# Interactions around a Multi-touch Tabletop: A Rapid Ethnographic Study in a Museum

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**Abstract.** Interactive multi-touch tabletops are increasingly making their way into public spaces such as museums, galleries or visitor centres, aiming to support interactions between friends or families. An 'in-the-wild' rapid ethnography was carried out in a museum to explore the interactions between users of different age groups who gather around a multi-touch table and investigate whether the spatial factor affects their behavior. Observations and interviews focused on the factors that attract visitors' attention, the impressions after the first touch and the group interactions. Honey-pot effect, latency times and the tabletop's physical appearance were the main factors that influenced visitors' behavior. Another interesting finding highlighted the importance of sound in attracting visitors' attention. This study identifies implications in developing engaging and usable applications used in real-world settings and provides suggestions on how interactive installations may integrate into a particularly constrained physical context to support and enrich the overall user experience.

**Keywords:** Multi-touch table; in-the-wild; rapid ethnography; public space.

## 1 Introduction

Interactive multi-touch tabletops are increasingly making their way into public spaces, such as museums and galleries [6], aquariums [9], tourist information centres [16] and other similar sites, aiming to provide access to multiple users simultaneously allowing for playful interaction [11]. The interplay around a multi-touch table between members of a group in such settings is an issue that has recently begun to be investigated. Previous studies have suggested several solutions for improving user experience while interacting with such installations in public spaces, however the context that these interactions take place can result in different behaviors and expectations from the users [11].

This work explores closely the interactions between users of different age groups who gather around a multi-touch table to interact simultaneously in a particularly constrained physical context: a museum's children-friendly room. More specifically, through a rapid ethnographic study [18], this work tries to identify the ways that people, individually or in groups, approach, behave, organize themselves and interact around a multi-touch table.

A. Marcus (Ed.): DUXU 2014, Part IV, LNCS 8520, pp. 434–445, 2014.

Through thematic analysis, specific patterns and themes are identified, coded, analyzed, and reported, reflecting the entire data set of the study. This aims to explore design considerations and understand ways in which such applications could be developed to invite and encourage diverse groups of people to start interacting, as well as support and enrich their interaction and engage their experience.

Based on these considerations, potential directions on the use of multi-touch tables in real-world contexts are discussed and several recommendations are proposed to designers for developing more engaging and usable applications for such systems.

## 2 Related Work on Interactive Tables

### 2.1 In-the-wild vs. Lab Studies

A two-week in-the-wild study [22] was conducted in a museum to investigate how people interact with a tabletop during a visit. Research in public settings has started to emerge and has been used to evaluate new technologies in situ, moving researchers from the usability lab to probe how interactions unfold in a real environment [22].

Although most work in tabletops has been carried out under lab conditions, the importance of studying interactive installations in real environments has been emphasized many times in the past [4; 9; 16; 21; 22; 23]. As opposed to lab studies, findings in real world can map more realistically onto the messy human computer interactions because people are much more unpredictable in such settings [22]. Moreover users can interact more naturally in-the-wild since the researcher's control is absent [22] and the user's attention is on the activity, rather than on the tool [2]. Marshall et al. [16] also highlight that people are often brought to the lab knowing that they are participating in an experiment; they are provided with instructions and someone explains the purpose and functionality of the application to be evaluated. Field studies on the other hand are especially useful in identifying patterns of use, breakdowns, and appropriateness when evaluating a technology [2], something that requires the researcher to be prepared in order to recognize unexpected patterns and events that may occur.

Recent studies undertaken in real world settings such as the home [14], a tourist centre [16] and a museum [11] indicate that people do not always behave in a predefined way, therefore applications designed for such purposes cannot be based on particular specifications. It appears that according to the context, different user experiences can be captured meaning that findings from 'in-the-wild' studies may evoke different design challenges each time.

