Social Coordination around a Situated Display Appliance

Kenton O'Hara[π], Mark Perry[τ] and Simon Lewis[π]

[π]*The Appliance Studio, University Gate, Park Row, Bristol, UK. {kenton, simon}@appliancestudio.com*

[τ] *DISC, Brunel University, Uxbridge, UK. mark.perry@brunel.ac.uk*

ABSTRACT

Advances in display technology are creating more opportunities for situating displays in our environment. While these displays share some common design principles with display-based interaction at the desktop PC, situated displays also have unique characteristics and values that raise particular design considerations and challenges. In order to further understand situated display design we present a field study of RoomWizard, an interactive room reservation display appliance designed to be mounted outside meeting rooms. The findings illustrate important ways that individual and social behaviours were oriented around the persistent situated displays. These observed behaviours are discussed in relation to particular design characteristics of RoomWizard. We conclude by highlighting more general themes supporting the design of other situated display technologies.

KEYWORDS: Situated display, peripheral display, appliance, field study, room reservation.

INTRODUCTION

Within the field of Human-Computer Interaction, display-based interaction is one of the predominant areas where we have a considerable body of design understanding. The vast majority of this understanding centres around interaction at a desktop PC display where an individual is in a relatively bounded context in terms of proximity to the displayed information and where the interactions are typically a central focus of user attention.

If we look around or environment, however, there is a huge array of information display artefacts available to us. For the majority of this displayed information, its value is not dependent on it being constantly at the focus of our attention. Rather, much of the time, this information remains peripheral to our primary goals and attention (cf [9]). But being situated in particular contexts and locations, these displays move fluidly into focus at appropriate points in our activity contexts. In line with the visions of ubiquitous computing and advances in display technologies, there are increasing opportunities for technology to play an ever more sophisticated role in the presentation of this situated information.

Situated display technologies cannot simply be regarded within the same interaction paradigm as displayed-based interaction at the desktop. While there are undoubtedly some

common principles, there are also many unique characteristics of situated displays that present us with particular design considerations and challenges. There are also many unique affordances of these display technologies that can have an important impact in the way they shape both individual and social behaviour. Within the HCI community it is therefore essential that we develop a consolidated body of understanding around these affordances and design considerations. Whilst there are already a number of existing efforts [5,6,7,9,13,14] contributing to this aim, these studies are limited in number and focus. This research programme needs to be accelerated as such technologies become ever more pervasive.

In this paper we present our own attempts to contribute to this body of knowledge by discussing ethnographic fieldwork observations around a new situated display appliance called RoomWizard that displays basic room reservation information outside a meeting room. Whilst we recognise that room reservation software in itself is not of particular interest to the CHI community, the focus for this paper lies in the situated display of this information at an appropriate location in the environment. Our aim here is to use ethnographic observations to offer insights into how people orient to such situated display technology as a resource for guiding their behaviour, and the values this brings to their work. More importantly, we aim to use such observations to reveal key dimensions of interest to designers of other situated display technologies by highlighting how particular design characteristics of this particular situated display relate to the observed behaviours and values.

ROOMWIZARD

RoomWizard is a situated display appliance designed to be mounted outside a meeting or conference room to provide a reservation management capability for that space. Like many of the recent generation of information appliances, RoomWizard incorporates a *web-host* capability allowing it to generate and serve a reservation web page visible via any standard web browser. When multiple RoomWizards are mounted on the same network, they federate together to create a unified user-interface across the web (viewable on a PC web browser) for the reservation of all rooms that have an associated RoomWizard. This allows bookings for a whole set of rooms to be managed together in a convenient way, and the RoomWizard appliances to be managed as a unified system.

RoomWizard then has two interfaces: a "local" one, which is presented on the situated display outside the meeting room; and a remote one that is viewable via the web. For all intents

and purposes, the PC browser-based reservation interface offers much the same type of functionality as a range of commercially available reservation systems. The person reserving the room over the web clicks on the timeline at the relevant point and simply enters information into the "Host" field, "meeting purpose" field and chooses an end time. The information in these fields will then be displayed outside the meeting room concerned from the specified start time to specified end time. The most important of these, for the purposes of this paper, is the local situated interface (fig 1).

