From entry to access: How shareability comes about

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From entry to access - how shareability comes about

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Abstract. Shareability is a design principle that refers to how a system, interface, or device engages a group of collocated, co-present users in shared interactions around the same content (or the same object). This is broken down in terms of a set of components that facilitate or constrain the way an interface (or product) is made shareable. Central are the notions of access points and entry points. Entry points invite and entice people into engagement, providing an advance overview, minimal barriers, and a honeypot effect that draws observers into the activity. Access points enable users to join a group's activity, allowing perceptual and manipulative access and fluidity of sharing. We show how these terms can be useful for informing analysis and empirical research.

1 Introduction

We have all experienced not being able to take part during group interaction, for example, with digital content on mobile phones and cameras while other group members are viewing them. To enable all to see, requires handing the device around, sequencing the interaction and providing a meta-narrative for those not in the loop at a given stage. This creates a very different type of user experience than when a whole group can view the same content, such as photos on a large TV screen. There is little understanding of the social interaction that such products alone and in combination are becoming a part of.

We need also to be able to understand how to effectively design for different kinds of shared collocated experiences, where the size, shape and kind of technologies available can vary. While there exist a number of design guidelines, frameworks and literature surveys that draw together empirical and observational findings on how groups of collocated users interact and work with technologies such as tabletops [18], tangibles [6] and large screen displays [2], there is a need also for new design principles that focus on social aspects of the use experience, such as sharing [cf. 1, 6].

Design principles act at a higher level than guidelines, providing abstractions to orient designers to different aspects of their designs and facilitating thinking about trade-offs between one design or another [20]. Examples include feedback, affordance, visibility and transparency. While these have been useful for conceptualizing, talking and thinking about interface design features for the single user and the interface/product [10, 20] it is less certain as to how applicable they are to shareable interfaces and systems that may prove to have quite different properties. We propose the

principle of shareability as a way forward in this area: referring to the extent that a system, interface, or device engages a group of collocated people in shared interactions around the same content (or object). Its focus is less on the particular properties of one type of device or interface that render it suitable for supporting collaboration and more on general notions that can be applied to all kinds of shareable technologies. In this paper, we describe what we mean for an interface or artifact to be shareable, and propose two core components: *entry* and *access points*, and unpack these.

2 Aspects of Shareability: Entry and Access Points

Sharp et al. [20] propose shareable interfaces as an inclusive term for systems providing multiple inputs and supporting interaction by a group of users. All group members can point to and manipulate shared content while simultaneously viewing the interactions and having a shared point of reference. Shareable interfaces thereby support people working, learning, playing, and discussing together, focusing on the same content while physically co-located and co-present. This term encourages a focus on the kinds of activity to be supported rather than on the design of an interface per se or on a particular type of system (such as tabletops, interactive wall displays, tangible interfaces or appliances).

Here we extend the notion of shareability to refer to any system, interface or device that supports co-present, shared, focused interaction, for example, cameras with large displays, and interactive gameboards. While this general notion seems intuitively clear, it remains to be determined what are the shareable properties afforded by the technology and the system design. In particular, a main attribute of shareable systems, interfaces or devices is the provision of multiple inputs that can support simultaneous interaction. The size, orientation, and input capabilities of a system is likely to have an effect on the emergent interactions among groups [18], but there is little research on what these might be. Initial work provides evidence that the provision of multiple inputs can support simultaneous interaction by group members [23, 26].

We here conceptualize these influences, building upon our prior work on *multiple access points* as an aspect of embodied facilitation [5, 6] and our adaptation of the notion of *entry points* [17]. These concepts refer to two levels of user engagement with a system, interface or device; firstly, they need to be motivated to interact with the system and secondly, must know how to and be able to use it.