**First Approach.** The ways that people notice and approach walk-up-and-use tabletops in public may differ. People may first notice the surface while others using it and then approach for further exploration [21]. Additionally, group members often arrive at different times to a tabletop and some might leave while others continue

interacting [16]. This may well be a challenge in a museum where groups of visitors often split up as they enter a room. The honey-pot effect refers to a crowd of people who gathers around a display attracting the attention of others and making it much more likely that they will also notice and approach the technology. Müller et al. [20] argue that the honey-pot effect might be a very powerful cue to attract attention and it has already been observed in several in-the-wild studies [4]. The physical layout in a public space might also influence the way that visitors approach a tabletop and the kind of interactions that take place around it. Koppel et al. [15] introduces many factors to be considered in order to understand the interaction between users and the system, including the location of the display, the architecture of the room or the flow of people. Marshall et al. [17] also suggest that the spatial environment of a public setting can either encourage or constrain social interactions [13].

**Engagement.** The first impression that a tabletop creates is critical to engaging users in public spaces [10]. Marshall et al. [16] highlight the importance of the first touch, suggesting that users might not give a second chance to the interface if they do not experience a successful initial interaction. Moreover, a walk-up-and-use tabletop should be self-explanatory and clearly indicate its purpose [11] so that people can engage without needing instructions [12]. Encouraging users to further explore the functionality of a walk-up-and-use system in public space and pay more attention to its content might be a challenge [12]. People might just be interested in the technology [16] or curious about how it works and not actually interested in the content it presents [11]. Successful encouraging mechanisms can result in deeper engagement as well as enriched and memorable experiences around a tabletop.

**Gestures.** Observing the physical actions that people use on a multi-touch table can say a lot about their understanding of the system, from their expectations towards technology to the challenges they might be facing. Marshall et al. [16] point out that previous experience with other interfaces can influence users' initial 'finger-tip' gestures. Additionally, a recent study by Hinrichs and Carpendale [9] investigated the effects that the presence of other people have on the use of gestures and suggested that users demonstrate gestures to other people even if they are strangers.

**Interruptions.** Interruptions are an unavoidable part of interaction around a multi-touch table especially in public spaces where either groups of friends and families or strangers gather around to interact simultaneously. Fleck et al. [5] argue that interruptions might have a beneficial effect for the ongoing collaboration around a tabletop. As observed in the CityWall study [21] conflicts between strangers encouraged them to interact with each other. However, in other contexts interruptions from strangers may not be perceived positively. In Marshall et al. [16] study there was a case where invasion of one user's personal space while interacting evoked frustration and social discomfort. Studying interruptions is worth examination to understand both the context in which they happen as well as the effects they cause.

# 3 Study

## 3.1 The Setting

The study took place on the visitor information centre in Kirkstall Abbey, in Leeds, UK, over a 12-day period at the end of June 2012. Kirkstall Abbey is very popular with tourists and locals as one of the most complete examples of a medieval Cistercian Abbey in Britain[1]. Over the past nine years, the Chapter House of the Abbey has become a visitor centre, including a children-friendly room used as an exhibition area. A Microsoft Surface1.0 SP1[2] sits inside the room, presenting a collection of historical images of the Abbey as well as objects that were used there via a playful application that enables gestures from multiple users.

The room where the Microsoft Surface is located is used for children's activities, such as drawing, dressing up as a monk or building arches of bricks. It also displays exhibits about the history of the Abbey as visual signs or maquettes. The table is placed at the far side of the room next to exhibits A and B (Fig. 1). There is little space around the Surface but chairs can be placed for visitors' comfort and to encourage them to sit and play for longer periods of time.

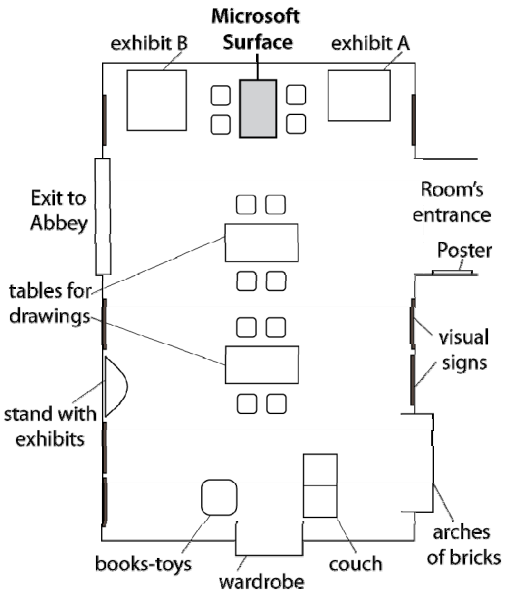


**Fig. 1.** Layout of the room

[1] http://www.leeds.gov.uk/museumsandgalleries/Pages/Kirkstall-Abbey.aspx

[2] http://technet.microsoft.com/en-us/library/ee692060(v=surface.10)