Fig. 1 RoomWizard web sign appliance: local interface

As can be seen, the information consists of a timeline for the day showing the blocks of reserved and "free" time: one line of large text above a line of smaller text. The larger text line displays the contents of the "meeting host" text field on the remote browser-based reservation form. The smaller text line displays the contents of the "meeting purpose" text field on the remote browser-based reservation form. When the room is not reserved, these large and small text lines respectively display "free" and "available for use" on the appliance display. The 8-inch colour display is also an interactive touch screen, allowing a free room to be "grabbed" in situ for an ad-hoc meeting. When such an in situ reservation is made, the two text lines on the RoomWizard appliance display "In Use" and "Local Reservation" respectively. This is reflected back in the web-based interface for the RoomWizard, which is updated over the network. The touch screen allows interaction with interface elements such as the host's name and the timeline for the purposes of accessing further information (e.g. contact details, details about other meetings that day, or room facilities) or control features. The top-level display however is designed to be simple and clear, reflecting its primary status as signage. The final feature of note in terms of signage is the red and green light strips on the sides of the appliance. These glow red to indicate the room is currently reserved or green to indicate it is currently free.

RELATED WORK IN SITUATED DISPLAYS
Before discussing the fieldwork, it will first be useful to place the current work within the context of some previous related work in the literature: to build on lessons learned and to raise appropriate points of similarity and contrast.

A significant body of work in the area of situated display technology has centred on the use of large displays as public artefacts [5]. For a number of projects in the area, the

primary goal of these displays can be loosely characterised as supporting synchronous collaborative work (e.g. [15]). They provide an appropriately large surface around which a group can simultaneously view and mark-up documents or use free form scribble to illustrate ideas. The displays are situated in appropriate collaborative workspaces but, in contrast to the RoomWizard appliance, are at the centre of focussed work activity rather than acting as peripheral displays.

Other projects in the area of situated displays place greater emphasis on the more peripheral and ambient display (e.g. [8]) of information at strategic points within the environment. It is the peripheral nature of the information display that is in common with RoomWizard. In contrast to RoomWizard, a good proportion of this work is designed for the purposes of disseminating and displaying information of general interest to or about a spatially defined community – [e.g. 3,6,7,9,13,14]. Studies and reflections on the use of these technologies raise a number of important points about the situated nature of peripheral information display. For example, the location of the technology defines a certain catchment area of interest and relevance to its users; the people that use a space, in part, define the community of people to whom the information must appeal. Placing these technologies in different locations can dramatically impact on the type of information that people find useful to display. For example, [14] showed that locating a community display in a cafeteria resulted in more leisure content being sent to it, compared to when the display was located near the workspace of a particular workgroup. Secondly, the different locations of the situated technologies present different behavioural contexts within which the displays operate. Thus, in Houde's [7] work, the placement of a newspaper display was important because it was an area where people would come to make a drink and have spare time in which to engage with any noticed content of interest. What these studies demonstrate is that the relationship between the technological functionality and the behavioural context associated with that particular location was the key determinant of the value of the situated display to its users.

These previous studies also demonstrate that making information persistently visible in the environment dramatically affects its value to users. In Snowden and Grasso's [14] work, for example, people who found useful information from the CWall would not have bothered to search for the same information directly from the web. The persistence and immediate availability is critical here, and makes such peripheral displays useful as resources for initiating and supporting ongoing general conversations around general content [cf 9,10]. The effects of persistent visibility have also been observed in relation to other situated display technologies aimed at promoting presence and awareness across disparate work and social groups [e.g. 4,12].

While existing situated displays derive value from their strategic spatial location, their content is not as tightly bound to that specific location in the same way as with the RoomWizard. In this respect, RoomWizard shares some characteristics with other situated display work such as OutCast [9], which closely binds the displayed information

to a particular person's office or workspace [cf 1]. OutCast is situated outside the office or workspace of a particular individual where it displays things such as calendaring information, messages or contact details. This information is both bound to that place and useful at that point in space. For example, when a visitor comes to an office and finds the person not there, the situated display provides information to hand that can help them interpret the situation and support judgements about, for example, where to locate them, or when to come back. In contrast to Outcast, which presents a variety of information useful to that particular space, RoomWizard is more specific in its functionality, and this has important consequences in its use as a display.