The terms entry points and access points have been discussed within computing and design to refer to the ways that the structure of the environment or an interface can mediate interaction with it [e.g. 3, 5, 9, 10, 17]. Entry points are defined as environmental structures or cues that invite or remind people to do something [9, 10]. Examples include the headlines on a newspaper or the headings and links on a webpage, guiding the reader to aspects of the content that may be of interest to them. Similarly, leaving an unfinished piece of work open on your desk can act as an entry point into reengaging with the task the following morning. In the sense of attracting interaction, entry points are related to the Gibsonian notion of affordance that has been popularized in interaction design [13]. In addition, the concept of entry points potentially provides a way of thinking about how to design for shareability in a way

that affordability does not. It does this by focusing on the structure of users' activity as well as the kinds of feedback to give relative to the spatial configuration of design elements [15]. Access points refer to the potential of multiple input elements or locations to support participation and social interaction as an aspect of embodied facilitation [5]. Here, we expand the notion of access points to comprise manipulative, perceptual and social elements (see figure 1).

The two concepts describe the different aspects of shareability in terms of:

- *Entry points* denote design characteristics that invite people into engagement with a group activity and entice them to interact
- *Access points* denote characteristics that enable the user to actually interact and join a group's activity.

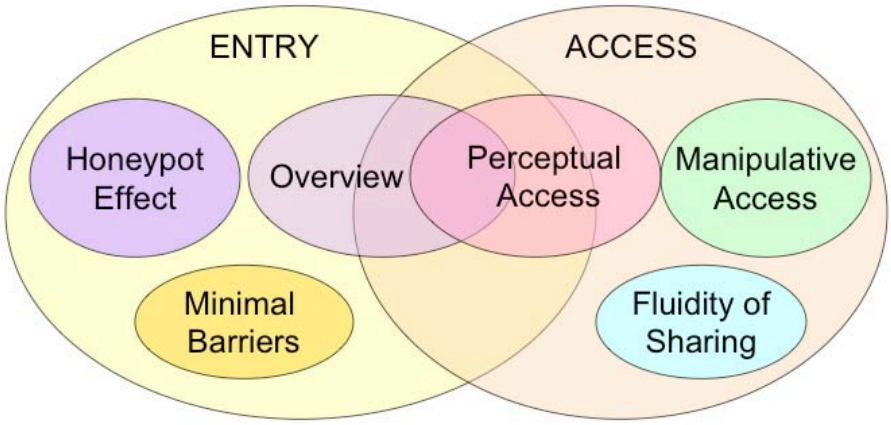

Fig1: A view of the relationship between elements of entry and access points for shareable interfaces. An *overview* of what the system has to offer and what one can do with it allows potential users to plan their approach. Overview can be given through the system itself or through watching others interact with it, which can provide an attraction point in itself, motivating active engagement *(honeypot effect)*. *Minimal barriers* are designed to make it easy for people to move through the entry points. *Perceptual access* refers to being aware of what a group is doing, allowing an individual to join and enter an ongoing interaction. *Manipulative access* refers to being able to actively interact with the system, while *Fluidity of sharing* denotes how easily people engaged in shared interaction can switch roles or interleave their actions. This diagram may also be thought of as having a temporal element from left to right, as perception of entry points will typically precede the perception of access points in an interaction.

The distinction between entry and access is one of level rather than a sharp categorical difference. Access refers largely to making it possible to do something while entry refers to inviting people in, showing them how they can move into the space and help detect access points. Entry points thus support the provision of access points and are typically perceived prior to access points in an interaction. In the next sections we unpack the notions of entry and access points further, showing how they relate and

describe how they might be used to analyze existing systems; to generate empirical research questions and as principles that can inspire design ideas.

