Rethinking 'Multi-user': An In-the-Wild Study of How Groups Approach a Walk-Up-and-Use Tabletop Interface

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ABSTRACT

Multi-touch tabletops have been much heralded as an innovative technology that can facilitate new ways of group working. However, there is little evidence of these materialising outside of research lab settings. We present the findings of a 5-week in-the-wild study examining how a shared planning application – designed to run on a walk-up-and-use tabletop – was used when placed in a tourist information centre. We describe how groups approached, congregated and interacted with it and the social interactions that took place – noting how they were quite different from research findings describing the ways groups work around a tabletop in lab settings. We discuss the implications of such situated group work for designing collaborative tabletop applications for use in public settings.

Author Keywords

Tabletop, public, in-the-wild, in situ, walk-up-and-use

ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms

Design, Human Factors

INTRODUCTION

Multi-user tabletops intended for shared use have started to move out of research labs into real-world contexts, particularly in retail, hospitality, exhibitions and education. A presumption is that groups will gather around and use them together to play games, plan tours, purchase goods, etc. Examples of commercial applications include Microsoft's Concierge and Harrah's suite of games. As yet, however, it is unclear how groups use shared tabletops *in situ*. In particular, very little is known about what people do when first encountering them, especially those who have never seen one before. The few applications that have been evaluated in public places have shown them to be primarily used *in parallel* [10, 18] rather than collaboratively.

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Furthermore, while many studies have investigated how groups work together around interactive tabletops, few have been carried out in-the-wild. A big difference between controlled and in-the-wild studies is that in the former, groups of participants (sic) are brought to the tabletop and shown their place by a researcher or assistant and provided with instructions on what they have to do. There is someone at hand to explain the purpose and functionality of the application. These demand characteristics are largely absent in-the-wild, making for a very different user experience. Research is needed to discover what happens in practice and how we can design applications for group working.

Our research is concerned with how groups approach and use walk-up-and-use interactive tabletops in public places. In particular, we consider how groups form, disperse and organise themselves in such settings and how tabletops can be designed to support this. Specifically, we describe how a walk-up-and-use tabletop application – designed to support group planning – was used by pre-formed *coherent* groups (i.e., family or friends) in a tourist centre. A 5-week in-the-wild study was conducted to examine what groups do when first encountering the tabletop and how they used it. Our findings showed that it was approached by, among others, individuals, couples, families, groups of students, and even complete strangers who joined others already using it. Contrary to our assumptions, it was rare for a 'family of four' to ever come to the tabletop at the same time and each take a side. Our findings of *in-situ* use are quite different from the *multi-user* notion that pervades much thinking about tabletops. We discuss the implications of these differences in terms of supporting *group working* and consider how best to design tabletop applications that support walk-up-and-use interactions in public settings.

BACKGROUND

Interaction with multi-touch surfaces

Multi-touch interfaces have a long history, but there has been a huge increase in interest more recently, particularly with the release of commercial hardware platforms such as the iPad, Microsoft Surface and Smart Table. While much research has focused on extending hardware possibilities

(e.g., [5, 7]) and the expressivity of interaction techniques (e.g., [28]), another main focus has been on the opportunities provided by multi-touch for *multi-user* interactions. The notion of multi-user has its roots in operating systems, such as Unix, that allow concurrent access by multiple users of a computer. It was extended to the vision of Single Display Groupware [27] – where applications were developed for co-present users to collaborate via a computer with a single shared display and multiple input devices. Its usage today retains this legacy with an emphasis on supporting simultaneous use of an application by multiple people. A wide variety of applications designed to support group activities have emerged, ranging from sharing media [26], to scientific data exploration [25], and medical conversations between doctors and deaf patients [20].

Detailed laboratory studies have also been carried out, describing how factors such as tabletop size, group size [23], surface orientation [22] and indirect input techniques [19] can influence group processes. Other work has detailed how horizontal multi-touch surfaces can increase workspace awareness of collaborators' action and consequently the density of interaction [9] and increase equity in the number of interface actions carried out by participants [13]. To date, most evaluation work on multi-touch techniques and systems has been lab-based, aimed at answering specific questions about group use and has typically employed comparative quantitative methods.

Although field trials of interactive surfaces are now beginning to emerge, we still know little about how people come to understand how to use these potentially unfamiliar technologies, particularly in walk-up-and-use scenarios where a coherent group of people will use the tabletop. As many of the envisaged real-world applications of multi-touch multi-user tabletops outlined in the introduction fit with this scenario, it is important for research to target this gap in our understanding. In the next section we detail some pioneering in-situ studies of interactive surfaces.

