

Creating Assemblies in Public Environments: Social Interaction, Interactive Exhibits and CSCW

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Abstract. This paper examines the use of a series of three low tech interactive assemblies that have been exhibited by the authors in a range of fairs, expositions and galleries. The paper does not present novel technical developments, but rather uses the low tech assemblies to help scope out the design space for CSCW in museums and galleries and to investigate the ways in which people collaboratively encounter and explore technological exhibits in museums and galleries. The bulk of the paper focuses on the analysis of the use of one interactive installation that was exhibited at the Sculpture, Objects and Functional Art (SOFA) Exposition in Chicago, USA. The study uses audio-visual recordings of interaction with and around the work to consider how people, in and through their interaction with others, make sense of an assembly of traditional objects and video technologies. The analysis focuses on the organised practices of 'assembly' and how 'assembling' the relationship between different parts of the work is interactionally accomplished. The analysis is then used to develop a series of 'design sensitivities' to inform the development of technological assemblies to engender informal interaction and sociability in museums and galleries.

Key words: art, assemblies, design sensitivities, ethnography, interactive exhibits, museums, social interaction, video

1. Introduction

There has been a growing concern within CSCW with the design of new technologies to support collaboration in a more diverse range of domains. This entails out not only a move 'out of the control room' (see Hughes et al., 1994), but more radically away from traditional workplaces and into arenas such as domestic settings, public domains and a range of additional settings relevant to 'mobile' activities (see Grinter et al., 2002; Brown and Chalmers, 2003; Crabtree et al., 2003; Esbjörnsson 2003; Fraser et al., 2003). This re-orientation of the CSCW agenda raises numerous challenges to design and

study, challenges unique to each new domain that demand novel developments within the social and technical work of CSCW. This paper concerns the design of interactive technologies within (semi-)public settings, namely museums and galleries, and examines some of the distinctive characteristics of action and interaction within such settings.

New technologies have been used increasingly within museums and galleries, both as interpretation devices and as interactive exhibits. At the same time, among museum professionals, there is growing recognition of work in cultural psychology concerned with the relevance of social interaction for learning. Whilst these ideas are recognised and respected, technologies for museum visitors continue to be designed predominantly for a lone user in isolation; they are rarely designed to support opportunities for interaction *between* visitors to an exhibition. Indeed the first generation of digital exhibits, with their conventional interfaces and forms of interactivity, seem to impoverish and constrain forms of co-participation. In this regard, museums and galleries pose significant challenges for system design, challenges that resonate with the agenda of CSCW. For example, how can we develop novel technological exhibits that support and enhance highly contingent forms of interaction and collaboration; exhibits which are accessible to a range of ‘users’ with differing expertise and interests; and exhibits that enhance opportunities for interaction between visitors who may be alone or with others?

This paper describes our involvement in a programme of work concerned with designing and deploying low tech interactive exhibits to investigate forms of social interaction within museums and gallery spaces. The paper describes our experiences with three exhibits, but focuses primarily on the design and evaluation of a technological artwork that was exhibited at the Sculpture, Objects and Functional Art (SOFA) Exposition in Chicago. Whilst the paper does discuss exhibits that we hoped would stimulate novel forms of collaboration and co-participation, it does not aim to present novel technical work. The exhibits are intended as heuristic devices to help to explicate the organisation of visitor action and interaction around interactive exhibits more generally. In this regard, the paper uses relatively low tech exhibits as core components of field studies of visitor behaviour in museums and galleries. Thus the paper aims to contribute to a growing body of studies in CSCW and cognate disciplines concerned with the naturalistic analysis of visitors’ use of museum technologies (e.g., see Hemmings et al., 2000; Büscher et al., 2001; Ciolfi et al., 2001) and also inform an associated body of work concerned with the design of novel technologies to support multi-participant engagement in museums and galleries (e.g. Omojola et al., 2000; Grinter et al., 2002; Woodruff et al., 2002). In doing so the paper develops some ‘design sensitivities’ that can be used to inform design and development of future low and hi tech exhibits to encourage interaction and co-participation between visitors.

The paper also suggests various ways in which the study has more wide-ranging relevance in relation to the areas of media space research and ubiquitous computing.

2. Museums, interaction and technology

The new technologies that are most readily being adopted in museums and galleries, whether interpretation devices (e.g. audio or electronic guides) or computer-based interactives, tend to individualise the museum experience rather than encourage collaboration (Büscher et al., 2001; Heath and vom Lehn, forthcoming). The size and shape of traditional computer screens, the tendency to use single input devices, the positioning and housing of computer exhibits, the use of headphone technologies and so forth all tend to constrain and restrict opportunities for flexible forms of co-participation (although see Woodruff et al., 2002). Moreover, and maybe in part related to the technologies commonly available, designers of computer-based exhibits tend to design activities for individuals.

Unfortunately this neither reflects the emerging interests of museum professionals to foster collaborative learning nor the fact that visitors often explore galleries with companions and use exhibits with them. Therefore, as Rob Semper of the San Francisco Exploratorium has argued, there is a growing need for museums to “think beyond the 20” cathode-ray tube... to create spatial media experiences that are integrated into the exhibit space” (Semper et al., 1998, p. 120).

We believe that this is an interesting research and design challenge for CSCW. The challenge is to consider how to adopt approaches common in CSCW to re-think museum technologies and provide museum designers, and indeed artists, with the tools and technologies to organise innovative *collaborative* experiences. Indeed, with its concern with understanding and designing for collaboration, CSCW would seem well placed to inform the development of exhibits and exhibitions which aim to enhance interaction and co-participation.

Aside from the interesting design challenge posed by (semi-)public spaces such as museums and galleries, the museum context also demands that we consider the design of *coherent assemblies* of interconnected and interrelated artefacts rather than single user interfaces. Despite a long standing concern of many researchers to inform the design of technologies with regard to a detailed understanding of the social, organisational and interactional contexts in which they will be situated, there has been rather less work on the *material* contexts in which the technologies will be placed and encountered. Traditionally HCI and CSCW research and development has been concerned to design systems that have single interfaces, either using traditional keyboard

and screen, or more innovative interface designs (large screens, HMDs, etc.). There has been less interest in considering how these technologies may be successfully deployed into an existing array of objects and technologies or how to create new and coherent technical assemblies. However, the placement and arrangement, ordering and organisation of an ‘array’ of technologies is an intriguing concern.

Indeed, this issue is of particular interest as researchers, technologists and organisations increasingly pursue the vision of ‘ubiquitous computing’ (Weiser, 1991). The concern to create intelligent environments, ambient technologies, roomware and augmented and mixed realities will necessarily fuse the concerns of technology with the concerns of architecture and interior design. The potential of multiple input and display devices distributed throughout homes, offices and public places will necessitate careful consideration of their relative and meaningful juxtaposition.

Museums and galleries provide natural laboratories in which to explore assemblies. Indeed, the coherent assembly of multifarious artefacts and technologies is an everyday practical matter for museum curators and exhibition designers. On the one hand, they provide opportunities to design and deploy technical *assemblies* for visitors to encounter and explore as part of their normal visit. On the other hand they provide us with the opportunity to investigate the ways in which people discover, explore and create connections between co-located objects; the organised practices of assembly or how ‘assembling’ is accomplished in and through social interaction. Thus museums and galleries provide domains in which to investigate both the technical and the social aspects of assembly.

