Dynamics of Strategic Negotiations on SharedWell

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Abstract

"SharedWell" is a single display system that allows multiple users to interact with both private and public information in a face-to-face co-located setting. It is suited for strategic cooperative tasks that include both competitive and collaborative aspects. This type of collaboration, called strategic negotiations, requires users to go through three phases: identifying the right timing, using epistemic actions to draw attention, and evaluating the value of the negotiation. We conducted an observational study to investigate and evaluate deeper strategic negotiations on SharedWell compared with other set-ups: a set-up using laptops and a real-world set-up. As a result, we ascertained that SharedWell is suited for each step of strategic cooperative tasks.

1. Introduction

Teams of people often work together in the same place at the same time and use complex shared technology. In ordinary meetings or discussions, many participants can access relevant information on their laptops or networks, and also can share their contributions by positioning their group display for the members to see. Collaboration while sharing information has been one of the most challenging topics in HCI studies. There is much literature devoted to interactive displays and novel techniques to facilitate face-to-face cooperative works [1].

Collaboration may be sought personally or imposed managerially. A variety of collaborative situations arises in everyday situations and has been analyzed by many researchers (e.g. [2]). Some types of collaborative tasks, especially in business situations, fundamentally include both competitive and collaborative aspects. Some examples can be found in playing card games or board games with friends or family. Members are competing with each other but the ultimate goal is for everyone to enjoy the game. Other examples can be found in various trading floor-like and auction scenarios. This type of collaboration, called strategic negotiations [3], requires users to go through three phases: identifying the right timing, using epistemic actions to draw attention and evaluating the value of the negotiation [4].

On the other hand, digital tabletops in particular are increasingly being situated in a variety of work and public spaces. Tabletops that allow multiple users to deal with private as well as public information are becoming popular. SharedWell [5] allows multiple users to interact with both private and public information on a single display according to their spatial locations and motions. It enables users to dynamically choose negotiation partners, create cooperative relationships and strategically control the information they share or conceal. These interactions are enhanced by varying the size of overlapping areas caused by changing the distance between users. Analysis of these interpersonal distances in this system might be an interesting topic.

In this paper, we investigate and evaluate deeper strategic negotiations on SharedWell through understanding the dynamics of user actions that accompany the above three phases of strategic negotiations. For this purpose, we conducted an observational study using a strategic game. In our study, subjects played the strategic game in three different collaboration set-ups. We analyzed subjects' movements and information transferences to identify differences among the three set-ups. The rest of the paper is organized as follows. First, relevant literature is reviewed, then we describe a study we conducted to investigate the dynamics of strategic negotiations, followed by a discussion of the results. Finally, conclusions and future work are presented.

2. Related Work

Recently, there have been a relatively large number of studies related to novel tabletop systems and dynamics of information sharing techniques.

2.1. Tabletop Systems

Tables provide common workspace where group members can interact with each other and conduct shared work. There is much literature devoted to interactive tabletop systems to support face-to-face cooperative works. For example, interactive tables called ConnecTables [6] can be reconfigured for rapid sub-grouping in an office environment. InteracTable allows a group to annotate digital content on a computational-enhanced table [7], and DiamondTouch is a multi-user touch-sensitive display system [8]. Other tabletop displays are surveyed in [1].

Almost all previous tabletop systems elegantly support cooperative works on a digital tabletop shared by several co-located participants; however, all the pieces of information displayed on the above tabletops can be easily observed by all participants equally. There is no information on the tabletop that can be used strategically. It is important for a system designer to build tabletops that support private and public spaces and have some harnesses of information transference among spaces. Information sharing techniques that contribute to strategic negotiations are described below.

2.2. Information Sharing Techniques

We organize existing techniques of information transference according to three dimensions, i.e., supported territories, information transferences within one space and between spaces.

Supported Territories: Scott et al. found that groups automatically divide the space on a tabletop into three territories: personal, group, and storage [9]. The territories are not necessarily mutually exclusive, and they are partially based on users' positions around the table. Many tabletop systems allow users to provide several spaces in addition to the public space by distinguishing between areas on the table surface. Personal Digital Historian [10] provides a central, circular area as the public space and as the personal space by orienting all items towards a particular user. However, the public and personal space cannot be maintained simultaneously. In RoomPlanner, users can create a private space on the table in front of them using a hand gesture that physically occludes the information from another user's view [11]. The Lumisight Table provides different images to different users around the tabletop, and can maintain each private space in addition to the public space [12].