THE STUDY

In order to further understand the impact of RoomWizard, we conducted a field study of the technology in use in a large multinational petroleum organisation in the UK. The site of the organisation housed several thousand employees distributed across many buildings on the campus. For the practical purposes of the study we chose to limit the deployment of the technology to two adjacent buildings on the campus and more specifically to two groups comprising about 50 employees (of differing levels of seniority, ranging from office administrators to engineers and managers). The first department was made up purely of employees from the main organisation; the second department comprised a mixture of employees from the main organisation and employees from an auxiliary organisation permanently contracted and housed by the main organisation to manage campus wide issues such as health and safety, facilities and maintenance. Visits from external contractors were also commonplace. In total, 5 RoomWizards were installed in the two buildings. In building 1, which housed people from both departments, RoomWizards were installed outside 3 dedicated meeting rooms off the main corridors of two floors (one room large enough for 10 people, the other two rooms for 4 people). In building 2, RoomWizards were installed outside two meeting rooms on the same floor, (one for 5 people) located off the main corridor of that floor; the other (for 8 people) located within the open plan office space itself off the main corridor.

The data collection took place in two phases. The first phase prior to the RoomWizard installation involved a series of interviews with a subset of trial participants and was used to establish some background context about the organisation, the individuals and an understanding of the current meeting practices within which RoomWizard was going to be immersed. Contacts at the organisation helped identify and arrange preliminary interviews with 10 key personnel responsible for the management of the current booking system and monitoring patterns of use (the office administrators) and people who booked and used meeting rooms for their own purposes (surveyors, managers, contractors). Participants were interviewed for 30 minutes about general meeting behaviour – such as how often they used meting rooms, whether they booked them for themselves, or on behalf of other people, whether the meetings they booked were regular, ad hoc, on the fly; formal or informal, how they informed others that they had booked a meeting. These were taped and transcribed.

The second phase of interviews took place after the RoomWizards had been installed. The same participants were asked to keep a journal of their meeting room usage – who was invited, when and how they booked rooms, used rooms, or were invited to meetings. The journals were used as the basis for in depth interviews carried out over the first 4 weeks of the trial. Interviewees were separated into two groups (we were limited by participant availability), the first group interviewed one week after installation and the following week, the second for the subsequent two weeks. Interviews were 30 to 90 minutes and were taped and transcribed.

Several days of observation also took place in the two buildings in the offices and around the meeting rooms to collect data about actual interactions around the RoomWizards, and the kinds of information put on the system. Where possible, observation episodes were elaborated through further questioning with those observed using the system, often taking place during or directly following room reservations. Briefer informal interviews were also carried out with a wider range of trial participants to validate details from in-depth interviews.

While the fieldwork revealed a vast array of findings in relation to the RoomWizard Technology, we focus here on those involved in the in situ display of information in relation to the meeting spaces, and the impact of these from an individual, social and organisational perspective.

PRE-INSTALLATION CONTEXT

Prior to the introduction of RoomWizard, room reservation was handled by two paper "booking" diaries (one for each building) located on the desks of the senior administrative assistants for the groups. Anyone could use the diaries to make a reservation or check availability. But having the reservation system embodied in paper diaries at a fixed physical location had resulted in a number of problems: 1) a disproportionate amount of reservations were made via the administrators which was a burden for them; 2) impromptu availability was difficult to check for particularly when walking past meeting rooms; 3) the effort of making a booking led to impromptu use without booking, leading to "bumping"; 4) over-running and uncertainties about booking led to conflict over room use; 5) unused rooms booked in advanced were not cancelling due to the effort costs of doing so.