One additional interest for CSCW in museums and galleries relates to the formidable problems of deploying prototype technologies in workplaces. Organisations are understandably rather hesitant about allowing prototype technologies to be used as part of everyday working practice. However, museums and galleries provide unique opportunities to explore alternative designs that are prototypes or even semi-functional. Whilst museums and galleries do present certain technical challenges and practical constraints, there are more possibilities to ‘try things out’ as part of the museum experience. This enables researchers to deploy technologies and observe and analyse the ways in which visitors (‘users’) encounter them in the course of their museum visit.

So, museums and galleries provide interesting sites in which to engage in CSCW study and design work. They exhibit flexible and contingent forms of participation with and around artefacts and technologies. They provide opportunities to explore ways of encouraging and engendering informal interaction and sociability amongst a range of individuals and groups. In addition they raise possibilities to explore how people encounter, discover and create assemblies of objects and technologies. To engage with these

concerns we began a programme of work that drew together the social scientific concerns of members of the Work, Interaction and Technology research group at King's College London with the artistic concerns of the craftmaker, Jason Cleverly.

3. Working with low tech assemblies

There were various aspects of the collaboration that seemed advantageous for the different partners. From the outset the collaboration was envisaged to spread over a number of discrete works. Thus the social scientists were afforded the opportunity to contribute to the design briefs for a number of works in turn, using findings from the analysis of the use of each to point towards new ideas and issues for the development of the next. It was also possible to design the pieces to resonate with a number of developments of contemporary relevance to CSCW. For example the pieces explore ways of interweaving everyday artefacts and digital materials in coherent assemblies. They also provide vehicles with which to explore social interaction and collaboration with around diverse objects, both material and immaterial, in public places. Indeed they enable us to explore the affordances and novel functionalities associated with different types and combinations of artefacts and displays. Furthermore they can be used to examine means of facilitating novel forms of (co-)participation by transposing action between various parts and regions of space; a theme that we discuss more fully later on.

In addition, the social scientists were given opportunities to investigate peoples' engagement with the works in naturalistic settings. In contrast to more complex technological exhibits, these low tech assemblies provided more opportunities to develop works robust enough for public consumption. Cleverly's position as a leading contemporary British craftmaker leads to works being accepted and commissioned by major exhibitions, fairs and galleries. Interestingly the involvement of academic social scientists seemed to be of interest and value to those commissioning works. As the evaluation work was 'built into' the design and recognised by all parties, it made it relatively straightforward to secure access for studies of use. This provided rare opportunities for pieces that were 'experimental' in some senses (i.e., for the social scientists) to be placed and analysed in the public domain. Thus the work provided opportunities to elaborate our prior studies of visitor behaviour in museums and galleries (e.g. vom Lehn et al., 2001) through the collaborative development and investigation of a number of exhibited craftworks.

Cleverly meanwhile was drawn to the project through an interest in interactivity and viewer engagement. He has a background in creating artefacts and simple automata that provoke surprise, curiosity and laughter. He tends

to work with relatively simple materials such as wood, metal, found or recycled objects, paint and gold leaf and a notable strand of his work concerns marine life and activity. Often his interactive craftwork has some significant functional as well as aesthetic properties, so for example, he has created a number of works that reconfigure basic cabinets or radios. Throughout, however, his work is playful as the selection of images in Figure 1 reveals.

Our collaborations have focused primarily on attempts to ‘encourage’ interaction between visitors using relatively simple technologies and ‘interfaces’. This has involved a reconsideration of the notion of ‘interactivity’ embodied in Cleverly’s work. His work is pre-occupied with engaging the viewer, often encouraging various forms of physical involvement and participation. However previously his work had not necessarily taken into account the social and interactional contexts in which viewers confront his work. As noted in our introduction, this is a widespread feature of technology and artefact design in the great majority of works presented in museums and galleries and indeed it is an issue that resonates with familiar debates with human–computer interaction (see Heath and vom Lehn forthcoming). So, for Cleverly, the work presented an intriguing challenge to explore new forms of engagement and to involve the viewers in novel ways.

The works of craft were designed and built solely by Cleverly. However as the collaboration has developed the involvement of Heath, Hindmarsh and vom Lehn has increased through the development of more and more specific design briefs to explore particular issues in further depth. Moreover, Cleverly’s designs have been inspired by the studies of visitor behaviour undertaken and reported by Heath, Hindmarsh and vom Lehn; both the



Figure 1. Some examples of Jason Cleverly’s craftwork – Left to Right: Moray Eel Automaton, Lobster Clock, Cherry Radio.

studies that pre-figured the collaboration and those that have been integral to the collaborative programme of work.

In opening up the design space to consider how to engage the visitors in interaction with others, we were keen to re-fashion traditional materials with digital media. The first set of works in our collaboration have explored the potential of video cameras and monitors to transpose action across seemingly traditional assemblies of craftwork. The use of cameras and monitors is a feature of all the exhibits and installations in our programme of work so far and is a relatively new type of 'material' for Cleverly to use in his work. Nevertheless, he has previously embedded small technologies within his work, usually lights or radios, so secreting cameras and monitors in the pieces we developed did not form a radical shift in his approach.

Interestingly, the use of cameras and monitors to reconfigure spaces and the relationship between people and actions in different spaces relates to a substantial body of research concerned with media spaces in CSCW, especially given its emphasis on interweaving spaces to enhance informal sociability and interaction (see Gaver et al., 1993). Media space research was inspired by a decision to deploy a video-computing infrastructure into office environments at PARC and EuroPARC in order to facilitate interaction and chance encounters between people and thereby encourage unstructured conversations between scientists; conversations which it was believed might lead to creation and innovation. Whilst the actual day to day use of the system failed, in part, to reflect the motivations behind its deployment, it did reveal the ways in which relatively basic video systems which interconnect distinct physical spaces can serve in the relevant circumstances to provide a foundation to informal interaction and provide a medium through which chance encounters can be engendered. These early experiments with media spaces, coupled with more recent developments (e.g. Tollmar et al., 1999; Heath and Luff 2000; Jancke et al., 2001), provide resources through which we can begin to explore how technologies within the museum environment can be used to refashion spaces and provide visitors with new ways of confronting artefacts and each other.

The first piece in our programme of work is called *Deus Oculi* and was exhibited at Chelsea Crafts Fair (see Heath et al., 2002). *Deus Oculi* is based on the use of re-cycled imagery. It consists of three parts: a main picture that displays a tranquil Renaissance scene and two fake 'hand-mirrors' (see Figure 2). The picture, which is framed by a wooden box, includes the faces of two individuals, a man to the right and a woman to the left. Each face is on a little door that can be opened up to reveal a small CCTV monitor. The hand-held mirrors to either side of the picture each contain a CCTV camera. Indeed, although they are designed to imitate the general form (if not scale) of a hand-mirror, they actually display a painting of an eye, behind which the hidden CCTV camera is located. The image from the left mirror appears on



Figure 2. *Deus Oculi* at the Chelsea Crafts Fair.

the right monitor behind the woman's face, and the image from the camera in the right mirror appears on the monitor behind the man's face. The three pieces are connected by wires. Thus, if a door is opened and someone is standing next to the mirror or holding the mirror up to their face, their image will appear embedded in the picture. The aim of the piece is to provoke curiosity, surprise and amusement, and it has certain similarities to cut-out pictures found at the seaside or at fairs. But in this case visitors are momentarily immersed in the painting, thus shifting the spectator into the work.