2.1 Entry Points

Entry points invite people and entice them to interact with a system or product. Kirsh [9] first conceptualized entry points from a cognitive science viewpoint as structures or cues that invite you to do something, to start with a new task or to enter an information space. His interest is in how people set up their environment with 'entry points' (post-its, open books and folders) to remind or cue them of work items and tasks. Entry points differ in a number of dimensions including intrusiveness, richness, visibility, richness and freshness. Intrusiveness refers to how attention-drawing and sensorially attractive entry points are; richness refers to how much advance information they provide and how well they trigger memory; visibility refers to how distinct and unobstructed their perceptibility is and freshenss refers to newness or last use. In addition, Lidwell et al [10] have described entry points as an example of universal principles of design. They define them as "a point of physical or attentional entry into a design" and list three key features:

- *Minimal barriers* do not impede people from getting to and moving through the entry points
- *Points of prospect* allow people to become oriented and to survey the object in question with enough time and space to review their options
- *Progressive lures* entice people to incrementally approach, enter and move through the design

This list of features focuses on *first entry* to a design and on *enhancing the users' motivation and curiosity* Both Kirsh and Lidwell et al.'s views of entry points share the notions of inviting someone to do something and providing visibility, overview and advance information. Their focus has largely been on one user's interaction with the environment. Here we see how it can be extended to collaborative settings, drawing on Rogers et al. [17] and Brignull's [2] frameworks, which conceptualize how the design of collaborative systems can invite people into shared interactions.

Rogers et al suggest how entry points can be used to refer to a work context in terms of a user's perception of the state of digital and physical resources. They can be designed to encourage or inhibit a person towards entering physical or digital spaces and acting upon them. A further extension was to operationalize the concept in terms of a hypothesis: the more an interface invites group members to enter at various points at appropriate times (i.e. the least it constrains interaction), the more likely it is that equitable participation will ensue.

Brignull [2] (see also [3]) investigated the properties of community displays that encourage people to engage in informal social interaction in communal spaces. These included whether a system allows 'entry' within the available time frame, whether this can be done spontaneously, and the social context (whether interaction is individual or in a group). The social ecology of the setting is thus included in these factors. Entry points in these situations are viewed as either 'open', allowing an interaction to proceed, or 'closed', preventing it. The implication of closed entry points is that they

can slow down or deter users' buy-in to the system. Offering a diversity of entry points enables different levels of engagement, allowing for gradual adoption and appropriation of a system.

2.1.1 Progressive lures and the honeypot effect

Progressive lures, as introduced by Lidwell et al. [10] encourage people to incrementally approach, enter and move through the design. This aspect of the design principle is related to the interaction design quality of 'seduction' [11]. The structural design of a shop or a web site may slowly draw people into more intense engagement, pulling them through a series of entry points such as compelling headlines or the display of popular products in sight of the entrance. Progressive lures thus offer the promise of an interesting or satisfying experience, with a reward being given at the next point of decision and the next lure in sight. They have a temporal aspect, and can be designed to unfold sequentially.

Brignull and Rogers' [2, 3] framework proposes gradual buy-in as a way of luring people to participate in a social setting using a shared display. To encourage people to take part, low commitment activities should be designed at the beginning that can lure people into more engaging activities (if they want to) later on. Furthermore, progressive lures can also have a social component, a *honey-pot effect* where "the manner in which the public availability of interaction with a large display enables passers-by to oversee and choose to join in, allowing group congregations to form spontaneously, without the need for any planning or coordination work". (A honey-pot is a metaphorical term describing something with attractive features that draws people to it, getting them to congregate and socialize in its vicinity). Observers are thus drawn in by watching others and passing through several stages of engagement, from a "threshold of attention", becoming aware of the display and deciding whether or not to learn more about it, to a "threshold to interaction", in which an observer decides whether or not to interact with the display. Also, through overseeing the activity of others, observers can informally learn how to use the system (if interaction is visually apparent). The honey-pot effect creates a positive feedback loop, whereby once there is a crowd of people, this becomes self-sustained as people are stimulated to find out more about what the crowd is involved in and to join in the social activities, or, after having seen evidence of its value for others, are motivated to have a go or want to contribute to the overall activity.