Information Transference within Space: Different interaction techniques allow users to handle information on tabletops. Direct input is a suitable interaction technique on large surfaces, for example, by direct touch [8, 13], through a pen [14] or with a tangible object [15]. Indirect input techniques such as standard mouse-based interactions or laser-based techniques [16] are also available without the user having to move around the table. However, these techniques have been found to be difficult to control when used from a distance [17].

Information Transference between Spaces: There are also tabletop systems with small displays, PDAs, or laptop computers for providing other spaces. The UbiTable provides users with private spaces on adjacent laptops [13]. This system includes a personal space along the boundary between the private and public spaces where a user can observe the other's actions. Augmented surfaces supports a shared continuous workspace among walls, tabletop and laptops, and examines the interaction technique – hyperdragging [14] in which a private space integrated with a public space that covers the entire table. ConnecTables [6] allows users to combine mobile desks as the personal space to create a shared space. This system can co-exist separate personal spaces and shared spaces.

2.3. Strategic Negotiations

In a collaborative task that includes both competitive and collaborative aspects, each user attempts to increase his individual benefit and this leads to an increase in the group's benefit. This process can be called strategic negotiation especially in business situations (e.g. [3]) and is complex because conflicts between the personal and group priorities frequently arise. With respect to tabletop systems, strategic negotiations required the user to go through three phases: identifying the right timing, using epistemic actions to draw attention and evaluating the value of the negotiation [4]. And the authors identified several implications for the design of digital tabletops supporting strategic negotiations. For effective strategic negotiations, users have to be careful about which parts of the information can and cannot be shared. A special framework is required to allow multiple users to deal with private as well as public information.

SharedWell allows multiple users to interact with both private and public information according to their special location and motion. With this system, users can interactively control private and public information strategically. Therefore, SharedWell seems to be suited for strategic negotiations. However, there are no studies conducting quantitative evaluations the dynamics of strategic negotiations on SharedWell.

3. Observational Study

The aim of the study is to investigate and evaluate strategic negotiation on three different set-ups: the SharedWell system, a set-up using laptops and a real-world set-up.

3.1. Task

We designed a fantasy player sharing game inspired by fantasy golf leagues [18]. Each participant started with

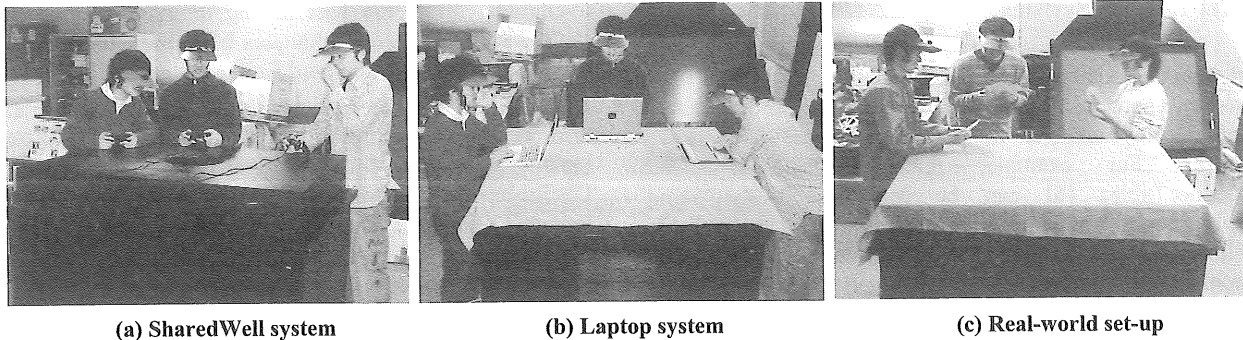| (a) SharedWell system | (b) Laptop system | (c) Real-world set-up |

Fig. 1: Tabletop set-ups.