### 3.2 The Application

The Surface Leeds application – designed to support group interactions – was implemented on a Microsoft Surface 1.0 SP1, supporting a set of multi-touch gestures commonly used on interactive surfaces such as dragging, rotating, scaling or flicking.

An initial screen illustrating a 'pebble lake' with sparse ripples draws visitors' attention towards it and encourages their first touch. On tapping the surface, more ripples are generated. At the same time, 4 access points appear in the corners of the screen, representing Microsoft's logo and users can hear a short sound associated with the Microsoft Surface brand. The four corners keep shining and making that sound every 10 seconds for the next 1 minute whether the users touch the surface or not, giving them a hint on where to press in order to start the application.

When users access the main application the screen displays a 'homepage' comprising of four elements: a 'flip view' handle, a 'tips' bubble, a 'show' handle and a 'timeline' bubble. It also presents the Microsoft logo in all 4 corners enabling the users to close the application at any point and return back to the 'pebble lake'.

The 'show' handle on the homepage reveals an 'imageline' from where users can select to view 'image boxes' that include an image (presenting objects of that time), a description and a question card related to the image. On the question card users can see comments from previous visitors and type in their own comment via a keyboard. The application enables users to simultaneously open several 'image boxes'.

The digital 'timeline' bubble is the main element of the application that displays a selection of images of the Kirkstall Abbey (pictures, architectural drawings, paintings, etc.) grouped by historical period. Images are distributed across the table in different orientations but users can move, rotate or even flip them to display a description. In the digital 'timeline' also floats the 'compare-o-meter', a circle where users can drag and drop two images from any period and display both their descriptions to compare the two digital memories. Users can select, move, rotate, maximize or minimize most of the elements of the application and the multi-touch functionality enables them to interact with many of these elements simultaneously.

The 'flip view' handle enables users to change the orientation of all the elements presented on the table. Finally, the 'tips' bubble works as a quick guide illustrating how to zoom in and out, pan and rotate the elements of the application.

### 3.3 Rapid Ethnography

**Observations.** During the 12-days period of the study unobtrusive observation of adults and children who entered the room took place. Observations followed the main principles of ethnography described by Blomberg et al. [1]. A guiding framework was developed using findings from previous observations [23; 21; 16; 12]. The researcher was located at different places in order to observe closely or more discretely as well as to take notes of interactions and conversations that could be overheard.

Field notes of how people noticed, approached, gathered around and interacted with the multi-touch surface were taken during the observations. Atmospheric impressions were documented with a series of sketches in the form of diagrams,

representing movements around the table. The researcher also recorded the approximate time of each group's interaction, as well as each visitor's gender and approximate age.

The notes were expanded each day, immediately after the observation. Those expanded notes summarized in short paragraphs the distribution of visitors within the room and what people were doing. The focus of observations evolved overtime [7] as the researcher noted each day's interactions, added thoughts and impressions of the day and concluded on aspects to be further studied and observed the following day.

Although video interaction analysis [cf. 8; 24] could have been an easier and more detailed method to capture visitors' interactions, it considered unnecessary. Apart from the fact that video recordings cannot capture the "taste, smell and feel" of the activity [1], being in the field was enough to capture the feeling of the events that were experienced.

**Interviews.** Observations were coupled with opportunistic interviews and informal discussions that were intentionally semi-structured and open-ended. 18 short interviews of 3-15 minutes length were conducted with a representative sample of visitors (couples, adult members of families or groups of friends). Most interviews took place when visitors left the table but there were also a few cases where interviewees kept interacting after having talked to the researcher. Most of the interviews were carried out individually but when a group of people had interacted together, members of the group were interviewed together. The total number of adults interviewed was 29.