The design of the physical setup determines whether a honey-pot effect can occur (e.g. if there is enough space for observers and participants, whether activity gets noticed etc.). The shareable artefact needs to be visible so people become aware of it, even in a first time encounter, and it needs to communicate its "nature and function clearly and concisely" [2]. Furthermore, it is central that the application domain and content of the activity are interesting enough that bystanders may develop the motivation to interact.

2.1.2 Points of prospect and overviews

Entry points provide an overview and preview of what is contained in the space to be entered and what one can do there. Points of prospect focus on the placement of entry points and their overall configuration. They allow people to become oriented and to

survey the object in question, giving them enough time and space to review their options [10]. If the spatial setup of a store does not allow a visitor to stop and look at a display because the crowd is pushing him or her forward, then this does not leave enough time to become interested and to decide to enter this area.

Points of prospect are thus less about the actual cues in isolation, than on their visibility in context and from a distance. We should note that this refers not only to the visibility and observability of the system space, but also to its legibility – it needs to be visible *what* the user can do and also *why* this might be relevant. Making visible what one can do furthermore implies the visibility of access points, i.e, *where* one can actively manipulate. They are concerned with not just one item (like a doorhandle or the greenness of one apple), but with the entire environmental configuration that the system is located in and the resulting at-a-distance perceptibility.

Points of prospect and overviews can also draw observers into the interaction after watching others, joining or following them, thus enabling the 'honeypot effect' discussed earlier. Brignull [2] suggests: "The informal social interaction that takes place in the vicinity of the Community Display is just as important as direct interaction with it… The vicinity needs to be large enough to house a gathering of people, and be considered comfortable." Positioning and flow, i.e. line of sight and flow of movement, will determine whether the content and the people interacting are visible, whether people come into the vicinity, and whether they have enough space to congregate.

2.1.3 Minimal barriers

Another aspect of entry points is if they are to be communicated, there should be few barriers [10], or closed entry points [2]. In their simplest form, barriers could be physical, for example an interactive museum exhibit could be positioned in an alcove blocking a clear point of prospect from most angles, or a group of people surrounding a screen could block the view for observers. However, they could also be aesthetic: someone is less likely to be attracted to interact with an interface or product that they do not find visually appealing; Brignull [2, p. 97] suggests using an "aesthetic wow factor" to capture attention. A further barrier to entry might include illegibility to the user. If a person does not understand what they can do with a system or why, then an entry point will be ineffective. The design of entry points must therefore be appropriate to the target user group; a good entry point for adult museum visitors will be different to one designed for a group of children.

There must also be the time and opportunity to interact. A system requiring tedious registration of peripheral devices, a long start-up time, or lengthy interactions would not offer an entry point to someone in a hurry [2]. Nevertheless, barriers can also be positive, providing a quick overview of what one can do, simplifying decisions, disambiguating, and channeling activity (cf. the design principle of constraints [13]).

2.2 Access Points

Access points denote characteristics that enable the user to interact, to participate and join a group's activity. Pinelle, Gutwin, and Greenberg [14] discuss negotiating access and transfer of objects as core actions (basic mechanics) of group work. Manag-

ing shared access to work artifacts, the workspace itself and time (e.g. who is active when) involves obtaining a resource, and is influenced by the workspace size as one needs to take the object into one's hand or to physically occupy an area of space. Coordination of a resource is eased if it is easily perceptible whether it is free to use and if it is possible to anticipate the intentions of other group members by observing their behavior. Managing shared access further involves reserving something for future use, by either bringing it into one's proximity or blocking access for others.