5 player cards. Each card displayed a picture, current-season statistics, skill-level (A, B, or C) and baseline score (1 to 100) for a unique golf player. The game was designed such that each participant had to exchange players with others to increase both their individual score and the total group score (which is a sum of the participants' individual scores). The participant's score was a combination of their players' scores. This combination was more than a simple sum of the player's baseline scores and depended on the player's skill level and his relation to the other players held by the participant. The participants had to carefully decide which players they'd bring up for transfer and evaluate whether the swap would result in an overall improvement of their score. It was therefore in the participants' best interest to not reveal all of their cards to other participants and carefully time their negotiations to increase their chances of a good transfer.

3.2. Tabletop Set-ups

We carried out our observations using two digital tabletops inspired by existing systems and a real-world strategic negotiation set-up. All experimental set-ups used a table with a size of 1219x914 sq mm. Users could stand comfortably in front of the table with their elbows resting on the table surface. Figure 1 shows the different experimental set-ups on the table.

In the SharedWell system (see Fig. 1(a)) [5], a game controller is used for participants to move their player cards. In this system, the users, whose head positions are tracked, look through a hole in the table to view their digital contents. This hole allows users to maintain a private view of their content even when they move around the table. To exchange players, users have to come close to each other so that their views through the hole overlap. The overlapping region naturally creates a shared space for users to exchange players. If a user wants to exchange players with a particular partner, he puts the player's card on the overlapping area by approaching the partner. By using the overlapping area, users can exchange cards freely. Each user's individual score is shown on the bottom of their display area, and each player's information is shown on the card by using a game controller.

Figure 1(b) shows the laptop system. This system uses three laptops, and each laptop's screen is divided into a private space and a public space. Users can handle their players on private space and transfer players to other participants by moving them to the public space. Users can move players between private and public space by clicking on the card and selecting from the drop-down menu. When a player is moved to the public display, all participants can see the player on their public space. Participants' individual scores are shown on the bottom-right corner of their screens, and the each player's information is shown by double clicking the cards. We anticipate that users might move around the table carrying their laptops (during the experiment all laptops were powered through their fully charged battery unit) to show important players to other participants by positioning them appropriately on the laptop and covering all other sensitive information on their display with their hand.

The third tabletop set-up is a real-world set-up. Here we use physical cards with player details printed on the card. Figure 1(c) shows the setting using real cards. Participants could exchange the cards physically as in a card trading game. When participants want to know their individual score they ask the human instructor. The instructor responds by examining the players' cards and writing their score on a sheet of paper.

3.3. Participants and Method

We asked 3 groups to play the game in a within participants design. Each group consisted of 3 participants for a total of 9 participants. All participants were male university students ranging in age from 22 to 27. Every group tried all setups with the order of setups balanced for any transfer of skills.

Each group started with an instruction on how to play the game. They were also instructed that the overall objective was for them to win individually and for their group to improve their total score. Following the instructions they got a 3-minute practice session with each set-up before beginning the experimental task for
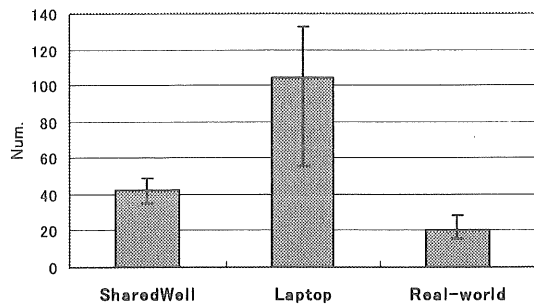
Fig. 2: Number of transactions.

Fig. 3: Transition in the laptop system
for three users (R, G, and B).

that set-up. For each set-up, the participants played the game for 20 minutes. At the end of the session, the participant with the highest individual score got a small reward. If the group score (which is a sum of the participants' individual scores) was higher than all other groups, the entire group was also rewarded (we contacted them at the end of the entire study to give the rewards).

3.4. Results

We tracked participants' head movements using a 3D positional tracker and also video taped the entire session for analysis in all the tabletop set-ups. Additionally, we also logged all system movements in the digital tabletop set-ups. Due to practical limitations, we could not track the movement of individual cards and we relied on video analysis to infer card movements.