Field trials of shareable technologies

Although they can be expensive and challenging to carry out, 'in-the-wild' studies of new technologies in uncontrolled environments have become central to HCI, CSCW and Ubicomp (cf. [15, 21]). Rogers *et al.* [21] argue that laboratory studies of Ubicomp technologies can fail to capture many of the complexities of the situations in which the applications will ultimately be placed. In particular, difficulties inherent in using technologies in a specific context often fail to emerge in laboratory studies; in-situ studies allow researchers to better explore how people come to understand, use and appropriate technologies in their own terms and for their own situated purposes.

Studies of multi-touch interfaces 'in-the-wild'

A small number of studies of interactive surfaces have taken place in rich real-world contexts. Researchers at Microsoft Research Cambridge have focused on how multi-touch technologies might integrate over time into settings such as the home or school. Kirk *et al.* [12] deployed a multi-touch device called the *Family Archive* in three homes for a month each. The system supported scanning and archiving of sentimental artifacts and memorabilia. They describe how it disrupted existing family roles and practices and was typically used asynchronously. Cao *et al.* [4] developed a narrative construction tool called *TellTable* on a Microsoft Surface and installed it in a school library for approximately two weeks, where children were able to use it during breaks and some lessons. They detail how the tabletop fitted into the existing school culture – access was controlled through a booking system implemented by the librarian – and also how the tabletop application was central to the development of genres, practices of planning and an emerging culture of storytelling reputation.

Other researchers have studied interactive surfaces in public settings where users might be expected to encounter the technology only once and for a short period of time. O'Hara [17] describes a (single-touch) tabletop system in a cafe, highlighting issues related to moving between interactive and non-interactive use: for example, the interactivity could draw attention to otherwise innocuous gestures such as tapping on the surface, causing social discomfort. Hornecker [8] describes a museum multi-touch system that asked users questions about natural history. While engaging, it failed to encourage social interactions and subtle usability issues impacted the experience. Hinrichs *et al.* [6] describe how the visibility of a (single-touch) museum installation in use drew groups to interact. Access was managed through turn-taking, with some members temporarily leaving the installation while waiting to use it.

Peltonen *et al.* [18] provide a detailed video analysis of people using *CityWall*, a large vertical multi-touch display installed in a city street, designed to enable photo browsing. They highlight several phenomena: the influence of users in drawing attention to the display, performative actions to communicate intentions or to engage others in playful activity, and patterns of shared use: primarily parallel activity by both strangers and acquaintances, but also working together and conflict resolution where the activity of one user interfered with that of another. The same group [10] also describe *Worlds of Information*, another walk-up-and-use vertical multi-touch display for browsing media. This extended the CityWall system with novel 3D interface widgets, aiming to encourage parallel interaction and user engagement. It was studied in-situ at an exhibition, indicating that users found the system (although not the content) to be engaging. Multiple people used the system in parallel: singly, in pairs or in groups.

Tourist applications

Previous research into developing technologies for tourism has focused largely on providing visitors with mobile and augmented reality applications that can be used outside the tourist information centre, such as recommenders and guides (e.g., [3]). Research inside tourist centres has focused on the interactions between staff and customers –

the mechanisms employed in queuing and working across the counter – as well as the importance of paper representations, which can be annotated, re-orientated and shared [2]. We have found no evaluations of shared tourist applications specifically developed for group use.

RESEARCH AIMS

While revealing in-situ evaluations of multi-touch, multi-user systems are beginning to emerge, they are still in their infancy. Studies have focused either on the effects of introducing a new technology into an existing social group with well defined roles and practices, such as a school or family, or on walk-up-and-use media browsers designed to be equally usable either by coherent groups or by strangers.

Our interest is in the potential of walk-up-and use systems for public spaces. In contrast to previous work and in-line with many of the expected future uses of tabletop technologies in settings such as retail or hospitality, our goal was to explore the potential of a shared tabletop system designed to be used by a *coherent* group of people in carrying out a planning task related to their situation. The public setting was a tourist information centre, where tourists come for inspiration when visiting a city. Typically, materials, such as leaflets and posters are available for them to peruse, together with public PCs for them to use. Counter staff can be asked questions and sell maps, arrange travel and accommodation, and take bookings and payments for walking and bus tours. In this setting, our goal was to place a walk-up-and-use tabletop supporting a stand-alone planning app that groups could use as an additional resource. The objective was to enable pairs and other groups of visitors to use it to find and share information and then plan their activities in the surrounding city.