VISIBILITY AND SOCIAL CO-ORDINATION
Ownership of space and resolution of conflict

In time-shared spaces such as meeting rooms, there are often difficulties and conflicts in terms of who has legitimate use of the space. Reservation systems attempt to alleviate these breakdowns to a certain extent, but problems still frequently arise due to: the ad hoc use of this space without reservation; the genuine uncertainties about correct times and spaces for meetings; and the genuine uncertainties about whether a reservation had actually been made or not. The display of the booker's name in situ outside the meeting room at a particular time provided people with the necessary sense of ownership over that space giving users the *ammunition* to enforce the booking times: they could simply point to the

display to reinforce their request for ownership. For example, while some people were looking at the display outside a meeting room, the meeting owner (a manager) came along the corridor and good-naturedly bellowed:

"That's my name, that's my meeting room"

Clearly, the room owner was referring to the display, and to the fact the people looking at the display could demonstrably see that it was booked in his name – it was *reserved for him*. The important value of this was the provision of a resource at the appropriate point in space and time where potential conflict could occur. Generally speaking, this applied to overrunning of meetings or people using meeting spaces without prior reservation. Prior to the use of the RoomWizards, there was a social asymmetry around space use with people already occupying a space having a stronger sense of ownership that made it awkward for the "legitimate" bookers to ask them to leave the room. Having the information there and then increased their level of confidence to be able to deal with these situations fairly. As a junior member of staff reported in an interview:

"People ignore it and sit in your room when you have booked it. Having the system there has given me the confidence to go in and turf them out."

RoomWizard did not completely remove this overrunning behaviour or use of space without reservation. Indeed, it is not designed to do this. There are all sorts of organisational contingencies that need to be managed in relation to space use, and these need to be mediated by people on the basis of locally interpreted information.

The use of local context in the interpretation of information on the display can be seen in the following example drawn from fieldwork. This example extends the idea of ownership to more clearly show how bookings are interpreted as resources for action, rather than as rules to direct action. During one of the lunch breaks, the people in the meeting left the room, but did not cancel the session, as they were going to return in the afternoon at some point. Whilst the room was empty, two senior managers walked in to use it for 10 or 15 minutes for an impromptu meeting.

So we see here that the RoomWizard does not *stop* people using the room. We do not see this as a limitation of the utility of the RoomWizard system – what it points to is that the use of local knowledge about activities in the office place is used to interpret what the information on the RoomWizard really means. In this case the senior managers knew that most people would be out of the office, because there was a team meeting that morning, and also made a judgement that the other room users would be at lunch (and that they would likely be finished before the original room bookers returned). This intermixing of local knowledge with information on the in situ display is interesting, because it allows an even more effective use of space than would have been expected using a simple rule-enforced booking system.

The example above had an additional dimension that makes it particularly interesting: whilst the managers were in the room, J (an external contractor) returned from her lunch and wanted to get into the room in order to have a look through her slides on her laptop. She did not go in, even though the room was actually booked for her, because it was socially

difficult, given that the occupants were on home territory, visibly engaged in deep discussion and that they were important figures (she had recognised them as the bosses from a previous visit), but also because it was not important enough to interrupt the meeting just so that she could get her laptop. So, the RoomWizard's situated display enables judgements to be made on the basis of local context, and allows 'lean' social mediation over room use when necessary, without breaking important organisational protocols. This lean social mediation is relatively effort-free to maintain, and allows a high degree of flexibility in its application, thus supporting what are judged as the most appropriate of follow on activities [cf 11].

RoomWizard, then, is not the only and absolute resource for booking and using rooms. People who have booked can be kicked out, and people may use the room without booking. This introduces lots of social interactions around the use of the device. People will use the room for longer than their booking, or conduct other time-related activities that are not directed by the room booking system. Some people are more affected by this than others, as the level of the user's organisational seniority affects interpretation of rules.

The RoomWizards were also seen as something that could help negotiate changes for meeting rooms when necessary. This swapping of room use was always seen as a socially mediated process. Showing who was the temporary owner of a particular space at a particular time provided the information to help initiate the conversation to perform this. As a junior member of staff described in an interview:

"I have been looking – if there is someone in the room you want to go - or who has nicked it already… and you have a look to see who it is… It could be useful because you think well maybe if I ask really nicely then maybe they would swap".