Deus Oculi seemed to provoke a great deal of interaction and discussion between visitors to the Crafts Fair. Visitors treated the piece as a puzzle to be solved. The curious combinations of images and hidden monitors seemed to encourage investigation and these investigations would routinely be conducted in collaboration with others. Moreover, and rather counter-intuitively, the success of the *Deus Oculi* as a puzzle to be explored through collaboration between 'novice' users in part rested on the asymmetrical nature of the resources distributed across the local ecology. Images of individuals in different spaces were displayed a few feet away, thereby connecting people, spaces and activities. The presence of others at the exhibit-face provided resources for

individuals to discover the ‘functionality’ of the piece through the unknowing conduct of those others. In inspecting the hand-mirrors, for example, a visitor’s face would be transposed into the main painting and often confront other visitors, thereby revealing the character of the assembly. Furthermore, once the functionality was discovered by an individual they would routinely attempt to animate it for others. In particular, rather than simply explaining how it worked visitors would try to configure the actions of another such that they would ‘discover’ the functionality for themselves.

Interestingly the various forms of interaction and collaboration around *Deus Oculi* that we observed were not confined to co-visitors, i.e. those that were together at the scene. Often complete strangers would spark up conversations while inspecting the work and in attempting to solve the puzzle.

Our analysis of conduct around the piece identified various issues of interest and we were encouraged to elaborate these further. In particular we were drawn to consider the implications of the spatial configuration of the assembly for the way it was encountered and used. The space that *Deus Oculi* inhabited was relatively modest and we were keen to push these boundaries. Given that the success of the piece in part rested upon the re-placement or transposition of action in one space to another, we were interested in the impact of broadening the space and increasing the complexity of the relationships between components of the assembly. We developed opportunities to progress these concerns in two directions when two works were commissioned from the research team, one by the UK Crafts Council and the other by an arts and crafts gallery in Eastleigh (UK). In one case, we were keen to expand the size of the assembly and in the other case, we were keen to distribute elements of the assembly across different spaces thereby positioning these elements amongst other artefacts within the local ecology. These works of interactive craft became known as *Ghost Ship* and *Keepsake*. The core of this paper will focus on *Ghost Ship*, because it raises a series of critical issues for the design of interactive installations.

4. *Ghost Ship*

Following the exhibition of *Deus Oculi*, the UK Crafts Council approached us to explore the possibility of developing a new exhibit for an annual international fair in Chicago. The Fair known as SOFA (Sculpture, Objects and Functional Art) is a major venue exhibiting leading work in the area of arts and crafts from throughout the world. Each year the UK Crafts Council, in collaboration with the Department of Trade and Industry, sponsor a British artist to create work for SOFA. The commissioners were keen to have work exhibited which reflected Cleverly’s distinctive approach to arts and

crafts. They were also keen to have work which would build upon *Deus Oculi* to create novel forms of participation and collaboration whilst preserving the intrinsic, aesthetic qualities of craft work. The anthropology, the contribution of the WIT group, was seen as a critical element to the exhibit, both by the Crafts Council and Cleverly. The work itself, like *Deus Oculi*, would represent and reconfigure conduct and interaction to the spectator, the visitor. We were provided with a substantial area at the Fair approximately 10 × 30 feet; an area which provided a unique opportunity to create a large assembly of artefacts and images and in which visitors could be actively incorporated into the art work.

The concerns that informed the creation of *Deus Oculi*, coupled with the research findings as to how people explored and responded to it, formed the backdrop to the new design. Cleverly decided, in discussion with the commissioners and the rest of the research team, to create one substantial work which would encompass the whole area and provide an opportunity to display images of conduct from various angles and viewpoints. The piece became known as *Ghost Ship* drawing upon Cleverly's long standing tradition of working with marine materials and artefacts. It was inspired by Samuel Taylor Coleridge's 'The Rime of the Ancient Mariner' and is also in part concerned with a voyage to the Americas. A more detailed description of the work can be found in the exhibition catalogue (Coatts, 2001).

The installation is composed of various elements – the scene of a cruise liner at sea painted onto a wooden façade to one side and a simulated deck area with railings on the other side (Figure 3). Life-size wooden figures were used to inhabit the space. In Figure 4, you can see that the ship is to the right and the deck to the left. On the far left of the image you can see an area which represents the 'inside' of the ship. Visitors can stand in this area and look through windows back towards the painted ship (see also Figure 5).

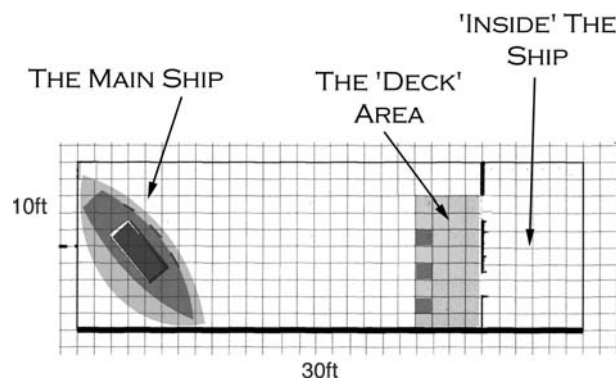


Figure 3. A plan view of *Ghost Ship*.

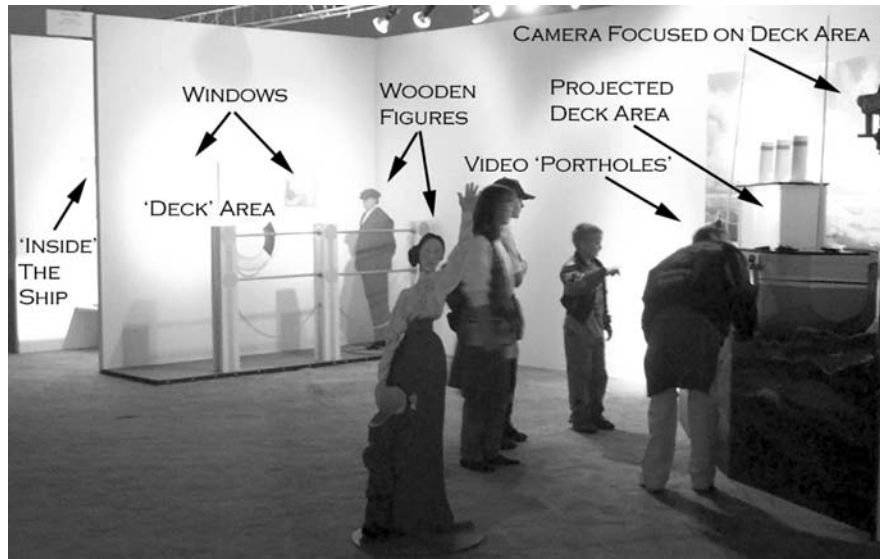


Figure 4. Ghost Ship.