THE SETTING

An ethnographic study of the tourist information centre in Cambridge, UK, was initially carried out to elicit requirements [14]. Cambridge is very popular with tourists, being home to many colleges, museums, theatres, galleries and other sites. The centre can have up to 2000 daily visitors, with busy and quiet times throughout the day. The tourist centre was moving to new premises nearby and was keen to explore the potential of a tabletop system that could provide added value to groups of visitors. They were concerned that it shouldn't interfere with the steady flow of visitors and that it should potentially add to revenue by including information about activities and sites on which they earned commission (such as tickets for bus tours).

When groups entered the centre they typically dispersed and foraged for information individually. The interior design and representations of information often made it difficult for groups to create the spatial configurations that would enable them to orient with equal access towards a shared source of information (cf. [11]). For example, the long straight shape of the counter could make it difficult for more than two people to focus on information being discussed with a counter assistant. Similarly, the small size of the books, maps, and leaflets on which tourist information was provided and the lack of surfaces where these artefacts could be laid out and compared restricted the potential for focused face-to-face discussions.

THE TOURIST PLANNER APPLICATION

Following the ethnographic study, we met with the centre's management team, and showed them some existing Surface applications, and sketches of our potential design ideas. We agreed on three overarching requirements: (1) to create a very simple walk-up-and-use interface that would be understandable by visitors who had never used a multi-touch surface; (2) to design an app to encourage groups of visitors to work together to plan their day out; and (3) to facilitate the flow of visitors through the centre by encouraging interactions of less than 5 minutes.

A two-day design workshop was then held where we brainstormed a number of design ideas. We took as a starting point, a group persona of an Australian family of a mum, dad and two girls arriving and wanting to plan a day out in Cambridge. We produced three quite different designs, which were tested using paper prototypes with a small number of volunteers. The final design selected was an interface that had two distinct phases: (i) working around the tabletop to read and select possible places to visit in Cambridge; and (ii) combining the different selections and compromising on a single plan. The first was intended to be carried out by each member individually (but with the possibility of observing and discussing the others' selections) and the second was constrained to encourage group discussion and itinerary planning. The final concept was worked up into a coherent flow and visual design and then implemented in Processing on a Microsoft Surface.

Screenshots of the application are shown in Figure 1. An initial 'attract' screen with animated guide (figure 1: left), was designed to draw visitors towards it and suggest what

Figure 1: Screenshots from the Tourist Planner Application. Left - attract screen; middle- four open decks; right - review screen

to do on first seeing the interface. The layout is intended to show groups and individuals, at a glance, where to stand as they approach: coloured silhouettes of people are positioned on each side of the tabletop with the text "touch to start", the colours also providing an identity to each person. On pressing a silhouette, a 'deck' of cards appears in its place. The deck consists of a rotating fan of 20 cards, of which only 5 or 6 are visible at any time (see figure 1: middle). They appear and disappear from the surface as the deck is rotated to the left or right. Each card features the picture and name of a tourist attraction. Dragging a card out of the deck results in it expanding in size to provide a short description about the site, opening hours and an indication of cost. A card shrinks again on returning it to the deck. Initial testing had found that the shared central area could quickly become cluttered and disorganized with cards being left. Therefore, only one card can be pulled out of each deck at any one time. A card can also be rotated with two fingers to show to other people around the tabletop.

During this initial phase visitors are each able to select up to three cards of potential sites to visit and place them in the three empty slots beside their deck (see figure 1: middle). This simple 'task' is clearly labelled next to the deck. After placing a card into a slot, a large round blue button, with the label 'next step' written around it, appears in the centre of the screen, designed to allow all to see what to do next. They can continue browsing and selecting cards until they have selected all three. Upon one person pressing the blue button a prompt pops up to ask all current users "Are you sure you've finished choosing your cards?". If all touch the "yes" button, the review screen appears (see figure 1: right). If one of them selects "no", it returns to the default deck interface. The idea is that everyone needs to complete their selection before moving onto the next stage.

When all have confirmed that they are ready, the decks disappear and all of the cards from the users' selection boxes are brought together and placed in the same orientation in a row at the 'bottom' of the screen. This same side card placement is deliberately designed to encourage users to move to one side and, if they had not already done so, begin to discuss and negotiate their selections. The idea was for them to reach a consensus on what to visit given their budget, available time and the relative distances.

Several pieces of new information are provided on the review screen as potential discussion points. These include (i) total time the visit will take if they go to all of the selected sites; (ii) a map of Cambridge with pins showing where the selected sites are; and (iii) color coding used for the pins and indicated as small icons on the cards showing who had selected them (based on the initial silhouette color used in stage 1). This was meant to help group members to identify their choices in the group set of cards and to notice whether they were the same or different.

Cards can be rearranged by dragging them left or right. They can also be removed (for example to reduce the time

Figure 2: Tabletop positioned in the tourist centre

of the visit) by dragging them into a box above. The corresponding pins are removed from the map, reducing the overall time to see all of the attractions accordingly. If a card is selected, more information is provided (e.g., whether it is accessible to wheelchair users) than on the previous screen, intended to enable the group to decide whether to keep the attraction in their planned itinerary.

