged in games, and use this as structure through which to develop our motivations and consider the possibilities of merging real world and computer games. In addition, we have found this model useful as a simple framework for critiquing games, and for considering the relative merits of different frameworks.

We provide a short treatment of this model below; for a more thorough treatment, see [11]. In this 'engagement model', a player's enjoyment of and engagement with a game is comprised of four aspects; mental, physical, social and emotional.

- Physical engagement is through exertion, dexterity, kinesthetic feedback, and other stimulation that affects the player's body. This may include environment engagement such as texture, smell, and temperature. Digital games are typically limited in physical engagement; no amount of 3D graphics in first person shooters can simulate the feeling of lying in the mud clutching a paintball rifle, though both games are engaging.
- Mental engagement refers to the exercise of a player's memory and reasoning abilities. The classic games of chess and go are good examples of mental engagement. Digital games can be very strong in mental engagement through their ability to simulate complex systems; for example, Sim City.
- Social engagement is a more indistinct quality. It describes a player's engagement with the game through their interaction with other players. Games such as Diplomacy, Dungeons & Dragons, and most live role-playing games are strong in social engagement, whereas as games such as an online game of Hearts are almost devoid of it.
- Finally, emotional engagement refers to a player's emotional attachment to game elements. It can refer to emotional attachment or association with game content (typically characters, and sometimes game setting). However, it can also refer to meta-game emotional attachment - for example, players may engage more thoroughly in games that they have fond memories of playing as a child.

This model is not intended as a hard categorization - rather as a conceptual tool for considering issues related to game play. As such, no game is limited to any one of these categories, but consists of elements from each.

Different game platforms have different capacities for engaging players according to these aspects. Computer games can provide for strong mental (AI, complex simulation) and emotional (compelling presentation of game content) experiences, but have drawbacks in physical (limited interfaces) and social engagement (mediated communications)[4].

5. OUR APPROACH

5.1 Iterative design and evaluation

It has been said by many that the only true way to learn game design and to truly understand games is to play them [14]. Game design should follow an iterative process of design, play, discuss, design, play, discuss.

Our approach to designing and developing augmented games follows such a process. We have developed a game (described in more detail below), offered it to players at public demonstrations and conferences, then taken our observations and modified the game accordingly. Our game, AR Tankwar, is now in its third incarnation.

While evaluation of this form is good for rapid iterative development, it is not sufficiently rigorous. We plan to perform more substantive user studies of our games, particularly in comparison to similar games in different mediums (table top without augmentation and on PC). Through an evaluation such as this we hope to be able to derive empirical evidence about the level and types of communication exhibited by players in different mediums.

[3]One might say addictions.

[4]Once again, these are informal, conceptual considerations - we do not claim to be able to quantify games according to this scheme.

5.2 Video See-Through AR

In video see-through AR, a user wears a head mounted display mounted with a camera. Images taken from the camera are augmented by the computer then shown back to the user. Thus, players can see real and virtual content simultaneously. Virtual imagery is aligned correctly through a tracking system (we use fiducial markers and the ARToolkit tracking library [7]).

This approach is cheap and easy but has limitations. Users experience a delay of up to 100 milliseconds as the computer processes and redisplays captured images. Unless expensive hardware is used, their view is monoscopic, and displaced forward by about 6cm. This can make users feel disoriented initially, but most are able to interact with the world effectively, though with reduced depth perception, given a short period of acclimatization.

Since users have to wear head mounted displays, their eyes and part of their face is obscured. This interferes with communication to some extent - gaze cues are impossible, and facial expression is hard to perceive. However, we have not determined the exact effect on communication.

We suggest that despite these drawbacks, augmented reality is superior to PCs for social interaction in games, as the communication and task spaces are aligned, allowing more consistent and richer communication. Thus, we believe that it is a suitable platform for augmenting digital games with social interaction.

5.3 Lens based interaction

To interact with virtual objects, we use a technique based on MagicLenses[4], which we call AR MagicLenses [8]. The user holds a controller, such as a gamepad or handheld mouse, augmented with a virtual lens. The lens provides the user with an area of focus, while maintaining context outside it. Integrating ray-casting results in a flexible selection technique.

Each lens projects a viewing volume into the environment. Explicitly rendering this volume, either translucently or in wireframe, creates a visual cue as to what each user is currently focussing on. Viewing volumes directed at the same location indicate a point of common interest. This feature goes some way to overcome the lack of eye gaze cues resulting from the use of head mounted displays.

6. AR TANKWAR

Table top war games have been around for almost two centuries. Initially used as a tool for military planning in the armies of 19th century Europe, they have since become a leisure activity that attracts modellers, history buffs and gamers in large numbers. In modern war gaming, players compose armies from sculpted and painted miniatures and pit them against each other in games of turn based strategy. War games range from 'beer and pretzels' games lasting an hour to grand games that may last a weekend, involving upwards of 10 players.