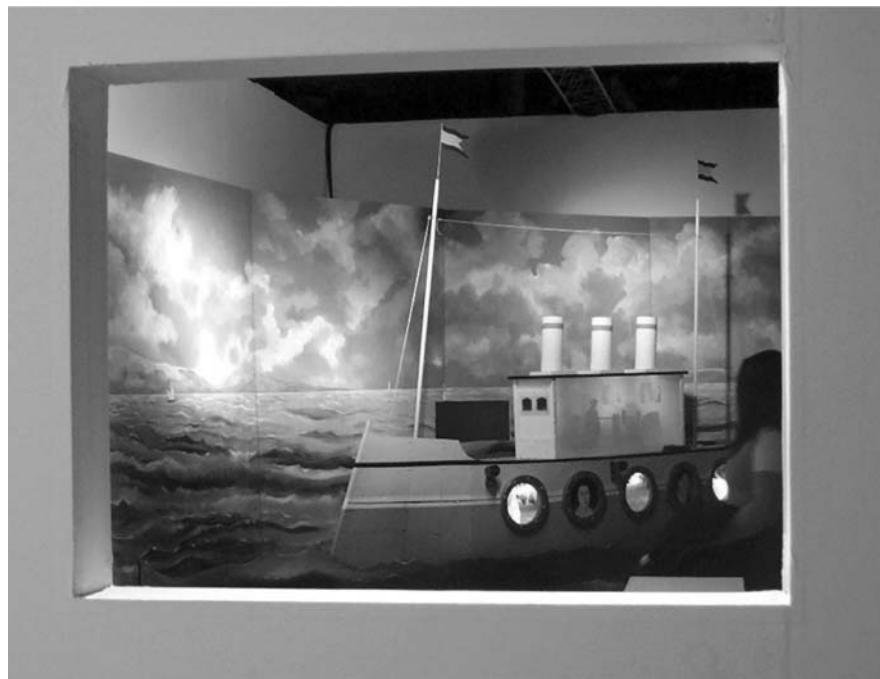


Figure 5. A view through one of the 'windows' looking towards the painted ship and the various video images.

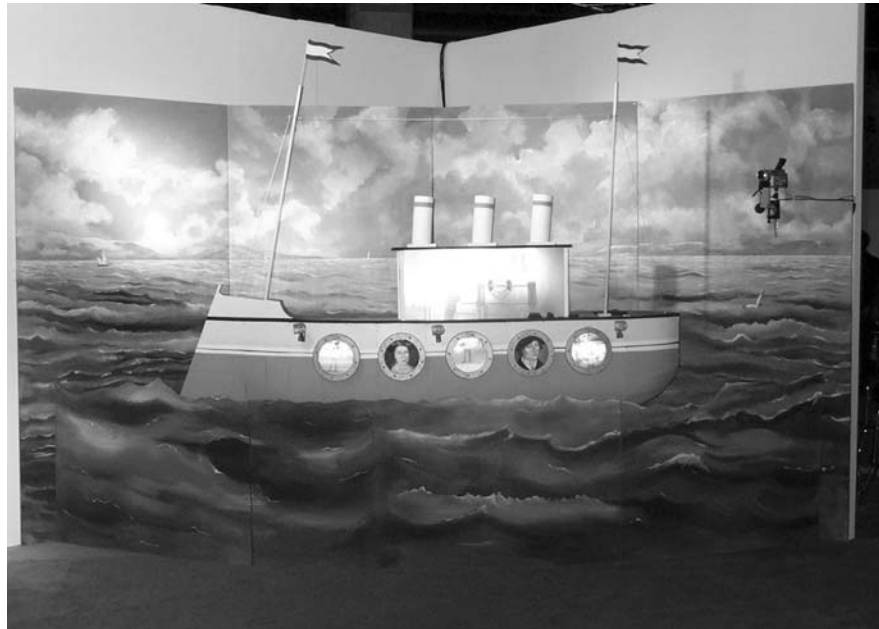


Figure 6. Visitors displayed on the back projected deck area and in the video portholes. The camera circled on the right feeds the monitor on the far left of the picture. A similar camera on the left feeds the right hand video porthole. The central video porthole is fed by a camera immediately alongside it.

Through a series of subtly positioned cameras, monitors and displays, visitors are transposed into the installation. They become part of the artwork and appear ‘on board’ the ship itself. For example, visitors who are standing directly in front of the ship appear, to their surprise, in one of the five portholes, three of which contain monitors (the others consist of painted faces looking out) (see Figure 6). The central camera displays an image into the central porthole. However, to make it a little more bizarre, the cameras alongside the bow and stern portholes display their images at the opposite ends of the ship. In effect, they swap images.

More curiously still, those who stand in the deck area (e.g. Figure 7), appear on a large back projected display on the painted ship. Also, due to the positioning of cameras around the space, often one individual can appear in multiple images. The overall impression therefore is of a ship peopled, both on deck and in the cabins below, by these rather ghostly figures, who of course consist of the very people looking at the exhibit.

In transposing figures into and onto the art-work we were keen to examine the ways in which visitors responded to the incongruent (re)appearance of others as well as themselves, and how they discovered the installations



Figure 7. This is an example of the kind of image that is back projected onto the ship's deck. As this image shows, when visitors are standing in the deck area they can see the projected image.

seemingly simple functionality. Of particular interest were the ways in which visitors configured the relationship between objects and actions and how their exploration both necessitates and provides a foundation for co-operation and collaboration.

5. Analysing interaction

It was evident that *Ghost Ship* was very much a success as a work of interactive craft. Reviewers and visitors alike evidently and observably enjoyed the piece. However, the deployment of *Ghost Ship* for the duration of the SOFA exposition facilitated extensive video data collection to enable a detailed consideration of visitor interaction with and around the piece. A particular benefit was that the visitors encountered the piece as a part of their everyday visit to the fair, and thus there was no need to organise artificial occasions of use; thus the piece was experienced 'in the wild' as it were. Video recordings were taken from a position that allowed the analyst to view the whole space of the exhibit: 'ship', 'deck' and so forth. Meanwhile a

microphone was placed by the ship, so that sound could be captured from those near to the video 'portholes'.

Working with audio-visual data collected in public environments does raise a number of ethical issues and concerns. In working with a range of museums and galleries across the UK and Europe, we have worked up, in collaboration with curators and museum managers, an approach to informing visitors about our studies. This involves the placement of notices at the entrance to the museum or gallery space, at the entrance to the specific part of the museum that we are filming in and on the camera itself. The camera is quite visible, but is motionless – we do not follow visitors around – and mounted on a tripod or clamp to the side of an exhibit. We also make copies of these notices for visitors to take away with them if they wish and they have our contact details on them. These notices inform visitors that we are filming and that the recordings will be used only for teaching and research purposes. They also emphasise that we will not make the recordings available to the general public and that we will endeavour to anonymise the individuals featuring on the recordings where possible. It also stresses that we are on hand to turn the camera off if a visitor does not want to participate and if they have already stepped in front of the camera then they can tell us to wipe sections of the tape that feature them. In several years of doing these kinds of studies many visitors have approached us to ask more about our work, but no-one has ever objected to being filmed. Indeed, visitors are normally not only willing but keen to participate in the research, in particular when they are informed about its use for the improvement of either a specific museum or exhibit design more generally.