Questions included visitor's motivation to approach the table, difficulties during their interaction, elements they found interesting and general suggestions that could improve their experience. A guiding framework was initially developed and used however through time and as the researcher understood better the setting, more structured and systematic interviews were conducted [1]. All interviews were audio recorded with interviewees' consent, then transcribed and analyzed according to interview questions and emerging recurrent themes.

**Gathered Material.** Overall, 328 pages of A5 written notes were generated, corresponding to 62 hours of observation. Before the analysis of the data, the notes were divided into sessions. Each session lasted from the moment a single visitor, a pair of visitors or a group of three or more visitors entered the room until they left the room. Even if a person did not notice the table at all, those were also counted as sessions, mainly to report whether the room's layout influenced visitors' ability to notice the interactive display. A grouping of those sessions was identified to assist in the analysis indicating 6 separate types depending on whether the visitors: a) entered the room but did not notice the table at all, b) just noticed or glanced, but did not approach the surface, or passed by without touching it, c) approached and just played with the 'pebble lake', d) approached and tried to understand further what else the application does and e) successfully interacted with the application.

Supplementing the descriptive sessions of each group's interaction, sketches on how people approached the table, positioned or moved around it, as well as the kind of gestures they used with particular interactive elements were collected, supporting the recollection of events and enabling further and more in-depth analysis.

**Analysis.** The method used to analyze the qualitative data was thematic analysis, following recursively the six phases as presented by Braun and Clarke [3]. Through thematic analysis, specific patterns and themes within the data were identified, coded, analyzed, and reported. This aimed to accurately reflect the content of the entire data set through a rich overall description.

In order to get familiarized with the data all the notes and sketches that collected each day were examined, to identify meanings and issues of potential interest (1st step). Therefore, during the study, some initial ideas and coding schemes had already started taking shape. After the completion of the data collection all interviews were transcribed to compare with the observations as well as deduce further possible themes. The next step was the generation of the initial coding (2nd step) by organizing the data in meaningful groups, identifying potential patterns and themes and then sorting the different codes into these themes (3rd step). Each theme that was identified was intended to capture something important in relation to the overall aim of the study. When a collection of themes and sub-themes was identified, the 4th step was the refinement of those themes. This was achieved through exclusion (where there were not enough data to support them) or merging two separate themes into one (where there was no important difference). After refining the themes and deciding how they fit together, the next step was to determine what aspect of the data each theme captured, in order to start defining and naming them (5th step). The last step (6th step) involved the final analysis and writing up of findings.

## 4 Findings

Within 293 sessions, 784 visitors were observed, staying in the room from a couple of seconds up to 60 minutes. 241 visitors did not even notice the table, whereas 252 managed to interact with the application. The rest 291 visitors would either notice the table from a distance or would just manage to play with the 'pebble lake'. The mean length of interaction lasted for 7.5 minutes, ranging from a little less than a minute up to 30 minutes. Only 7 sessions lasted 20-30 minutes and most of them lasted for about 3-5 minutes. A small number of visitors were observed coming back to interact again with the table.

Generally, the majority of visitors perceived the application positively and experienced high levels of engagement. Interviews suggested that the table successfully integrates educational and informative content into a playful application, achieving at the same time its purpose as a multi-touch technology. Interestingly, most of the visitors who stayed more than five minutes around the table and were able to actually read some of the content of the application, would immediately leave the room after having interacted, without being interested in looking at other visual signs or exhibits in the room.

The thematic analysis identified a series of themes. The most noteworthy ones are presented below along with quotations from the interviews that supported the observations.

### 4.1 Noticing and Approaching

What seemed to influence whether people would notice the multi-touch table was mainly its physical appearance (Female, 27: *"To me it looked like a big iPad or something like that...at the beginning it looked like a table game..."*) and the context, as well as whether their natural walking path was directed towards it by other stimuli in the environment. This was confirmed by Müller et al. [19] who argued that public displays installed in specific contexts compete for visitors' attention with other stimuli (like other signs or exhibits). A typical behavior was observed by the younger members of a group who would normally run towards the other side of the room, either to do some drawings or to play with the toys. A considerable number of adults who were visiting alone were observed not entering the room at all and leaving after a quick glance, probably discouraged by the children-friendly nature of the room.