The group itinerary can then be printed out at a nearby printer by touching a "print our guide" button. The first printed page shows the same map displayed on the screen, with all of the chosen attractions marked. Additional pages follow with information about the chosen attractions.

Figure 2 shows a photo of the tabletop positioned in the tourist centre. Much thought was given as to where to locate the tabletop. It was placed at the far end of the centre next to the roped area for queuing for the counter. This is where people have to slow down and wait in line when it is busy, providing the opportunity to observe its use by others. Sufficient room around the tabletop was also left so that people could gather around all sides. We wanted the groups to be able to use it while standing, rather than having chairs around it that might get in the way or encourage people to sit for long periods of time. As a Surface is coffee table height, we raised ours by approximately 25 cm by placing it on a plinth. Steps were provided at either end to enable small children to reach the tabletop. To inform people of what it was and how they could use it, signage in the form of posters was placed next to it and at the centre entrance.

IN-THE-WILD STUDY

The Tourist Planner was studied *in situ* for 32 days. For the first 22, one or both of two researchers wrote field notes (both textual and diagrams of movements around and near the table), based on observations of how people approached and used the tabletop and short interviews with visitors. There were no pre-specified categories of behaviour. The focus on the analysis was progressively developed over the course of the study. For the final 10 days, video footage was also recorded from which clips were selected for detailed analysis.

All of the video footage was also summarised to give an overview of how the tabletop was being used. Following Peltonen *et al.* [18], we divided times when the tabletop

was being used into sessions. If there was more than a 20 second gap between a person interacting with the display (unless they continued to stand facing the tabletop while discussing with others), then this was counted as a new session. In addition, as we were interested primarily in group interactions, if all of the people currently using the tabletop left and different people arrived within 20 seconds, then this was also counted as a new session. Sometimes people touched the tabletop without meaning to interact, for example leaning on it while looking at a map (cf. [17]). These weren't counted as a new session unless that person went on to interact further with the tabletop.

We counted 297 sessions, with a mean length of 2 minutes 10 seconds, although these ranged from a couple of seconds up to 14 minutes, when the tabletop was being used by a large group of users. 158 individuals interacted with the tabletop, as did 184 people in pairs (92 sessions) and 183 people in groups of three or more (47 sessions). If those who didn't actually interact with the tabletop, but were clearly with those who did use the tabletop are included, then the totals are 121 individuals, 204 people in pairs (102 sessions) and 284 people in groups (74 sessions). Thus, while the tabletop obviously enabled individual use, the dominant pattern of interaction was with other people.

Below, we provide a series of vignettes that illustrate in detail how different groupings of people approached and used the tabletop. To begin, we describe how people initially approached the table; second, we outline what they do on first touching the surface and how important the success of that first touch is as to whether they continue to use it; and third, we detail how multiple users congregate, engage with it and interact with others. A striking observation in the third section was how rare it was for groups to arrive together and each stand at a side of the tabletop; instead, they wandered up to it by themselves and then later attracted others in their group to join them. The software was designed to accommodate these kinds of staggered arrivals. However, another unexpected finding was that, sometimes, complete strangers joined someone already using it, unaware that it was a shared planning tool and not a single user application. As it was not designed to be used in this manner tensions arose - that are highlighted.

(i) Approaching the tabletop

People showed quite variable levels of engagement when they initially approached the Tourist Planner. Some walked right up to the tabletop and either looked directly at it for some time, trying to work out how to interact or immediately started to explore the interface. Interviews with some of these participants indicated that they were drawn to the tabletop simply because they were interested in the technology, or by the signage positioned nearby.

Many others would just glance at the tabletop while walking past it and perhaps tap on some of the objects on the screen. If the interface provided immediate feedback, it sometimes led them to explore the interface in a more focused manner. Often, however, they would simply continue past. This suggests that such serendipitous lightweight approaching may not be fully sufficient to draw people in to using the tabletop application.

Figure 3 shows a typical episode. In frame 1 a man is walking through the centre towards the queue with his hands in his pockets. He stops as he draws level with the tabletop and takes his right hand out of his pocket, pausing while he holds a finger over the tabletop (frame 2), looking at the interface. He taps on a silhouette, opening a deck of cards and tentatively taps and then drags out some of the cards (frame 3). All of this time, the lower portion of his body remains pointing in the direction in which he was walking, indicating only a temporary engagement in the activity being conducted on the tabletop (cf. [24]). Finally, he turns his body towards it (frame 4), indicating a longer-term engagement in interaction and begins to more systematically scroll through and read the cards.