The analysis of the data drew on a tradition of video-based work very familiar to the CSCW community (see for example Heath and Luff, 2000). Around 30 hours of audio-visual data were collected whilst the piece was exhibited. All of these data were reviewed and in the initial data review a 'collection tape' was produced to assemble usable data extracts. Whilst in the review stage, we did note general observations regarding the activities of individual visitors at the exhibit, we were primarily concerned with forms of interaction and co-participation around the installation. Therefore the bulk of the extracts collected for further review featured more than one visitor. Moreover, many collaborative encounters with the piece were not usable as the audio recordings failed to capture talk in sufficient detail to facilitate an analysis of the conduct of the participants. Individual extracts were then subject to detailed analysis, focusing on the sequential organisation of contributions (vocal and non-vocal) to the emerging collaborative exploration of the exhibit. This focus encourages the analyst to consider the ways in which individuals make sense of the conduct of others and indeed how they interactionally constitute the significance of the exhibit and features of the exhibit (see also Hindmarsh and Heath, 2000).

The analysis reveals various ways in which *Ghost Ship* was encountered and seem relevant to future design and development work. Here we highlight three of these issues: (1) How *Ghost Ship* engendered and sustained interaction between co-located visitors; (2) How visitors discovered the connections between, and affordances of, the assembly of objects and technologies; (3). How problems arose for participants attempting to instruct others of the use and functionality of parts of the assembly. We will also reflect on issues regarding interaction between strangers in the space.

6. Aboard the *Ghost Ship*

6.1. ENGENDERING INTERACTION

One of the successes of *Ghost Ship* is its ability to engender interaction among groups of visitors. In many cases people would collaboratively explore or ‘play with’ various aspects of the piece. For example, in one case a group of five boys approach the exhibit and immediately begin to peer ‘into’ the portholes. As they approach, they are spread out in a line along the length of the ship. Therefore, rather than taking turns to look into one porthole they begin looking into different ones simultaneously. Within moments, two of them, Terry and Steve, happen to duck down to look at the extreme portholes at the same moment (see Figure 8). Please note that the images are taken from the raw video data and are therefore subject to certain constraints on quality, given the lighting conditions and the distance from the subjects.



Figure 8. Terry and Steve bend down to look into the portholes.

Just as Steve starts to straighten up again, Terry cries out “Hey Steve, I can see your face. Put it in there again”. Having discovered a connection, they begin to explore the nature of the interconnection further. Terry says “Can you see mine?” and “Yeah, man” comes the reply from Steve. The group then take turns to pull faces for each other and create various curious and humorous images, thus playing with the discovered functionality of the piece and the various connections between parts of the assembly.

As they explore different interactive elements of *Ghost Ship* in differing combinations, they step back and around each other and they move in and out of looking into the portholes and the cameras. In stepping back from the group, Steve steps into the view of another camera and appears on the large screen. He notices this and they begin to discuss where the camera is and begin to re-configure that image as well.

The ‘chance discovery’ (Heath et al., 2002) of a familiar face displayed in the artwork provides an occasion for interaction and discussion. The public broadcast of another’s image in the space is a topic of interest to the visitors. However, once these connections are discovered, *Ghost Ship* seems to provide opportunities for people to explore its possibilities, to be creative, playful, humorous and so forth. Visitors can alter the display by the movement of their bodies and their faces; they can create images and scenes.

Whilst these uses of the piece may seem unremarkable, it is worth reflecting that many ‘technological’ exhibits do not stimulate such collaboration and creativity. Indeed, many ‘interactives’ in museums and galleries follow a simple stimulus–response model (e.g. press a button, see an effect), or provide a constrained sequence of actions to follow before being shown an outcome. Rather, this assembly allows visitors to configure it in different ways and create endless possible images for friends and others. It provides progressive opportunities to create and develop novel forms of interaction and participation with and around it.

Indeed there are many cases of this. For example, with the porthole cameras visitors would often create an image of themselves ‘stuck’ inside the ship seemingly banging on the window to get out. On the other hand the large screen was used to create images of people waving from the deck of the ship (see Figure 7) or maybe an image of a shark patrolling the waters just beside the ship. Also, in one rather surreal instance, a man told his son to look at the screen because “there’s a giant hand strangling you”. He stood close to the screen and positioning his hand so that its image on screen ‘grabbed’ the image of his son. When the boy saw this he conspired in the act by shaking and collapsing to the floor.

Even longer ‘episodes’ of creativity emerge. For example, in the next instance Mark, Antonia and Lex are exploring *Ghost Ship* together. They are taking turns to look through the windows in the partition such that they appear on the large screen. When Mark steps behind the partition he ducks



Figure 9. Mark ducks down underneath one window in order to appear first the farther one.

down and creeps underneath the windows (see Figure 9). As a result, he does not appear on the ship's screen immediately and Antonia turns around to look for him. As she turns, Mark pops up. Just at this point Antonia starts to turn back to look at the screen and says "where are you?". When she sees Mark's face beaming out from the screen she bursts into laughter.

Following her laughter, Mark ducks down again and then springs up to appear in the other window – again Antonia laughs. Mark then steps to the side of the screen, grabs a leaflet and waves it through the window – Antonia once again laughs. Once more, Mark ducks down, moves over to the other window and waves the leaflet again. This time there is no laughter. Mark continues to wave the leaflet for a little while, but then peeks out to discover that Antonia has walked away! Whilst he hid himself, he was unable to watch her and thus could only hear her response. Once he realises that he has been waving the leaflet for no one to see, he saunters off.

The surprise, indeed the humour, is created in part through the way in which Mark corrupts the expectable trajectory of his actions. Given his speed, orientation and the alignment of the technology, Mark could be expected to appear on screen in the near window first and relatively quickly. When he does not appear, Antonia turns to find out what he is doing.

We routinely read into the current bodily actions of individuals to establish a sense of what they are doing next and how that might be relevant to our own conduct. Abilities to infer the trajectory of someone's action is clearly critical to our abilities to walk down a crowded street without continually bumping into others (Ryave and Schenkein, 1974) or cross the road without being run over. Studies have also discussed how such abilities are critical to the professional organisation and co-ordination of co-located team working (e.g. Heath and Luff, 2000; Hindmarsh and Pilnick, 2002). In designing workspaces, CSCW designers are often engaged in an attempt to maintain the mutual awareness of actions. However, here we find that an individual's ability to corrupt expectations is critical to creating a humorous episode. This enables us to reflect on aspects of the ordinary state of everyday affairs, here, with regard to trajectories of movement and the like.