Supporting Interruption

The RoomWizards did not simply allow the improved management of reservation times, but also supported some other features of co-ordination and collaboration behaviour. A particularly important by-product of the displays was the provision of useful information for judging interruptability of a meeting. The interruptability status of a meeting or a person in a meeting is not something that is absolute by definition. Rather, it is dependent upon factors such as the status of the interrupter in relation to the status of the interruptee, the type of meeting, the reason for interruption in relation to the reason for the meeting, etc.

The data show that interruption judgements were made using knowledge of local context. The information on the RoomWizard displays about meeting owner and meeting purpose supported these situated judgements about interruption. For example, the subject header "Quiet working" had a completely different level of interruptability to that indicated by a "one-to-one" meeting. This information would not have been practical to ascertain using the previous, paper-based system (or even a solely web-based system) because of the high level of effort required to locate the room's calendar and identify the nature of the booking. A "one-to-one" meeting was regarded as largely non-interruptible, except in urgent circumstances or by the most senior of people, whereas the note "quiet working" was

something that was interruptible for less serious reasons. An example of this was given where the organisation's vice-president was in a meeting, and because the RoomWizard had his name on it, people interpreted this as definitely a non-interruptible situation – even though they had overrun their booking. When the administrator had booked this meeting she (unusually) typed the names of the three people in there so that people would know it was an important meeting, and who was attending it, all adding to the richness of context for interpretation. Interestingly, this was not something just made use of by viewers; the administrator, aware of this, made use of the display's affordances to alert others about the meeting's interruptability.

VISIBILITY AND AWARENESS
Navigation and reassurance
The display of in situ information about the use of a space was also important as a confirmation device that members of the meeting were in the right place. While very simple, this was regarded as important, in the sense that room information is often abstract and easy to forget or confuse with other similarly labelled rooms. It was particularly important in reassuring external visitors, unfamiliar with a building, that they were in the right place - the name of the meeting host and meeting purpose were meaningful and recognisable to them more so than abstract room name.

Peripheral Awareness
The situated display of information outside the meeting rooms provided a level of incidental awareness of ongoing activities in the office. While this information was not something people would have explicitly sought out elsewhere, RoomWizard's visual immediacy and people's general sense of curiosity meant that office workers would frequently look at the information on the displays as they went about their business. For example, a number of people commented how by casual intermittent looking at the displays they had acquired information that had subsequently allowed them to answer questions about people's whereabouts and to build up understanding of habitual work patterns of others. As one office administrator described:

"Every time I walk into the office, if anyone's in there, I tend to just check the screen, just as I walk past, just to see if they've actually put anything in because ... it's helpful to me ... because then I know who's in there. Other people do this as well…It's a good way of giving people information about what is going on. We have a lot of people coming in saying "Have you seen P, have you seen M?" – and having walked past and looked at the display I know how to answer them"

What is important about the provision of this awareness information, compared with some other approaches to awareness, is that it is provided on the back of a genuine need for room reservation rather than being based on any sense of moral obligation to make it available. As such, it remains up-to-date and relevant, without requiring extra work to provide this information.

Not just reserving but informing
Users were very much aware of the link between the reservation information entered into the remote interface and what was displayed at the local interface. Users creatively

adapted what they wrote in the reservation fields on the Web-based booking form because they knew it would be visible on the RoomWizard displays outside the rooms. In one incident the "meeting host" text field was filled out as "R <name of office administrator> for J <name of external visitor>". The reservation was actually for J who was a visitor and not known well by the rest of the people in the office. R put her name down to make herself visible as a contact person. Because people would not know who J was, R judged that they would be more inclined to bump her, or act in an inappropriate way towards her booking. To prevent this, she put her own name on the RoomWizard as well as J to indicate this was a legitimate booking and legitimate use of the room. The creative use of the free text field allowed R to anticipate a certain reaction and inform others with the necessary information to overcome their concerns. So, RoomWizard users were doing more than just reserving meetings: they were also aware that they were providing information to others. There were other times when people wanted to restrict the information they were giving to others. In the case of confidential meetings, or when people did not want others to know what they were doing, they would put something deliberately cryptic and difficult to interpret thereby overcoming privacy concerns of increased information visibility through social mechanisms.