The concept of access points [5] was initially introduced to refer to options to see "what is going on" and to actively manipulate relevant objects, determining the opportunities to observe and to become involved hands-on. Systems might be analyzed in terms of the resources that allow people to access and interact with the objects of interest (enabling them to participate and have a say) and in terms of privileges and limitations of access that may affect the power structure of the group. The number and location of access points are important, as too is simultaneous access, which can distribute control in a group. There is evidence from a number of field studies, e.g. of children's learning with tangible interfaces or multi-mouse systems, that the provision of multiple access points leads to less conflicts, shifts power away from the verbally articulate or more self-assured and supports equal participation and more equal roles in interaction [25, 24]. A range of questions seem suited for empirical study, such as the influence of size and form of interaction spaces and number of input devices; a possible systematic relationship might exist between task, number or location of access points, number of actors and interaction patterns. [5]

Similar to the previous discussion of entry points, access points are related to, but different from affordances. While a single input device has affordances, e.g. for picking it up, with access points we consider the entire configuration that the device is a part of, where it is located, how many devices there are, how the space is shaped etc.

Summarizing, access is seen as having a *perceptual* component (to observe and understand what is going on) and a *manipulative* component of actively engaging with the object of interest. Observing and understanding the activity is a prerequisite to becoming involved and furthermore enables a group member to contribute verbally (even if manipulative access is not possible).

2.2.1 Perceptual access

The importance of perceptual access to a social activity and awareness of what others are doing have been discussed in many studies comparing co-located versus on-screen interaction [14]. The observer is constantly engaged in gathering information and inferring what might happen next or what other participants' intentions are in order to adjust their own behavior. This supports being able to understand the activity better, to react adequately and to join in.

Manual manipulation of objects in the real world (not via mouse and keyboard on screen) is characterized by three categories of visibility [14]:

(1) body movement, posture and gaze provide perceptible signs of the action taking place and allow it to be followed 'in real time' as it unfolds (consequential communication)

(2) an action can be anticipated as precursors to it can be observed, such as moving one's hand toward the object and changing its form to a grasp pattern

(3) effects of the action on objects are directly visible or perceptible (feedthrough, [4]).

How much an observer notices depends on his or her attention and the 'volume' of these signals. Moreover, it is not just the visibility of the actions of others but the legibility of actions that determines whether an observer can make sense of something happening. Legibility for bystanders tends to be a problem with gestural interaction with computers, as for observers it is often not clear whether someone is addressing a computerized device (or which out of many) or 'just' gesturing, especially if the device's reactions is non-perceptible. An issue discussed often in tabletop research is how to provide an optimal view of the objects of interaction for all participants, focusing on the legibility of the representations used [18]. For example the orientation chosen for text may provide a privileged viewpoint for one group member.

2.2.2 Manipulative access

The *number and type of input devices* used in the design of a shareable interface or product are important factors in determining who can interact and when. This can also have a significant effect on the type of social interaction. These effects will vary with the kind of interactive task being carried out and with different user groups or social settings. For example, Stanton and Neale [24] describe how increasing manipulative access through the provision of multiple mice enabled individual children to take part more actively in a collaborative drawing task, however it also decreased the number of collaborative interactions relative to when children had to share a single mouse: when provided with multiple manipulative access points in this way, the children tended to work in parallel on different parts of the drawing rather than discussing or working together on the same part.

One way of increasing access is multiple points of access [6], provided through multiple interaction objects that distribute control or through spatial distribution of input points/areas. Resources for access can refer to the ability to touch something, reaching out to it and having a chance to do so. There can be variations in the type of multiple inputs provided, consisting either of a number of identical objects or a diversity of specialized objects or devices. This will affect collaboration patterns, influencing how much coordination is needed. *Simultaneous interaction* increases the ability to work through multiple access points since group members will not need to compete over a 'time slot' for interaction. This enables shy and people to contribute more easily (in physical action), as they do not need to wait (and fight) for their turn in the conversation (cf. [16]).

The *size and form of an interaction space* can have important effects on the ability of users to actively participate and their social interaction with other users. This involves reach, visibility, but also social norms and social atmosphere. Certain physical configurations seem to provide social signals that can influence social interaction patterns. Standing around a table or in a circle creates a shared transaction space [8, 26] from the overlap of personal transaction spaces (a half-circle in-front of one's body that one can see and interact within). Establishing a shared transaction space tends to initiate social interaction [8], providing a social signal of appropriateness of interaction. Designers could intentionally manipulate these social signals by providing and enforcing specific physical configurations [5]. There are natural limits to shared

transaction spaces, determined by physical laws of visibility, audibility, and the ability to enter and physically occupy a space.