(ii) Touching the surface

People approaching the tabletop brought a history of interacting with other kinds of interfaces, which guided their exploration of this novel system. The first touch for most was a tap or double tap, suggesting that they treated the tabletop surface like a mouse or phone. Others attempted 'standard' multi-touch interactions like pinch zooming. Interviews with some of them confirmed that they owned iPhones or other multi-touch devices while others had seen demos of the Microsoft Surface online. Hence, previous experience with multi-touch and other interfaces can influence people's initial finger-tip gestures, i.e., whether they start by pressing, double tapping or swiping, which depending on the feedback provided, will determine whether they continue or walk away.

Most participants worked out how to open the deck of cards by tapping on a silhouette. However, a significant proportion were confused by the animated guide playing in the centre of screen, dragging and tapping on that rather than the interactive sections of the interface. Once the deck of cards had opened, some immediately dragged out a card

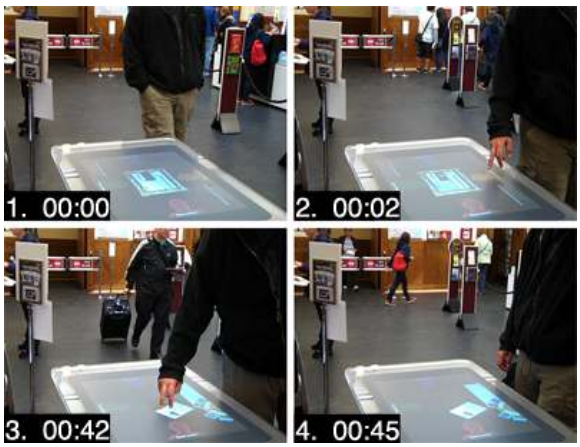

Figure 3: Approaching the table

or rotated the deck. Others, however, continued the strategy of tapping, double tapping or tapping and holding on cards in the deck (some continued by tapping or double tapping the guide text and arrow that appeared on the screen saying "drag out a card"). One serendipitous feature of the design was that when visitors tapped on a deck of cards, it would often wobble slightly. This provided many of them with sufficient scaffolding to immediately realize that they needed to scroll the card deck by dragging their finger.

A usability issue encountered by some visitors was that they approached the tabletop quite tentatively and either tapped on the surface too lightly for the touch to be registered or touched with a fingernail, which again didn't register. A further interaction problem was because there was a slight lag between people starting a dragging movement and the graphical interface responding, people often lifted off their finger before completing their planned interface action, believing that it hadn't worked, thus failing to drag a card out of the deck. In this public walk-up-and-use scenario, people often didn't give the interface a second chance: if they weren't immediately successful in interacting, they would give up and walk away.

(iii) Working as a group

In contrast to the scenario we had used to inspire the design of the TouristPlanner – of a family of four arriving together at the tabletop and all using it – we discovered that members typically arrived at different times and often left while others continued to interact. This is illustrated in the extended series of interactions depicted in figure 4: a woman (W1) arrives at the tabletop (frame 1) and starts to read through the text on some of the cards (another unconnected woman is already standing by the tabletop). She is joined by a man (M1; frame 2) who also starts to read through and select cards. The pair select four cards between them, and print off their plan. As W1 goes over to the printer, two other members of the group approach the tabletop from the entrance to the centre (frame 3). W2 goes over to the tabletop, where M1 demonstrates how the interface works. M2 goes to stand next to W1 at the printer. They talk while jointly looking at the printout.

Figure 4: Group members arriving at different times

W1 and M2 then turn and move closer to face the tabletop. (frame 4). W2 and M1 have by this point selected 5 cards and the group read through information on the review screen about a bus tour. As they continue to look at the review screen, W1 turns and gestures at someone at the far end of the centre (frame 5). Another man, M3 walks over and arrives at the tabletop (frame 6). M1 selects the bus tour card again, so that M3 can see the information. By frame 7, W1 and M2 have turned away from the tabletop again and are looking at the printout. M1 then moves away and walks round to stand behind W1 and M2 as they continue to look at the print-out (frame 8). In frame 9, W1 and W2 both lean in to the tabletop as M3 looks over the review screen. The group all turn to look at M3 interacting with the tabletop and they discuss how long M3's selection will take (frame 10). As the group continue to discuss the selection, M2 turns and walks away (frame 11). Finally in frame 12, the remaining group members turn and walk over to the desk.