Game state is primarily represented by the location of models on a game table (perhaps covered in miniature terrain). Additional game state may be represented through tokens placed on the table, or noted on paper. Play is turn-based, and often proceeds in phases. A turn usually consists of unit movement, exchanges of fire, and morale. More complicated games include considerations of unit structure and cohesion, ammunition expenditure, lines of sight and visibility. In such complicated games, it can take upwards of an hour to plan out, resolve and update the position of figurines for each turn.

War gamers attribute their attraction to war games to several factors - modeling, historical recreation, strategic gaming and social interests are the most common. War gaming is also a very social activity - players may spend significant amounts of time discussing strategy, history, equipment, and other related subjects. Players often join war gaming societies, and some travel regularly to conventions to play against gamers from other cities in tournaments. A good introduction to war game design and culture can be found in [6].

However, table top war games are not without their difficulties. All game conflict is resolved by humans, and often relies on measurements and interpretations of game state from the layout of the table. This can lead to ambiguities, and the resolution of these can become bitter and contentious, particularly among younger players. Another limitation of table top war games is the complexity of game rules. One motivation for war gamers is the desire to replicate historical scenarios with realistic looking units and terrain with realistically simulated rules of combat. However, as players must resolve rules manually, rules must be simple. These two constraints are often in conflict. Finally, while a well painted war gaming army can be an impressive sight, certain types of visualisation such as smoke, fire, aircraft, shell fire and so forth are impossible or impractical.

AR Tankwar is our attempt to build an augmented war game. It draws ideas from both table top war games and computer strategy games. Our design focused on building a playable strategy game for two or more players, with both collaborative and competitive play. We wanted players to be able to engage in effective face to face communication while playing. We also wanted to support spectators.

AR Tankwar is similar to a miniatures war game, except that the game map and pieces are all virtual. Play is asynchronous in real time, though it proceeds much slower than a typical PC real time strategy game to allow more time for strategy and communication between players. AR Tankwar uses a simple set of units - tanks, helicopters and artillery, as well as a similar set of fixed emplacements. Players can play against each other to capture objectives, or together against a computer player.

In normal war games, the viewing perspective is limited to an isometric view from above. Some modern real time strategy computer games allow camera control such that players can see the game from the ground. In AR Tankwar, we have implemented a transitional interface in which players can shift between an augmented reality viewpoint (exocentric) and a fully virtual viewpoint (egocentric) on the game map.

To interact with their units, players use a magic lens mounted on a wireless gamepad. The lens is used for selection, while buttons on the gamepad are used to issue different commands. In addition to issuing orders to units, players can alter the zoom level of their lens, take snapshot images using the lens as a camera, and transition to and from VR mode.

Finally, Tankwar supports different viewing clients including an orthographically projected game map with team statistics for view by spectators. Other viewing clients include a real time strategy like desktop client, a web based client, and a client for tablet PCs that allows spectators to 'draw' on the game map.

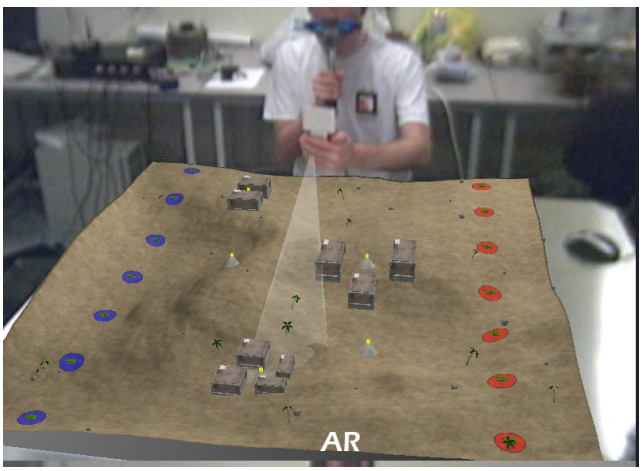

Figure 1: AR Tankwar - tabletop view. Units can be seen highlighted in blue and red

6.1 Design Process

AR Tankwar is our second attempt at an AR game - its predecessor 'Hybrid AR Worms' is described above, and our experience with it helped guide our design decisions with AR Tankwar. Firstly, rather than build a single large game, we developed Tankwar as a set of distributed clients around a single server. This allowed rapid experimentation and introduction of game interfaces, including an attempted speech interface. Secondly, AR Tankwar takes place on a single tabletop approximately 1.5 metres square - a significant reduction from AR worms. Thirdly, we attempted to reduce the interface overhead in AR Tankwar. Players issue orders to vehicles, but do not control them directly. Finally, we shifted from turn based play to a slow real time strategy game such that each player was always involved.