In a comparative study based on the same task with different size tables Ryall et al. [17] found that groups evolved different work strategies depending on table size and distribution of resources (a single printout versus multiple copies of an important item). They identify as important issues the availability of resources and their position along with physical reach and visibility. Thus, the size and form of space interacts with the number and type of input devices. Toney and Thomas [28] introduce a formal mathematical model based on anthropomorphic characteristics predicting workspace segmentation and territoriality in tabletop interaction. This model essentially is based upon the 'reach envelope', that is the distance easily reached by the arm from the shoulder angle point. It assumes that the area comfortable for bimanual action will be used as primary working space, and predicts the impact of shape, height and position of the workspace. Based on this model the optimal size of a table in relation to the number of users (and their height) can be calculated. A limitation is that the model assumes a seated user who does not move around the table.

Toney and Thomas' work implies that users should be provided with a comfortable engineered area in which to work. However, interesting social effects might also result from violating this rule. Research in cognitive science has shown a link between physical activity and processes such as attitude formation and emotion [12]. For example, pushing upwards on a table from underneath (pulling something towards yourself) can be associated with positive attitude formation about a novel stimuli, whereas pushing down (an action associated with avoidance) can be associated with the formation of negative attitudes. It is therefore possible, that designing interactive spaces that are 'too big' for users might influence the attitudes formed during interaction by necessitating reaching for and pulling interface elements towards them.

The ease of getting hold of resources, that is to 'access the access point' is related to the number of input devices, the size and form of the interaction space and the location of input devices or areas within this space and also by the number of people who can reach for a device or area, potentially competing over control.

2.2.3 Fluidity of Sharing

By fluidity of sharing we refer to how easily people engaged in shared interaction with a system can switch roles or interleave their actions, handing over control, continuing somebody else's action at mid-point or inserting something into it. This is important, as in truly collaborative discussions it is often not possible to determine who contributed what. Often people will continue each other's sentences, add to them or tweak their ideas in a different direction. Collaborative learning or discussion aimed at the creation of shared understanding or 'co-construction of knowledge' [21] is often characterized by this discourse pattern of argumentative dialogue [27]. Video analysis of such session usually reveals that there is no single author of an idea; instead, it evolves in the dialogue between the participants [22; cf. 7]. This indicates that the ability to fluently continue or react to each other's thoughts and statements (verbal or nonverbal) is important for supporting creative discussions. Furthermore, the ability to continue, add and intersect allows others to demonstrate agreement or

shared ownership 'on-line', while the person talking or contributing to the ongoing task continues with their statement or manual activity.

Work on tabletop collaboration often emphasizes the importance of providing individual territories or of distinguishing ownership of objects and providing access control for owned objects. Yet distinguishing the author of a contribution can be detrimental as it can inhibit fluid sharing and interleaving of action, emphasizing individual ownership instead of the shared creation. Wang et al. [29] discuss a dimension of sharing content, which is the psychological notion of ownership. They found that the provision of 'ownership markers', indicating that an item is owned by someone or acting as 'defensive markers' to thwart access by non-owners, increased task completion time for a collaborative puzzle on a tabletop system. Markers seemed to enhance the feeling of territoriality, made people feel less as a group and more uncomfortable and competitive. This finding suggests that is often more useful to emphasize shared creation instead of individual ownership.

3 The design principles in use

We have discussed the two overlapping design principles of entry and access points as part of the overarching notion of shareability. We have described how entry points might be thought of as attracting people into a social interaction by providing an overview of the interaction space, by encouraging and utilizing social groupings to draw more people in (the honeypot effect) and considering the effects of barriers to the interaction. We have also described how entry points can lead to access points, which are the elements that actually allow (or prevent) interaction. These include perceptual and manipulative elements and can also refer to design features that allow users to switch roles, for example by passing an input device to another user.