Real-world set-up: Based on the analysis of head movement and video data, we found that in the real-world set-up users rarely moved physically. Users, however, often turned their bodies toward each other and used hand gestures to point at each other. The most common user actions were rearranging the cards in their hand based on the player's score and skill level, and removing a card from the set of cards to carefully examine the player's score. We found that users first established a negotiation partner by moving their hand toward the participant, while hiding the card from the other. If that negotiation failed, the user would drop the card on the table so that the third participant could join the negotiation. We also found that exchanging partners deliberated a lot before completing the negotiation with a successful or unsuccessful transaction.

Laptop system: Figure 2 shows the number of card exchanges in each set-up. There were many more card exchanges in the laptop system than with the other systems. Figure 3 presents a typical time segment showing each user's score variations in the laptop system. A user's score changes whenever they exchange a card. Participants exchanged cards in quick successions so that they could compare their individual scores with the newly acquired card against the original set of cards. An interesting part of the transaction was that whenever a
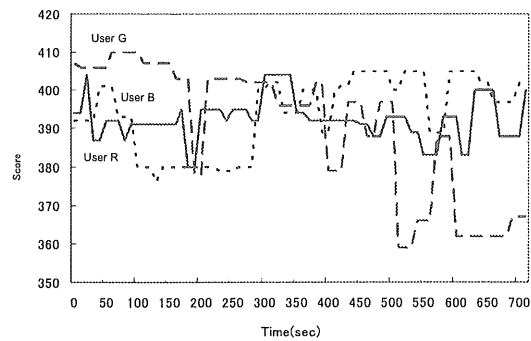
user was unhappy with the transaction, they quickly undid that transaction by returning the cards. There were several such trial-and-error style exchanges. Our analysis of the video and 3D trackers revealed that users did not move during the session and they preferred to initiate negotiations through verbal communications. The most common user action was to send a card to the public space or receive a card from the public space. When filling out the exit questionnaires most users complained that they had problems finding out which user placed her card in the public space.

SharedWell system: Figure 4(a) shows the user's position represented as directional angles in a typical time segment. Figure 4(b) shows a typical user score in the same time segment. For starting a negotiation, a user actively approaches with his body another user in order to share the information through a shared display area. The number of explicit movements for exchange is shown in Fig. 5. Because of the nature of the SharedWell system, users performed many more physical movements than with the other systems investigated. Typical user actions in the SharedWell system included moving players between private and shared spaces for evaluating individual scores, moving toward different users to establish negotiation partners and rearranging cards in the private space. We noticed that if an adjacent user approaches too close, their private space shrank to small areas due to too much overlapping space. Therefore, often only one user moved around the table actively while the other users moved inactively.

4. Discussions

4.1. Dynamics of Strategic Negotiations

In our tasks, negotiations are based on the global benefit, so all users involved choose the result that can be most beneficial to the tasks. Based on the results discussed above and user's feedbacks, we can breakdown the negotiation action into 3 subtasks: (1) observing and deciding, (2) starting and doing the negotiation, and (3) finishing and re-evaluating.
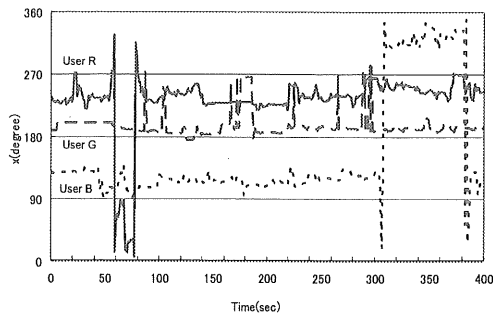
(a) Time-position graph
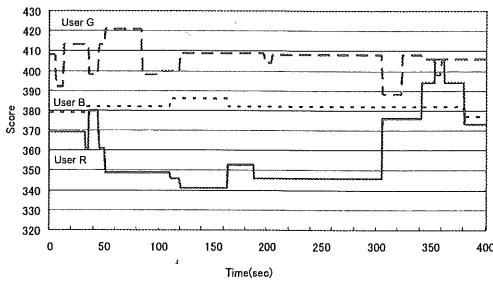
(b) Time-score graph

Fig. 4: Transition in the SharedWell system for three users (R, G, and B).

Fig. 5: Number of movements for transaction.