An important part of the design of the RoomWizard was to give users freedom over the information they put in the text fields. Although the text fields were labelled as "meeting host" and "meeting purpose" it was clear that users were creatively appropriating these fields for their own purposes. Alternative design possibilities were based around integration with a corporate directory that would have automatically entered the user's name in the meeting host field. Likewise, we could have devised a series of meeting categories from which people could quickly choose, again ensuring that a certain type of information would appear in this field. While this stricter approach may have led to some benefits later in terms of categorising information for visualisation or search purposes, we felt it was more important to give people the freedom to use the fields in the way that they saw fit for the contingencies of their particular circumstances. That is, we have attempted to mediate rather than automate activity, allowing flexible appropriation and evolving strategies of use to support contingencies.

Assessing availability
The RoomWizard's red and green room availability status lights were useful in assessing a room's availability for impromptu meetings at a distance; as one user said, it is:

"easy to see when the room is free or in use for those on-the-spot meetings."

This feature of the device provides important affordances in relation to its role as signage since it supports what we have come to describe as "drive by" usage as opposed to "walk up" usage. That is, it afforded quick glance assessment of high-level status without the need to interact with the more detailed information up close. As the above example shows, this is often all that is needed as a resource for making a decision about action.

Whilst useful for assessing room availability, some

participants also used it to monitor the availability of other people. For example, a participant needed to see her boss about a particular issue. She knew her boss was in a particular room down the corridor in a meeting of unpredictable length but was able to intermittently peer down the corridor to monitor the light colour. This allowed her to determine whether the meeting was finished so that she could initiate a conversation with him. The indicator light was not just a simple indicator of room use, but was adopted here as an organising resource for locating people.

Assessing a room's availability before the introduction of the RoomWizard system could sometimes create a sense of social awkwardness. Looking into a meeting room through a glass window had some benefits in terms of providing information about room use. Catching someone's eye was also useful in some respect in terms of initiating a potential interaction, e.g. to remind someone they should finish the meeting up. However, for those instances when people were just checking room availability for impromptu use, this could be socially awkward, not wishing to discomfort the room occupants, or pressure them to finish up unnecessarily. The information provided on the RoomWizard display helped alleviate some of this social awkwardness by allowing some judgments without peering into the room.

Nevertheless, the RoomWizard's displayed information was not always a perfect reflection of what was actually happening in the room, and could not be relied upon completely in making these judgements. Sometimes there was still a need to look through the windows to confirm the information if there was a really strong immediate need for the room

"People in the office do tend to look in the glass, but it can be hard to stand outside looking in" (because the people in the meeting can also see out). "So the RoomWizard is useful for that…I think it's just curiosity most of that time. I wouldn't like it like it if we had a meeting room with the door completely closed off … there are some meeting rooms like that, and it's awful because you can never tell if the room's being used - sometimes they may just shut that door, and you could just walk straight in and there's a massive meeting going on."

There were some examples when having the RoomWizard on red outside an empty room would actually stop people going in and making use of that room in an ad hoc way. On the other hand, some people did not mind going to an empty room on red with the understanding that they might be kicked out if the legitimate user of the room returned. People were using the situated information to help make decisions about whether these "illegal" occupations were appropriate or not, e.g., people would be less inclined to go into the empty room if the RoomWizard indicated it was the beginning of the supposed meeting (assuming that people were late). On the other hand, they were more inclined to go in nearer the end of the booked time, assuming it to be over early but without the reservation having being cancelled.

POLICING, SELF-POLICING AND ACCOUNTABILITY

With the use of any shared resource such as a meeting room, there is always potential for selfish or inefficient use. For example, people would: make reservations *just in case* they needed it; reserve a room for a longer period than necessary;

reserve a "plush" room with capacity for 10 people when only needing a simple room for 2 people; not cancel a reservation if a meeting was moved or the meeting was shorter than the reservation, etc. These behaviours are a natural part of the utilisation of any shared resource and are due to a variety of factors such as social selfishness, forgetfulness and the high effort costs of making changes to bookings. Prior to installation of RoomWizard these individual misuses of the (paper-based) reservation system would either go relatively unnoticed or be policed to a certain extent by the administrators, who would keep an eye on people's use of space in relation to their reservation behaviour. While the installation of the RoomWizard web signs did not remove these behaviours completely there were ways it helped change user's space management behaviour.