Part of the reason for this staggered arrival could be the tabletop being placed at the opposite end of the centre to the entrance. Groups typically split up as they entered the room and started foraging by themselves for information, such as leaflets, maps, etc. By the time one of them happened upon the tabletop, the others in their group were often scattered around the room, with some still near the entrance, another at a PC, and another moving towards the counter. However, once a member of a group of visitors had arrived at the tabletop, they tended to attract the attention of others. This often wasn't deliberate, and was simply a consequence of visibly attending to the application (frames 1 and 2 in figure 4). Visitors also deliberately attracted others' attention towards the tabletop. Mechanisms employed included calling to them (as seen in frame 5 of figure 4), gesturing to signify interest (as seen in frame 3), and, particularly when the centre was very busy, walking over to them and leading them over. Once other members of the groups had been attracted to the tabletop, the person who had been using it would often demonstrate what they had learned.

Types of groups

As mentioned, our design was based on the scenario of a family distributing themselves around the tabletop and each first choosing items of personal interest before negotiating with the rest of the group which things to go and see. While many examples fitted with this scenario, there was huge variation in the configurations of groups using the tabletop, ranging from siblings squabbling for control of the interface, groups of young adult backpackers, pairs of elderly visitors, large groups of foreign students all trying to use the tabletop at the same time and many single users.

Interestingly, when children used the tabletop, adults seemed less likely to use it than if they visited on their own, perhaps perceiving it as a toy. Some parents used the tabletop as something to keep their children occupied as they found out information in different parts of the centre.

While users did frequently spread out around the tabletop, it was also common for two or occasionally three people to use just one deck of cards. Sometimes a different sub-group would select from another. Interviewing groups where only one deck was opened indicated that some didn't realize that they could all interact with the system at once, while others said that they just preferred to work with a common focus.

Levels of focused discussion tended to differ with different configurations around the tabletop. In situations where two or more people interacted with a single deck of cards (as in frames 1 and 3 in figure 5), as might be expected, there tended to be more focused discussion about the content of the cards than in situations where only one person carried out all of the interactions (frame 2) or where multiple decks were open and each person was looking through their own (as in frame 5). However, there were frequent exceptions to these trends. Where there were larger groups, there also tended to be more discussion in the initial individual selection phase. For example, in the situation depicted in frame 6 of figure 5, while two of the visitors made most of the interface actions on the two open decks of cards, the other members of the group were actively engaged in the activity, commenting upon the information contained on the cards. Where a participant played a more passive role, they would often stand slightly back from the tabletop (as can be seen in frame 2 of figure 5).

At the review screen, when the participants' choices were collated and represented on a map and a single collection of cards, the configurations at the tabletop very frequently

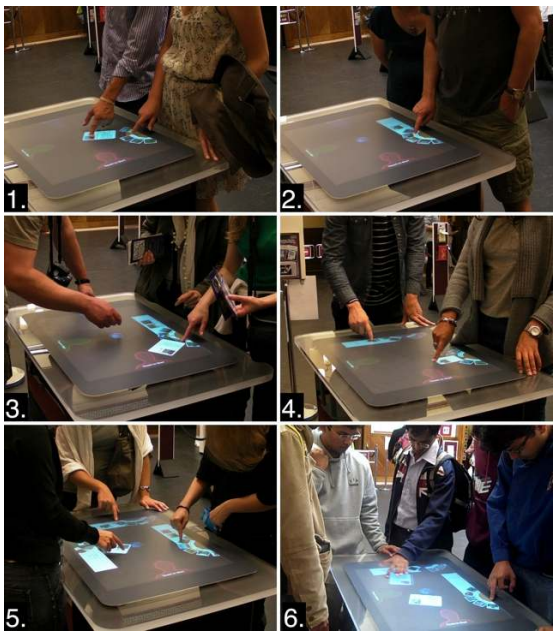

Figure 5: Different configurations around the table

Figure 6: Moving around the table

changed. The majority of participants not on the side with the canonical view moved around to be able to see the interface better (see figure 6), although with larger groups of four or more, there wasn't enough room for all people to move round in this way. Groups who viewed this screen for any length of time also tended to discuss choices more at this stage, while other groups also frequently restarted so that they could make new selections or immediately printed off their guide with little discussion.

Bystanders and observers

People who were not part of the group currently using the tabletop often stood and watched what was going on before deciding whether to use it themselves. This was similar to the stepwise engagement described by Peltonen *et al.* [18]. They would either stand somewhat behind those interacting with the tabletop and watch what was going on, or stand at the tabletop, but without interacting. Children in particular were more likely to stand close to the tabletop when watching others interact. People observing the tabletop being used attracted others' attention, creating what Brignull and Rogers [1] describe as a 'Honey Pot' effect. There was also an effect of the physical context in eliciting observation of tabletop use. People waiting in the queue for the desk would frequently watch what was going on.