Again this success should not be underestimated in museum contexts where users with no training have found ways to creatively use and alter the piece. So, in these environments there might be interesting purchase in providing participants with the abilities to conceal their actions, to play with, surprise and confront others in unexpected ways; to provide opportunities for participants *themselves* to configure novel forms of co-participation. As we have shown, *Ghost Ship* provides lots of opportunities for companions to talk, discuss, explore, create and assemble images and novel forms of experience. Indeed, giving resources for visitors to alter displayed images seems to sustain interest and interaction by providing potentially endless ways of (re)configuring the exhibit.

6.2. DISCOVERING ASSEMBLIES

Given the relatively large space that *Ghost Ship* occupies, the connections between cameras, monitors, 'scenery' and other artefacts are not readily apparent. The examples above demonstrate that when visitors inspect one part of the assembly they often encounter a familiar face or a witnessable nearby activity. This provides opportunities to initiate collaboration, exploration and play. Indeed, we have seen how it provides resources for visitors to create novel forms of co-participation and engagement.

The involvement of large groups of visitors provides ample opportunity for discovery of these interconnections between parts of the assembly. The spread of objects around the exhibition space meant that individuals in the group would not simply look at one part in turn, but rather break into smaller groups to examine different parts of the assembly simultaneously. Given the various cameras and monitors in the space, a 'familiar' face would often appear on-screen. However, it is not just large groups of visitors that have such resources available to them.



Figure 10. Stephanie (left) steps on deck and on screen.

Consider the following instance in which Marjorie, who is inspecting the exhibit alone, discovers the relationship between the screen on the ship and the deck that lies behind her by virtue of the activities of others. She is looking at the screen just as Stephanie and Sophie approach the exhibit from behind her (see Figure 10). Stephanie moves towards the deck area and beckons Sophie to join her.

As all of this unfolds, Marjorie continues to inspect the ship ahead of her. However, the moment Stephanie steps onto the deck, her image appears on the screen in front of Marjorie. Marjorie immediately turns to see Stephanie. She is able to relate the change in the image (i.e., the appearance Stephanie on screen) to activities in progress behind her. One key resource here may be that she can hear Stephanie behind her as well as see her on screen. She then moves onto the deck herself to make her image appear on screen.

So, the co-presence of others in the space and their simultaneous digital presence provides Marjorie with the resources to discern the relationship between the video image displayed on the ship and the local assembly of physical objects. Her experience of the piece is enhanced by the activities of others in the space.

Connections between different aspects of the assembly are less readily available when the exhibit space is less populated. In particular, when individuals enter the scene alone, they often inspect different parts of the assembly without discerning the nature of images. They are restricted to those aspects that reveal an image of oneself, but often overlook the others. In part this is due to a lack of screen activity, rendering some images confusing or surreal, rather than reflecting the functionality and possibilities of the live video feeds. Even when pairs of visitors, especially couples, examine the space together, they often stand so close to one another that they do not discover the character of the assembly. They then look at different parts of the assembly together rather than separating to explore individually. So they rarely encounter dynamic images

that would reveal connections. In attempting to present a puzzle for visitors in order to encourage co-investigation, we have tended to exclude individuals and pairs who explore the space without others nearby.

Nevertheless, the sheer numbers of people present at any one time was not solely responsible for the availability of the relationship between parts of the assembly. Rather, it is necessary to explore how people differently inhabit the space. In the next instance a couple do discover the relationship between parts of the assembly. Bob and Rose have been briefly looking at the portholes and playfully pushing one another into the line of the cameras. It is clear however, that they have not seen how to create images on the large screen situated on the ship. When they turn to move away from the portholes Rose asks Bob to pick up a copy of the brochure lying at the feet of the wooden captain. While he does this she starts to wander off. However, rather than immediately follow her, Bob inspects the deck area. Unbeknownst to him his image is thereby beamed onto the large screen.

As often happens when companions explore (semi-)public spaces, such as shops, museums, train stations and the like, when one wanders off a little bit they will routinely notice that they are not being followed, turn around and wait for, or join, the other. Here as Rose turns around she notices Bob's image has appeared on the large screen on the ship. She immediately points it out to him and as a result he starts to pretend to be a seagull flying around on the edge of the projected deck (see Figure 11).

Their movement as a couple around the space provides an opportunity to discover the relationship between the action of Bob in one space and the public display of that action elsewhere. So, participants tend to discover aspects of the assembly by chance when witnessable events appear on a screen as they inspect it. However, such events are less likely with fewer people inhabiting the space. Indeed, large numbers of individuals left the exhibit confused, because they were not in positions to be able to discover the connections between, and thereby the sense and significance of, the different parts of the assembly. Nevertheless the final example points towards ways of



Figure 11. (a) Rose points out Bob's image on-screen; (b) Bob pretends to be a seagull.

building in facilitators to discovery, which we will return to in the later sections.

6.3. MISSING CONNECTIONS

As with *Deus Oculi*, the recognition of the connection between different parts of the assembly was in part stimulated by the chance discovery of a recognisable image on screen; recognisable as a familiar face or a nearby and witnessable activity. However, as the number of cameras and images was larger for *Ghost Ship* than *Deus Oculi*, the constituent parts of the assembly were distributed over a wider space, and thus the complexity of relationships between exhibit elements increased. This raised difficulties for some participants to discern connections between parts of the assembly and therefore some visitors completely missed the creative possibilities. Difficulties also arose when one person recognised a connection and attempted to instruct a companion about the nature of that connection.

Consider the following instance, in which Jean is exploring *Ghost Ship* with her daughter Edith. In particular, Jean is showing Edith how the video portholes work (see Figure 12). Edith is standing in front of the left-hand camera and her image appears in the right-hand porthole. However, when Jean attracts her attention to it by saying “Look over here, who’s this?” Edith steps towards it to inspect it more closely. In doing so she simultaneously steps out of the range of the camera, so her image slips out of the porthole. Jean says “Oh, you’ve just moved off the camera” and then proceeds to more rigidly manipulate Edith between the different camera positions by physically moving her.

This is rather an inflexible experience for both participants. The joy of discovery for Jean is in part heightened by the fact that she is confronted by the sight of her daughter in one of the video portholes. To preserve the surprise and joy of the experience for her daughter, Jean attempts to allow her to encounter



Figure 12. (a) Edith is depicted in the right hand monitor; (b) When Jean tries to show her, Edith steps off camera

an image of herself to preserve the surprise and discovery. This fails as the cameras and monitors are not positioned to enable such self-confrontation. Instead, a more ‘mechanical’ process is necessary to accomplish the exploration of images and connections. Thus, those wishing to show others how their actions can influence the display of images in the scene are restricted in their opportunities to do this smoothly.

Often, having discovered connections between cameras and monitors, companions take turns at placing their head near a camera to show another. Then they step back to watch another’s face appear in the monitor. However they cannot see the image themselves as they appear to others. So they will often check ‘can you see me now?’ before being able to alter the image with their facial expressions. Thus, they have relatively constrained opportunities to ‘shape’ the experience of their companions.