Older adults' postures and attitudes manifested their reservation towards an unknown technology, which would affect their decision on whether and in what way they would approach it. Latency times seemed to also negatively influence whether a visitor would approach or even notice the table. There were occasions where visitors of a group who entered last in the room would immediately approach the other members of their group, who had already moved towards the other side of the room.

Interestingly, whenever the honey-pot effect worked, it could either have positive or negative effects on whether visitors would notice the tabletop. That appeared to mainly depend on whether the effect was created by familiar people or strangers in which case a considerable number of visitors would not even notice it.

### 4.2 First Touch and Impression

Users' first impressions were clearly affected by previous experience with similar technologies and their expectations towards it. They were often overheard comparing Microsoft Surface to similar technologies they had used before (Male, 45: *"Oh, yeah, I've heard of that before, it's Microsoft's version of a big iPad..."*) and they would also compare it to a computer when they could recognise similar functionalities (Female, 65: *"So, the water screen is something like a screensaver?"*). This finding contradicted with Ryall et al. [23] who suggest that "Users do not view an interactive tabletop as a computer".

A novel finding was that the audible sound of the application after the first touch could give clues, either guiding the users on how to interact or re-attracting their attention to the surface. In some cases, even when visitors had already left the table without being able to initiate the main application, the sound generated 10 seconds after their initial touch on the 'pebble lake' would attract their attention back to the table. However, since no other salient feedback was represented to give a clear indication of what was happening, the sound itself would create more confusion than assistance (Female, 75: *"We were listening to the noise but we couldn't understand what we should do. We gave up because we didn't know what was happening."*).

### 4.3 Interaction between Visitors

The interactions observed between older and younger members of a group were diverse. In most cases adults would help younger members to interact, by motivating them and giving them instructions or hints. In other cases, adults would either perceive the table as a toy for children and would not pay much attention to it (Female, 40: *"I thought it was something just for children."*) or would be prevented from exploring the application further because children were 'messing around'.

Nevertheless, the multi-touch surface enabled collaborative behaviors between members of a group or even between strangers that reinforce collaborative thinking and playful interaction. Visitors were able to interact, look at things together, read and write collaboratively. In certain cases, members of a group would even create incentives through the application in order to motivate other members to join the interaction.

When interruptions – mainly accidental – occurred, they would be regarded as "part of the game" and would be easily manageable. A few cases were observed where interruptions led to frustration (Male, 50: *"...I got a little bit frustrated (with my kids) because I wanted to read what was on..."*).

The design elements of the interface did not invite special types of gestures so people's gestures on the tabletop seemed to be influenced by their experience with similar interfaces. Additionally, individuals' gestures would reveal different emotions towards the surface [9] or even insecurities around the technology. The interaction gradually unfolded with visitors usually starting interacting with very subtle movements, revealing an initial reservation towards the surface. A few seconds after the first touch, they would increase the expressiveness of their movements [cf. 20] expressing this way their enthusiasm towards the possibilities of the application. People were observed using either one or both hands to interact, depending on the amount of control they desired to have while interacting.

Finally, there were cases where people would implicitly demonstrate their knowledge using exaggerating gestures to demonstrate to other members of their group or even strangers how to interact. This validated the effects that the presence of other people can have on users' behavior and on the use of their gestures [9].

### 4.4 Usability Issues

Usability problems were mainly observed around cluttered screens, which after accidental touches could interrupt a user's activity causing confusion, tenseness or frustration. Users were frequently observed leaning on their elbows or arms while interacting and accidentally touching the corners of the surface causing interruptions of the interaction, an observation also remarked by Ryall et al. [23].

Usability issues were also related to wrong interpretations and expectations of interactivity. People were observed trying to move or maximize an element that could not be moved or maximized or tapping in a non-interactive element.

## 5 General Discussion and Conclusions

### 5.1 Implications for Design

Latency time and splitting up can frequently happen in places such as museums where people of the same group might enter a room at different times [cf. 16] and follow

different walking paths, attracted by several stimuli according to their interests. Both the various stimuli in a room and the nature of the room itself can influence the walking path that people will follow or even their willingness to enter the room. It would be advisable to consider the location of interactive displays when installed in public spaces so that other exhibits do not unduly draw attention away from them.