Hall of shame: Visibility and accountability

The visibility of the reservation information made people more accountable and socially aware they were using shared resources others might need. There was a sense of moral worry in some people if they forgot to cancel a reservation they were not using. There was not complete improvement in this respect since people still forgot to do this on occasion, but the RoomWizard displays made this behaviour more publicly visible. This encouraged others, particularly office administrators, to remind people to cancel. The displayed name also made it easy to attribute responsibility for the behaviour making policing easier.

There were clear expressions of annoyance at the behaviour of people having their name outside an empty room and that with repeated instances over time, they would be likely to say something to the offenders. In this sense there was an emerging "Hall of Shame" phenomenon in which people's visible antisocial reservation behaviour was being mentally monitored by others over a period of time. As one senior office administrator commented:

"You can see who has been booking them and not using them so if you see repetitive names then you would be able to go and tell them off – but people can take individual responsibility as well – so someone wants to use the room and it is already booked but the booker is not there the person can always locate the booker to see if they are going to use the room – that is the nice thing about the system."

This information was useful to her in that it allowed her to manage room space more effectively – but also because it allowed other people in the office to manage room space more effectively. This was repeated numerous times in interviews. The interviewees reported that by making this information more visible, individuals would become more aware of their own anti-social use of space and would lead to a degree of self-policing. At the same time, room bookers would also be made aware of other people's unsocial behaviour, leading to potential policing by them, rather than by the traditional enforcers of the room booking system, the office administrators. The evidence from participants suggests that there were less unattended meetings than on the paper-based system, which distanced planning from action and which kept behaviour hidden.

One solution used by a group within the organisation for management of booked but unattended meetings was to devolve the policing role from an administrator to users

through the proposed creation of a '15 minute rule': use it or lose it. This was only proposed by one of the two offices, so would only be a locally enforced rule. It is interesting that the rule was not intended to be used in the office where contractors and non-office staff were frequent visitors: these were often late and their visit might involve a break in the middle for other visits to be made to other offices, etc. This demonstrates the importance of *not* enforcing rules within the technology – local conditions may preclude the usefulness of this type of functionality – but rather, designing the technology to allow socially mediated (and contextually appropriate) policing of this rule.

Overcoming visibility

The impact of visibility on people's awareness of social norms in relation to reservation was also seen in attempts to make their antisocial behaviour less visible. To elaborate with an example relating to policing of intrusion and the visibility of the booking behaviour, there was a difference in the status of bookings with planned meetings based on advanced reservations being perceived as more important than ad hoc meetings. While this was typically respected, people would still employ tactics for their own gain, e.g., if a RoomWizard was 'on green' but the meeting still going on, people would not use the RoomWizard display to make a local reservation even though in theory this would give them the right to use the room. To grab the room locally under such circumstances was considered rude and the visibility of this fact on the screen prevented people from doing this. There was therefore a strong social imperative for these ad hoc intruders to go elsewhere. However, the technology allowed them to go back to their PC and book the room remotely for immediate use. This made their behaviour less *visibly* anti social, as it obscured the time the booking was made, and whether it was ad hoc or planned.

DISCUSSION

Whilst the RoomWizard at first appears to be a simple electronic duplicate of a room reservation system, it is far more complex than this *in use*. The field study observations have shown how a situated display technology can create a more socially translucent [2] system around which important user behaviours and values emerge. In this section we relate these behaviours and values to a discussion of key design characteristics of the device – to raise awareness of these issues for other designers of situated display technologies.

The first issue relates to the control model of the device. With RoomWizard, the control model is decentralised so that the whole community of users has direct responsibility over the contents on the display. A decentralised model like this is dependent on trust among the users and open to certain abuses. As such, while it might not be appropriate for more critical information it is suited to the information associated with room reservation – indeed it is this decentralised model that allowed many of the creative behaviours to grow and the technology to be effectively incorporated into people's everyday coordination and work practices. Placing responsibility on users of the device, allowed lightweight socially mediated coordination to emerge.