In contrast to design guidelines, which offer a prescriptive set of rules or approaches to follow, design principles provide a set of abstractions designed to sensitize the designer to different possibilities. Entry and access points can inspire designers of shareable products and facilitate their thinking about the trade-offs associated with different design decisions. Below we show two further ways that the design principles we have described might be used: (i) facilitate the analysis of existing shareable interfaces or products, and (ii) to generate research questions that can be explored experimentally.

3.1 Analysis of a Shared Museum Installation

We introduce an example from one of our own studies in evaluating and developing recommendations for museum exhibit design. As part of a larger exhibition on modern media, a blue screen studio in the typical set-up for TV news was constructed in the Technical Museum Vienna. Here visitors are led through reading the news by instructions on a touch screen and can videotape themselves. The video is overlaid with the local TV news intro and logo and shown in public.

Figure 2. Visitors in the exhibition – a three step approach to the NewsRoom:
a) long distance view, attracting attention,
b) focused attention
c) close-by observation and lining up

The photos in figure 2 show how the set-up calls for attention. This not only refers to the physical set-up but also for the use of color and light. The large room is relatively dimly lit and densely populated with benches and seated exhibits. Standing, one sees through the entire room to the Newsroom, which is well lit, with a bright blue background. This point of prospect drew people to the installation and to observe other visitors using it (the honeypot effect), often coming back several times. A further noticeable feature is the long aisle leading up the podium. Similar to a stage, it separates observers from interactors and turns both interacting and observing into a defined, distinguishable activity. The long aisle appears as a threshold for some visitors, but also attracted curiosity. Figure 2 shows three stages of approaching the installation that appear to provide a form of progressive lures. From the center of the digital room, observation is a peripheral activity, in which visitors may become interested and move closer. The balustrade provides the location for focal awareness activities, where people observe and socialize. Here there is a shared focus for a large number of people, which provides content for chat (honeypot effect). Standing at the podium is the last stage of direct interaction. Moving from one activity to the next means crossing a threshold, and from observation visitors acquire an understanding of what the next stage offers them (overview, progressive lures, and the honeypot effect). While actual manipulative access is limited to whoever is on the podium, the medium

of video does allow for a group to perform in front of the camera, e.g. improvising a quiz show format.

It was evident that visitors learned how to use the installation through observation and became keen to do it themselves largely through observing others. Furthermore, observation indicates that without seeing other visitors interact, some visitors did not recognize it as an interactive installation, as solitary visitors on quiet days often did not walk up the aisle. Observing other users demonstrates the functionality, shows its desirability and gives insight into how to interact.

The overall study analyzed visitor interaction with a larger set of installations in the exhibtion. It also revealed how the physical setup affected the maximal group size and level of involvement [5, 6]. Small touch screens were used by one person or pairs while larger setups with physical input devices and some distance to the screen were used by entire families and small groups. Visible and manipulative access for smaller touch screens simply got blocked with as few as two visitors in front of it. With the latter, the larger setup increased visibility of the screen, enforcing a larger circle around the installation, and eased observing what the others in the group were doing (perceptual access). The physical input devices further eased taking turns or distributing subtasks of the activity (manipulative access).

3.2 Generating research questions for experimental studies

A focus on access and entry points encourages a more comparative approach to thinking about the design of interfaces for shared use. It can be used to generate a number of more specific research questions and hypotheses that might be investigated experimentally. For example, increasing the number of access points to a shareable interface might be expected to have the general effect of leading to more equitable collaboration and making it easier for less dominant members of a group to join in [e.g. 16] In contrast, collaborators' awareness of each others' activity with a shareable interface might be expected to be highly related to the type of access point: the more overt actions of someone using a direct touch interface such as a DiamondTouch table [21] would be expected to lead to increased awareness as compared to the more subtle movements of someone using a mouse. We are currently designing experiments to uncover the relative effects on collaborative activity and dialogue of different numbers and types of access points to a shared horizontal display. Of course, it is not to be expected that these findings will extend to all user groups and types of collaborative activity. In future studies we will investigate how different configurations of access points will influence collaboration for a range of collaborating groups and activities.