In both types of case, difficulties arise because the *action point*, at which an individual can create an image, is distanced from the *view point*, at which the created image can be viewed. Thus it is very hard for an individual to witness the visual effect of their own actions. Our concern here is not simply to provide a vanity mirror for visitors, but to support opportunities for creativity. Seeing one’s own image provides the potential to more delicately and flexibly configure the experience of others. A critical element of visiting museums and galleries with others relates the sharing of experiences. In the large corpus of video data collected in numerous studies of visitor behaviour (see vom Lehn et al., 2001), we routinely and recurrently witness people introducing features of exhibits for others, often attempting to preserve the surprise of the outcome for them. However, *Ghost Ship* inhibits opportunities for flexible presentations of features of the assembly amongst companions. Although participants are able to see the responses of colleagues, they are unable to see the details of the image that they are creating. This restricts opportunities for playful and inventive interaction. Indeed, the physical distance between camera and associated monitor seems to disrupt opportunities to share views of images. The design challenge is to consider ways of preserving the possibilities of the discovery of images of nearby people and activities, whilst providing support for more flexible forms of co-participation.

6.4. PUBLICISING INTERACTION

We noted earlier that at times individuals use the actions and activities of others in discovering the sense and significance of connections between parts of the assembly. This is not a phenomenon unique to *Ghost Ship* of course, but rather it is a common feature of visitor conduct, and indeed visitor learning, in museums and galleries (vom Lehn et al., 2001). However, during

the exhibition period, despite the fact that individuals could be seen to be sensitive to the conduct of others who happened to be in the same space, it was extremely rare for strangers to strike up discussions or debates whilst exploring the piece. Nevertheless, there were occasional instances in which this happened. The following is a clear instance which reveals a brief conversation between people who are not at the exhibit ‘together’.

Arthur, a man on his own, has taken some interest in *Ghost Ship*. He has spent several minutes wandering around and inspecting different parts of the assembly. As the fragment begins he is standing in front of the ship itself and staring at it. Just at this point, two women (Tina and Andrea) approach. They are together, but do not know Arthur. Nevertheless Tina steps alongside him, whilst on the other side of him Andrea inspects area in front of the deck. Figure 13 displays the three participants as well as one of the wooden figures that were included by Cleverly to inhabit the space.

Simply by exploring the area in front of the deck, Andrea’s image is beamed onto the large screen mounted on the ship. In some ways, her ‘presence’ could be said to be augmented by the video display. Her appearance is twofold – physically in the space, and visually or digitally on the ship’s public display. She is unaware that her image is publicly available and presented in the exhibit that she is inspecting. Meanwhile as Arthur and Tina are



Figure 13. L to R – Andrea, the wooden captain, Arthur and Tina. At this moment, Tina is telling Andrea that she is on screen.

looking at the screen, Andrea's image appears before them. Indeed, almost as soon as she appears, Tina turns towards her companion and says "Andrea, you're on there. Heh heh".

However, Arthur is standing between the two women. So, as Tina turns her gaze in his direction he treats the utterance as designed for him. Indeed, he may mishear, because he says "You think that's me do you?". This misunderstanding is quickly resolved when Tina says "No there she is see" and points towards her companion. Arthur replies "Oh, oh, her. Heh heh heh". Nevertheless, it initiates or opens interaction, an opening that then develops into a discussion between the two women and Arthur about the piece. Indeed they go on for some moments to discuss how the assembly interconnects and in particular the curious relationship between cameras and video portholes. So the mishearing or misunderstanding provides an occasion for interaction.

The large space that the exhibit occupies often leads to different members of a group of companions investigating different parts of the assembly. Also, given that numerous groups and individuals occupy the same space at the same time it means that there are often groups bisected by other groups or individuals. This case is a prime example. To talk to Andrea, Tina must talk over, around or through Arthur, or else step closer in towards to her companion. In this case she talks across him and confusion (and verbal interaction) emerges. Interestingly, reference to the common screen before them may provide Bob with further evidence that the utterance is for him. The utterance relates to an image before them and it is physically projected towards him.

On a tangential point, before this moment Andrea did not know that she was appearing on screen. She was simply inspecting and exploring the assembly whilst unbeknownst to her, her image was broadcast publicly a matter of feet away. We are of course potentially in view when we wander through a museum. Others can see us and may be even surveillance cameras are tracking us, but there is something quite different about being incorporated into an exhibit – to be put on show. Even though the image is only a few feet from the actual person, this shift seems to transform the obligations of people within the scene. If Tina were not to tell her friend that she her actions are being exhibited, then this might, in some way, be accountable. In such a way, *Ghost Ship* explores the character of relations in public.

Ghost Ship engendered very few cases of verbal interaction between seeming strangers. In this case the spatial organisation of the participants contributed to the misunderstanding and the opening to interaction and discussion. Indeed, it may not be coincidental the two people who do spark up conversation are standing right alongside one another and facing the same display. This co-orientation is similar to the much smaller scale *Deus Oculi*. Usually with *Ghost Ship* the distribution of aspects of the assembly meant that when individuals did confront images of strangers they were

some distance from them. They would use the appearance of others as a resource to make sense of the assembly and to explore it further (as with the example that features in Figure 10). However they would rarely be close by them and, maybe relatedly, would not stride over to discuss the organisation of the assembly. Interestingly strangers would rarely explore the video portholes at the same time and thus the opportunities for interaction evident in the similar organisation of materials in *Deus Oculi* did not occur.

7. Further explorations with *Keepsake*

In parallel with the design of *Ghost Ship*, we obtained a further opportunity to develop our exploration of the issues that arose from *Deus Oculi*. We successfully submitted a proposal, highlighting our programme of work, to an open call by the Beatrice Royal Arts and Crafts Gallery for a new exhibit. In our meetings with the gallery management team, they expressed a number of requirements for the piece. The gallery is a non-profit making organisation aiming to promote the wider appreciation and ownership of contemporary art. Therefore, one of their key requirements for a new work of art was that it should encourage visitors to donate to the gallery – either by taking the form of a donations box or in more subtle ways. Also, the gallery wanted to exhibit the piece for a significant period of time and thus demanded something robust and reliable enough to withstand regular use by the public and to require little maintenance. A further issue that was emphasised in our discussions with the gallery was that they were keen to introduce ways of encouraging visitors to explore the more remote parts of the site. The layout of the gallery is such that visitors often stroll through without entering or even noticing certain exhibition areas.

This last issue encouraged us to explore our interest in engendering interaction by turning more markedly towards the spirit of media space research discussed earlier. We decided to develop various craftworks that could be distributed throughout various rooms of the gallery, that again used cameras and monitors to interconnect those spaces, transpose action and activity between the rooms and potentially support informal interaction between those spaces.