Observing and Deciding: It is generally considered that for collaborations to be successful each participant must maintain awareness of what the others are doing [19]. In the real-world set-up and the SharedWell system, we observed that participants performed the epistemic actions [4] such as rearranging the cards or checking their player's information. In addition, the physical proximity and body language of the participants served as a strong awareness cue in gauging the extent of others' negotiations in the SharedWell system. On the other hand, in the laptop system, observing participants could only see the movement of cards from the public space and often missed or failed to observe who placed the card in the public space.

An important step in successfully carrying out a strategic negotiation is deciding the negotiating partner and timing. For preparing a negotiation, participants would access their private information frequently. In the SharedWell system, it is easy to access one's own private information and to keep it private because of the nature of this system. In the laptop system and the real-world set-up, however, the participants can see all information and have their own information seen by others sometimes. Therefore, they have to pay attention to hiding their own private information.

Starting and Doing the negotiation: We found several differences in the type of modality used by the participants in different systems when starting negotiation with a partner. For example, most participants used voice
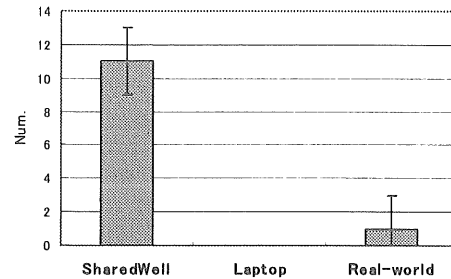
instructions and conversations in the laptop system. One reason for this is that they could not know who placed objects in the public space. In contrast, voice and gesture were used together more frequently in the real-world set-up while physical proximity, and indicating one's own cards was used often in the SharedWell system. In addition, many explicit movements for exchange were observed in the SharedWell system. While in the other systems they thought that it was not necessary to move around the display and see all information for exchange.

During the negotiation, there was considerable variation regarding how the participants indicated the information for exchange in the public space. In the laptop system, shared pieces of information are copied onto the public space that users can access through their individual displays. Information sharing forces participants to be constantly alert to whether the information displayed on the individual display is also being displayed on the others' display. The participants should maintain careful observation of the information being displayed in the public space. Meanwhile, the most activity took place in the SharedWell system. According the situation, they moved around the table and conducted the negotiation. As there was explicit ownership of information in the SharedWell system, the takeover was difficult to accomplish without any need for negotiation.

Finishing and Re-evaluating: After exchanging the information or refusing the others' demands, all participants finished the negotiation and re-checked their score frequently. It is easy for all of the systems to access the individual score. In the SharedWell system, the participants were away from the negotiation partner because of the expansion of one's own private space. These actions helped to maintain awareness of finishing the negotiation and perform the epistemic actions for preparing the next negotiation.

4.2. Strategic Negotiation on SharedWell

The SharedWell system provides that users can smoothly negotiate with particular partners by showing their own private information on the overlapping area. First, it is the most important factor for effective strategic

negotiation to indentify the right timing. In the SharedWell system, it is easy to access one's own private information and to keep it private. And the SharedWell system promotes epistemic actions through the dynamic size of private space caused by the change of distance between users. It is the second factor of strategic negotiations. Finally, because of explicit ownership of information in the SharedWell system, users are forced to change ownership of a card after indicating the card to a particular participant. Therefore, the takeover was difficult to accomplish without any need for negotiation. However, it is the most important process for evaluating the value of the strategic negotiations.

One of the drawbacks is the physical proximity; that is, the SharedWell system required users to be close to each other to enable negotiations. However it is a strong awareness cue of what the others are doing, so we believe that the SharedWell system must be able to harness the body and hand gestures of users with greater finesse for strategic negotiations.

5. Conclusion and Future Work

We investigated the dynamics of strategic negotiations on SharedWell compared to a laptop system and a real-world set-up. We found that users strategize at multiple levels and also identified several characteristics of group dynamics on SharedWell. Our results show that SharedWell is especially suited for strategic cooperative tasks. Users carve out shared spaces that can only be seen between the two users who are negotiating intuitively, dynamically and strategically.

In the future, we plan to conduct more observations with different even and odd numbered groups. We are also looking into studying strategic negotiations in non-game-like situations and with a variety of personalities and leadership qualities to see if there are any differences. We are also exploring novel ways to extend digital tabletops to capture the nuances of negotiation that are evident in the real world.

Acknowledgements

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