A second example of how these design principles might generate research questions for experimental studies is in the placement of shareable interfaces such as museum exhibits or shared displays within space. If points of prospect are important in drawing users in and letting them know what interaction is possible, then there should be particular relationships between the structure of space and the positioning of these technologies that are more effective than others for particular purposes. This kind of relationship has been described by Scupelli et al. [CHI poster] who have proposed using the architectural concept of isovists to place shared displays within hospitals to increase informal communication between different groups of workers. An isovist is

defined as the area visible in all directions from a particular point. They may represent one way to operationalize the concept of points of prospect in experimental studies. Scupelli et al. have suggested that positioning shared displays in areas which maximize the overlap in isovists between different groups of workers in a hospital might increase informal interactions between coworkers. They present preliminary evidence to support this hypothesis.

It should be possible to use isovist analyses of different physical spaces to make hypotheses about how shareable interfaces placed at different positions within the space will be used and it will be possible to test these predictions experimentally. We predict that it will be possible to operationalize other elements of the shareability in a similar way to generate experimental designs for particular contexts.

4 Discussion

Design principles provide abstractions to orient designers to different aspects of their designs and facilitate thinking about trade-offs between one design and another. In applying the principle of shareability, it is therefore important to remember the role of context; many of the phenomena we have described here are influenced by social rules and etiquette, including cultural norms. To take museum exhibits as an example, visitors in arts museums need very explicit signals about being allowed to touch exhibits, because it is normally prohibited to touch arts objects. In science museums touching exhibits is more normal, and there is a long history of hands-on exhibits. Visitors are used to these genres and interpret things accordingly. At the same time the entire set-up and design of a museum will influence people's perception of appropriate behaviors. Furthermore in different cultures and groups there are norms for what is considered appropriate behavior, e.g., to touch an object at the same time as somebody else; which kinds of objects one would share, and on how much physical closeness with others is considered normal. These norms can greatly influence whether people mind reaching over somebody else's arms to manipulate an object or shared interface.

Although we began this paper by describing some of the issues related to sharing content on small devices like mobile phones and cameras, in describing the design principle of shareability, we have focused primarily on large sharable systems intended for collocated groups, such as public displays and tabletops. It is currently unclear how well the elements of shareability that we have described might apply to these small products and devices.

One possibility is that focusing on access and entry points with these devices might lead to creative design to work around their limitations. For example, extending the number of manipulative access points by facilitating the sharing of digital content across multiple devices or designing a mini projector to enable pictures from a digital camera to be projected against a surface, increasing points of prospect and drawing people in to social conversations. It might also be possible to analyze new products in terms of their shareability. For example, might the touch interface and size of Apple's new iPhone encourage more sharing?

Conversely, it may be that a completely different set of design principles are necessary to think about shareability on small devices. We believe that uncovering the issues particular to sharing small device will be an important focus of future design and theoretical work in this area.

5 Conclusion

In this paper we have presented a design principle of shareability, which refers to how a system, interface, or device engages a group of collocated, co-present users in shared interactions around the same content. We have described it as comprising two main components: entry points to the interaction and access points to participation. These components were further operationalized in terms of a number of abstractions, intended to highlight core aspects and trade-offs that need to be considered in designing and evaluating shareable systems.

We have found the design principle of shareability to be useful in the analysis of existing systems and in framing experimental questions about the properties of particular shareable systems. However, we believe that the primary use of shareability will be as an abstraction to help designers think about trade-offs in the creation of new products for multiple users. The utility of shareability as a design principle will therefore only be determined by its use in design.

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