Making people notice and calling them to interact with an interactive display in a public space is not easy [20]. Physical appearance seems to attract attention, meaning that incorporating more visible attractive cues might help people notice an installation easier. What seems to be a particularly hard obstacle for users to overcome before they approach a display is their reservation towards technology. A tabletop's appearance could comprise novel and surprising design elements that intrigue all age groups' interests, stimulating their curiosity and motivating them to use it.

The honey-pot effect might have negative as well as positive outcome on whether people notice and approach an interactive exhibit. It might work negatively on members of a group who enter last, since familiar people who are away from an interactive table may draw attention away from it. Furthermore, strangers around a tabletop might not always attract other visitors' attention; if they do, it is less likely for them to join in. Nevertheless, it would be interesting to intensively explore the causes of this effect in similar contexts.

Interactive displays should not be designed in a way that is too complex for users to understand [cf. 19]. That seems to be more important when it comes to the first touch, which determines whether the user will have a positive experience and continue interacting. Therefore, when the initial interaction is not supported by external factors, such as instructions on how to interact, it seems important for an interactive display to provide this kind of guidance to the users intuitively.

A novel finding in this study highlights the importance of sound in interactive displays in public spaces. It appears that properly indicative sounds, along with visual output, could provide clues to users, either by attracting their attention or by guiding them to successfully interact. Assuming that sound can also add to users' experience, it would be interesting to examine further whether it could work as an additional sensory effect in tabletop interfaces in museums or other public spaces.

Interactive exhibits in museums aim to provide incentives for older and younger users to adopt smooth, collaborative behaviors. This is not always possible especially when one of the members of a group is not interested in interacting. Designers could consider that when designing such applications so that the content is addressed both to adults and children in order to engage all age groups at the same level and mediate their attention leading to a smooth and collaborative interplay.

In a multi-touch tabletop located in public contexts, it is very usual that users' actions might interfere. As Fleck et al. [5] argue, when harmless interruptions happen, they can be beneficial and lead to an overall enjoyable user experience. Nevertheless, accidental intrusions may sometimes cause unpleasant disruptions of the flow of interaction. For that reason, it is suggested for designers to consider whether such applications could be designed in a way that enables freedom of interruptions.

As technology is getting more advanced, users seem to have higher expectations of newly introduced systems. Contrary to a few years ago when they were not surrounded by such technologies, they now inevitably compare similar systems that they are using daily in several ways; functionality, capabilities or ways of interaction. Usability appears to be the main factor that does not meet users' expectations of such

technologies. As stated, different expectations and interpretations of interactivity in multi-touch tabletops may result in negative overall experience. Interactive elements could present an indication on how they can be manipulated, giving assistive hints on the functionality, enabling the users to have better control of interaction. Moreover, the interactivity or lack of interactivity of certain elements of the application could be obvious so as not to confuse users on whether they can be operated or not. Providing users better control capabilities through their gestures, without nonetheless restricting the way they interact could enable more pleasant and effective experiences in multi-touch tabletops.

### 5.2 Conclusions

Multi-touch tabletops in public spaces can constitute a novel form of interaction, upgrading the way that friends or family members function as a group throughout their visit. In a particularly constrained context like the one in this study, interactive displays seem to attract visitors' attention and raise their interest more than the static displays. Provided that they offer educational and informative content through a usable playful application, interactive tabletops could even replace the most uninspiring traditional exhibits, enabling a whole different experience for the group.

This study confirmed findings from previous literature, but it also presented novel outcomes that could be used to assist developers in the design of multi-touch tables in such increasingly technology-intense environments. Taking into consideration all the implications to the design of multi-touch tabletops in similar public spaces, further work could be oriented to this direction.

Multi-touch surfaces in public spaces provide a new tool that could positively influence users' lives, providing to the members of a group the opportunity to speculate and discuss simultaneously a number of themes, enhancing their collaborative thinking and achieving a shared experience.

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