Second, the elicitation of the observed value with such a

situated display technology was not simply due to the *display* of appropriate information in space. Rather it was also dependent upon the time and effort costs associated with getting the information there, and as such is an important consideration for designers of situated displays. As we have seen, an important characteristic of RoomWizard was that the useful displayed information was built on an already required behaviour – namely, reservation of a room by entering your name into the reservation system. The situated display of this information was not dependent upon any additional effort[1] or moral obligation on the part of the user.

The third point concerns the spatial "zones" that exist around situated display technologies and the different behaviours that need to be supported in those zones. Consider some examples from RoomWizard. The green and red lights and their placement on the sides of the device supported behaviour in the outermost zone, the furthest distance at which the device supports behaviour. Simple assessments about availability could be made using these lights, extremely quickly from the end of a long corridor without need for more detailed analysis of the booking information on the display. No other information was available to support other user behaviour in this zone. In a zone closer in, the next set of behaviours centred around visibility of the meeting host's name. The larger font size of this information allows it to be resolved from a greater distance while other aspects of the display are too small to be resolved and therefore blend into the background at this distance. This means primary information (the name of the meeting host) can be extracted at this distance without distraction from other interactive interface elements. A further issue about RoomWizard was that its purpose was not primarily about attracting people in from a distance as might be the case with other situated displays. Rather, it allowed key information to be perceived quickly at a distance while walking by. Consequently, the graphical elements designed in support of behaviours in this zone were deliberately static rather than animated, giving it a more sign-like quality. Finally, as you move to a closer zone around the situated display, more of the information becomes visually resolvable, affording a greater number of behaviours and values that are dependent on these more detailed interface elements – e.g. pointing at the display in support of conversation. Finally, there is an interactive zone when the user is stood right in front of the display. For the designer of situated displays, these different "zones" impact on choices of physical form factor, content properties and information architecture so need to be explicitly defined and considered in the design process.

A fourth point concerns choices about whether the device should have single or multiple functionality. While the basic technology of the RoomWizard appliance can potentially host a whole variety of web based content and functionality, the single functionality of the RoomWizard was an important component of its utility in a social context for many reasons. Most notably, the display space on the RoomWizard is not competed for by multiple sources of content. As such, the useful information is persistently visible. If this display was

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[1] User's details are recorded as a default value for RoomWizard on an individual's PC, reducing the effort costs of data entry.

time-shared between different sources of content, it would dilute the value derived from such persistence – its *always* there for ad hoc conversational and awareness support. The dedicated functionality of the RoomWizard situated display also contributed to a stronger sense of simplicity and predictability around the device that was important in an individual and social context. Its predictability allowed users to develop a reasonably well-defined set of normative rules around their use of the device that would be more difficult in a multi purpose situated display. Predictability also supported understanding the relationship between the remote and local interfaces helping avoid uncertainties that can arise in other systems in terms of how and when remotely entered information will appear on the situated display [e.g. 7].

A final point arising from observing this use of a networked technology (i.e. RoomWizard) in managing a shared resource, such as space, is the importance of designing to support social mediation rather than automation. In designing RoomWizard we have not built in formal rules that force its users to act in a certain way (e.g. booked rooms that lock out other users): it has normative rules built into it that its users *orient* to. These normative rules can be 'broken' to achieve different outcomes, and this aspect of the design allows social mediation. As places and things are increasingly becoming networked, they will need some method to manage their control and availability, and as we have seen, this cannot be easily managed through a purely technical solution. Consider, as a simple example, a networked printer that can be accessed locally (e.g. over infra-red or Bluetooth). If multiple users need to use the device simultaneously, which print jobs should be given priority? The organisationally senior person? The most urgent? The shortest document? No clear answer is likely to be applicable in all cases. Technologies that allow socially mediated co-ordination protocols to develop around them are likely to fit the needs of their users better than those that enforce rigid application of embedded rules. One of the ways that this social mediation can be operated is through the use of easily visualisable system states - not just of the systems' current internal modality, but also of their social states and status.

In conclusion, what might initially have been regarded as a simple room reservation application actually turns out to have important behavioural consequences by virtue of its situated display component. By studying the ways that individual and social activity is oriented towards this device, it has been possible to identify important issues of concern to designers of other situated display technologies.

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