As seen before with other large multi-touch systems [8, 18] in public spaces, when a group moved away, onlookers would often immediately take their place at the tabletop, leading to chains of interaction that could last for some time. This is shown in the example in figure 7. A woman, marked OL is standing behind one other person in the

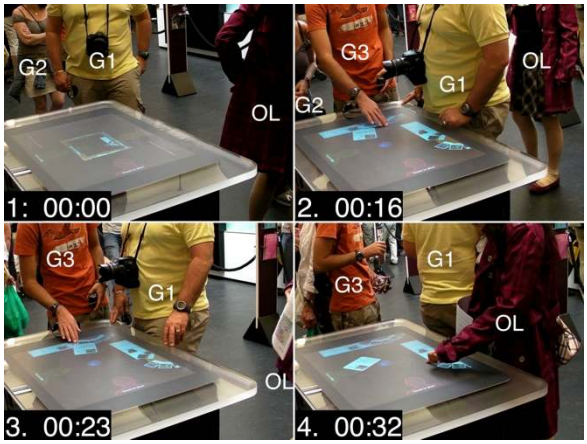

Figure 7: An onlooker (OL) watches a group interacting with the table and immediately takes over when they leave

Figure 8: An unresolved clash between strangers

queue for the desk as a group of three people (G1-G3) approach the tabletop in frame 1. Two of the group (G1 and G2) open decks of cards and begin to scroll through the deck and pull out cards. OL turns slowly and stops to look at the group (frame 2). She steps closer to the tabletop and stands watching the interface, as G3 continues to drag out cards (frame 3). As the group turns and moves away, she moves straight over and starts to pull a card out of the deck formerly being used by G1.

The transition between groups using the tabletop, therefore, was fairly smooth even in busy times. Most people would wait their turn, with the exception of children, who would sometimes invade other's personal space, being unaware of the role of such implicit norms in public places. It also happened on occasions that a stranger would join the tabletop while others were already using it without asking if it was alright to do so – again, such behaviour is rare in the analogous situation where you don't sit down at a table where people are already sitting without asking if it is OK to join them – as described below.

Tensions between strangers

While on most occasions people who used the tabletop simultaneously were members of the same group of friends or family, it was also not uncommon for strangers to attempt to use the application at the same time. As the application was intended for a coherent group to formulate a plan for their day out, this often led to interaction problems and social discomfort, particularly at the point where one user would press the 'next step' button to move on to the review screen. While, similar conflicts were seen with the large vertical interactive surface used in the CityWall project [18], which was designed to primarily support parallel use, it is notable that they are also seen between people interacting face-to-face around a table, where it might be expected that social signals would prevent them from happening. Furthermore, these conflicts were more difficult to recover from than in the Citywall interface, where there was little dependency between the actions of different users.

Here, the interactions between strangers were resolved in three ways. Firstly, sometimes the person or people using the tabletop would leave quite soon after strangers started to use it simultaneously, perhaps feeling that their personal space had been invaded. A second way this kind of conflict could be resolved was for one user's attempts to carry out an interface action to be frustrated by another user and for them to give up and leave. For example, in the situation depicted in figure 8 the woman in the centre of the picture had joined the tabletop after the man on the right had already started to select cards. After they both scroll through the decks and select cards, the man having selected all three of his cards presses the "next step" button bringing up a dialogue box asking each user "Are you sure you've finished choosing your cards" (frame 1). The man presses "yes", but after a short pause, the woman presses no and continues to interact with her deck of cards. This leads the man to press "next step" again and then "yes" on the dialogue box. This time, instead of pressing "no", the woman withdraws her hand and looks at the dialogue box (frame 2). Next, the man drags his finger over the "next step button", pressing it several times, withdrawing his hand, pressing it and then dragging his finger over his deck of cards again (with no response, as the system waits for a response from all dialogue boxes before enabling interaction). The woman at this stage presses "No" and starts to move cards in her deck again. The man moves a card in his deck and then presses "next step" again (frame 3). Again, the woman withdraws her hand and looks at the dialogue box. The man taps a card in the deck and then presses next step again (frame 4), before pressing next step and the deck of cards again. Then, sweeping his hand across the button in an expressive gesture, the man turns from the tabletop and walks away (frame 5).

Finally, these interaction impasses were sometimes resolved verbally through discussion between those using the tabletop. Typically, this caused some social discomfort. For example, in the vignette depicted in figure 9, a man (M1) is selecting cards from a deck at one end of the tabletop, when a woman (W) opens a second deck at the other end (frame 1). They continue to interact without acknowledging each other, and are joined by a second man

Figure 9: A verbally resolved clash between strangers

in frame 2 (M2), who opens a third deck of cards. After selecting three cards, M1 presses next step and all three press "yes" on the dialogue box that appears in front of them.