As mentioned above, our design focus was on collaborative play. The view frustum of magic lenses helped to enhance players' awareness of each other by showing what other players were focused on. We also implemented moving avatars on the game surface to represent players in virtual reality mode.

We considered tangible user interfaces for our initial interface design, but felt that tangible augmented reality was inappropriate. We have since begun to consider an interface approach similar to the SenseTable of [12], but have yet to implement it. Lens based interaction is very similar to the select and order approach used in computer games, and we found that our implementation was quite easy to use. To improve players' sense of attachment to their lens controller, we implemented transparent window beneath the lens that allowed players to see their game controller and hands. Early test players reported that the lens was much easier to use with this feature.

AR Tankwar was designed to be as extensible as possible, to facilitate iterative modification and extension of the game based on our work. It is implemented in a combination of Java, C++ and PHP, and uses the ICE middleware framework [2].

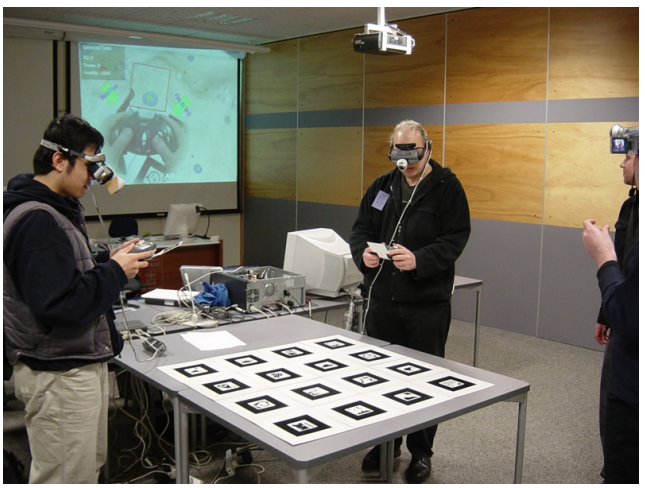

Figure 2: A game of Tankwar in play (NZGDC 2004). A spectator view can be seen in the background.

6.2 Evaluation

At time of writing, we are preparing to perform a formal evaluation of AR Tankwar based on the framework described above. However, we have begun to establish a body of anecdotal and informal evidence suggesting that we have been at least partially successful in achieving our goal of building an augmented game in which players can interact socially.

In June 2004, we demonstrated Tankwar at the New Zealand Game Developer's Conference in Dunedin, New Zealand. It was played by approximately 50 attendees over the course of the conference. Players and spectators were observed communicating frequently and spontaneously. Topics of conversation ranged from game play and strategy to the interface and novelty of the game. Despite the HMDs, players would look at each other while speaking, point at parts of the game board, and move around the table. Spectators viewing the game from above or through a player's viewpoint would comment frequently, in a way that seemed similar to spectators around a gaming table. Although the game's novelty can account for some enthusiasm, we believe that AR Tankwar is at least as open to social interaction as a multiplayer computer PC game.

In [6], Dunnigan offers a criticism of computer wargames

that also applies to AR Tankwar. He suggests that knowledge of the game rules is an important part of table top war gaming, and the fact that they are hidden in computer war games decreases players' engagement with the game. He also argues that by eliminating players' ability to tinker with the game rules, it is more difficult to recreate and play diverse scenarios and conditions. Since AR Tankwar attempts to augment existing table top games, it should refrain from limiting the original game like this.

HMDs cause several standard problems as outlined in section 5.2, though some of these dissipate as players get used to wearing them. Furthermore, game setup is complex and time consuming, making the game impractical outside the lab.

7. FUTURE WORK

The iterative design process we advocate above relies on frequent and continuous evaluation of game designs. Thus, we are preparing a formal study of AR Tankwar. In this study will compare AR Tankwar with analogous table top and desktop PC games. Pairs of players will be recorded solving in-game problems in each game interface. These recordings will be analysed to determine types and levels of communication according to the framework described above, as well as the frequency and types of gestures. Players will also be asked to fill in a questionnaire from which we will gather subjective measures of effort, frustration, ease of use and collaboration. Finally, players will be interviewed to gather their general impressions and solicit commentary. From this evaluation, we hope to derive evidence to support our hypotheses as outlined above, as well as gaining insights into future improvements of AR Tankwar.

We intend to continue developing AR Tankwar. We are expecting to exhibit the game at the GenCon Indy convention in August 2005, and are improving the game's graphics, AI and interface for this. Also, we will add a new tangible user interface similar to that described in [12]. Dunnigan's Dunnigan's criticisms on game rule transparency and scenario flexibility are salient, and we have begun to address these by including game mechanic information in the game display. Finally, we intend to explore a possible projected AR interface for Tankwar

8. ACKNOWLEDGMENTS

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