As the review screen appears on the surface, all three participants look at one another and M1 makes a gesture of surprise (frame 3). After a short pause, M2 says, "Aah. That was me" [pointing at his chest] (frame 4), and then "Sorry". W1 says something inaudible, and then M2 responds "Sorry...you have these ones [pointing at some of the collated cards at the bottom of the screen] (frame 5). After some halting discussion and nervous smiling at one another, M2 removes his card from the collection and leaves the tabletop. W also removes her one card and leaves the tabletop, leaving M1 to continue using it.

While these scenarios usually led to social discomfort and frustration, on occasion they did lead to positive experiences. For example, a young Italian woman was observed trying to use the tabletop when two Brazilian women were already using it. This led to a conversation that resulted in all three women deciding to explore Cambridge together and printing off a map and guide that represented all of their interests.

DISCUSSION

The main finding from our *in situ* study was that cohesive groups often did not come to the tabletop together as a family or cohort of friends, and start planning their day out all together. Instead, on arriving in the centre they dispersed, and when one of them found the tabletop and started using it, the other members would be drawn to it by them waving or calling or by the others noticing later that they were using it. The TouristPlanner app worked well for this; it enabled each new person coming to the tabletop to start at a different time to explore the cards. However, it became more problematic for the second phase of the planning, which requires the co-located group to move to one side and discuss their choices and decide on the final itinerary. If some are still choosing, it means the others have to wait.

This finding that groups split up on entering the centre, gravitate towards the various information resources around the walls and then congregate at the tabletop in a staggered way has a number of implications for the design of tabletop applications for similar public spaces. First, the sense of *multi-user* in the conventional sense is not borne out. Instead, what tends to happen is that people approach the tabletop in a variety of ways. Its use in a public space is more akin to a staggered 'buffet' table style of interaction than a 'dining' table sitting where all come together at the same time and use it. As noted in the introduction, the latter has tended to be the underlying model of lab studies – but may not be appropriate when considering shared applications to be used *in situ*. One possibility is to constrain the tabletop and/or the software so that people do conform more to being like a multi-user group. But as we saw, when strangers come to the tabletop this can cause social discomfort and frustration. Likewise, introducing a constraint to only let the shared app start once all members of a group have arrived might backfire, as the first to arrive might simply walk off again. Another is to provide more signage in the space that it is a group tool, but again it is unlikely that the group would all read it at the same time and realize they have to come together to the tabletop.

Furthermore, the finding, that many visitors approached the tabletop quite tentatively, without exhibiting a strong level of commitment to exploring the interface, suggests that walk-up-and-use tabletops in public spaces face greater challenges than in managed settings such as the laboratory, schools or exhibitions where user interaction is supported (cf. [6]). To enable potential users to make their mind up whether they might like to use the application, designers need to grab their attention immediately to communicate its purpose and mechanisms of interaction.

The positioning of a tabletop in a physical environment can also help groups become aware of how to use it. In our study, it was the visibility of the tabletop in the tourist information centre, that enabled visitors to attract other members of their group to interact with the application, either unintentionally by simply visibly being engaged in interaction, or more explicitly through gestures or verbally. A further feature of the visibility of the tabletop was in generating a buzz about it, increasing the interest of onlookers, and helping them to learn how to use the application (cf. [1, 6, 8, 18]). This was particularly facilitated by the position of the tabletop next to the queue.

Finally, the finding that a significant minority of users had difficulties in interacting with the tabletop points to the need to better scaffold user interactions, particularly while large (vision-based) multi-touch interfaces are relatively rare. That tapping seemed to be the main mechanism by which some visitors attempted to use the interface rather than dragging chimes with Norman's recent observation [16] that "natural user interfaces aren't natural". While parts of our interface were designed to look like physical decks of cards, it also looked like a computer screen and the 'natural' way for most people to interact with these devices is to click or tap on interface icons. That other users attempted to use more 'standard' multi-touch interactions such as pinch zooming highlights the difficulties inherent in designing for multi-touch systems in the transitional phase prior to large-scale uptake of these technologies with well-known interface conventions.

CONCLUSIONS

The in-the-wild study of the TouristPlanner in a public place has shown how a walk-up-and-use, multi-touch interface, intended to be used by coherent groups, can have quite different demand characteristics than those identified in laboratory studies of group work or in more organised settings. Our presumptions about *multi-user* interactions need to be re-examined in light of these new findings,

especially how tabletops are to be used *in situ*. It requires rethinking how shared apps can be designed more flexibly to accommodate the vagaries of *group use,* where individuals, couples, families and strangers, all arrive at different times with different expectations and prior input device experience.

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