Again the technologies were housed in a variety of ways using relatively traditional materials. We created a series of craft objects that would seem ‘at home’ within the distinctive character of Beatrice Royal – a large vase, a giant fake enamelled keepsake, a portrait painting and a viewing box (which, as you will see, became the back of the painting). In part the idea was to augment traditional craftworks in such a way that the discovery of additional ‘functionality’ of the pieces would surprise and entertain visitors. We paired up the objects: keepsake and vase; portrait and viewer. We placed a camera

on each object to transmit images from one artefact to its pair. So, an image from the bottom of the vase is beamed into the centre of the keepsake and vice versa (see Figure 14). Visitors who peer inside the vase confront a monitor displaying an image of the gallery in front the keepsake. Meanwhile, those looking at the keepsake are confronted by an image of people looking into the vase. As a result, curious images of people looking and even reaching

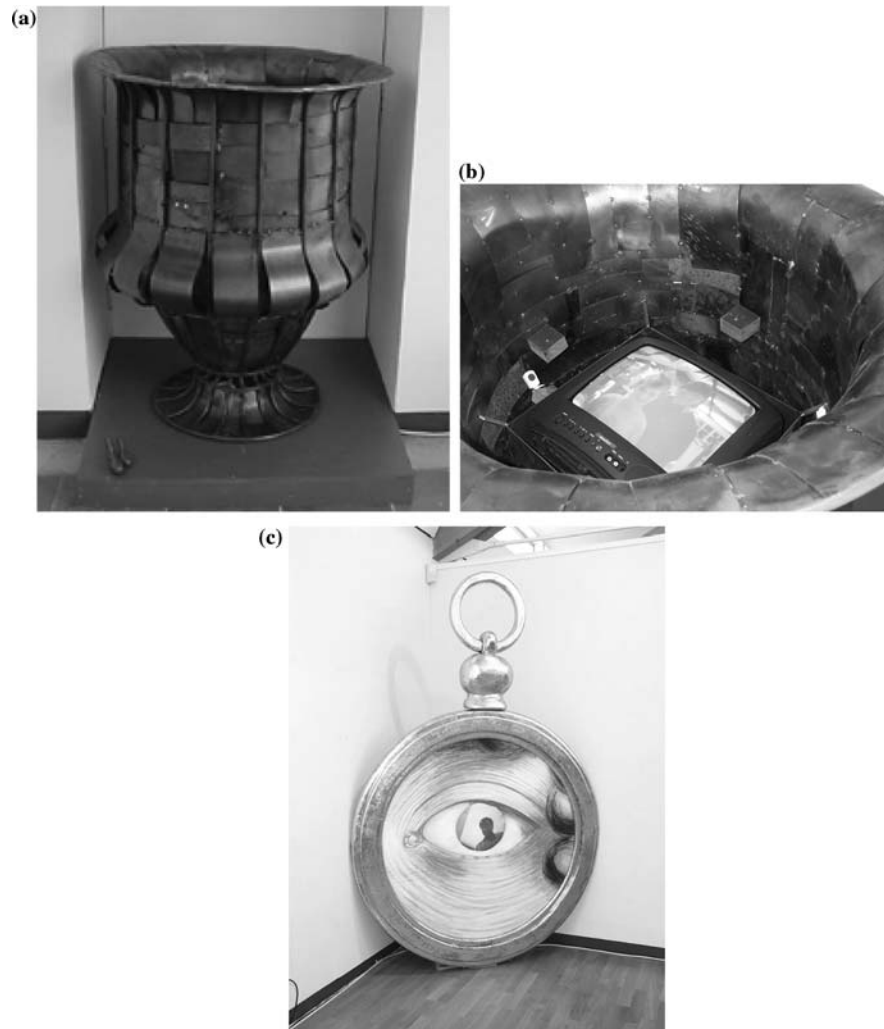


Figure 14. One of *Keepsake's* video connected pairs; (a) the large vase, (b) a monitor inside the vase presenting an image of action in front of the keepsake and (c) the keepsake with a monitor at its centre presenting an image of someone looking into the vase.

out upside down are displayed on the keepsake. They are often unaware that this image is taken from the bottom of the vase.

The other pair of cameras and monitors are mounted onto the portrait and the viewing box (see Figure 15). Once again one part of the pair encourages visitors to peer into it. In this case, the viewing box requests (through a text label) that visitors ‘view’ and viewing involves the visitors in leaning forward and positioning their head close to the box. Once there, they can see into another room in the gallery. Meanwhile by placing their head in position to look inside the box they are simultaneously in position to have a camera capture an image of their face in such a way that the eyes appear in the eyes of the portrait (see Figure 16). This creates an effect common to some movies, where the eyes in a painting are removed for someone to spy on people in a room. When you look at the portrait, therefore, you see moving eyes in a static, painted face. Thus, visitors encounter various sorts of curious images emerging from bizarre artefacts. However the provenance of the images is not revealed. Thus, the design aims to encourage visitors to discover where the action is. In order to encourage visitors to donate to the gallery curious images of visitors (looking into the vase, or staring out of the portrait) were captured and visitors could subsequently purchase them at a cost that would include a small profit for the gallery.

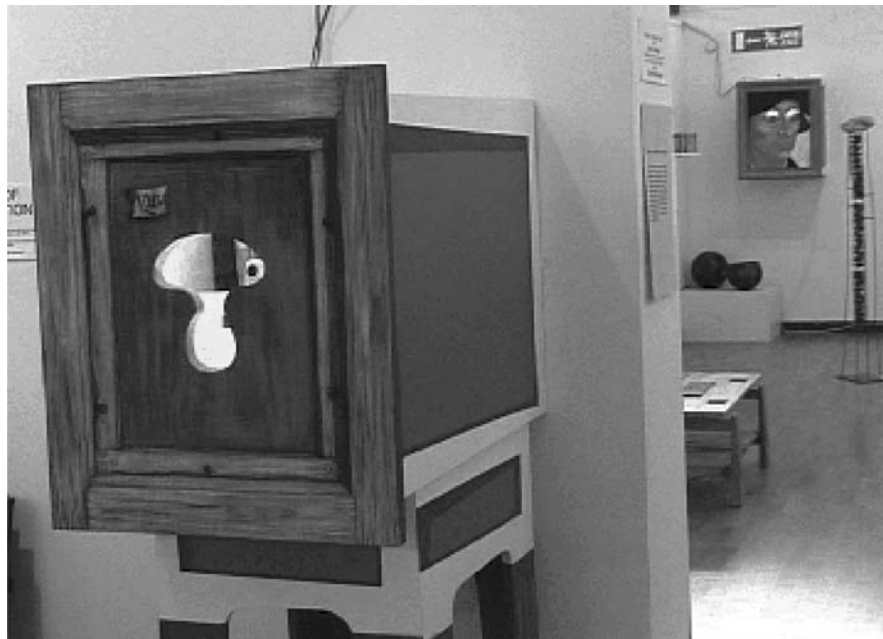


Figure 15. The other one of *Keepsake's* video connected pairs (and the distance between).



Figure 16. A visitor's eyes in the portrait.

Keepsake was in place for several months, but in many ways was not as successful as *Ghost Ship*. Whilst the various pieces were carefully tailored to the character of the gallery, the piece failed to have much of an impact as we had not taken enough consideration of the usual visitor density and flows in the gallery. There were rarely enough people distributed throughout the gallery for visitors to witness other visitors on the monitors at the moments they encountered them. Thus some of the problems noted in the case of *Ghost Ship*, were markedly exacerbated in this case. The lack of 'action' on screen and indeed the lack of familiar 'landmarks' (as, for many, the gallery is an unfamiliar space) led to confusion amongst visitors. Most visitors simply looked puzzled when they encountered the individual pieces which displayed images of bare rooms, and moved on quickly. Others expressed dissatisfaction with the work. For example, one visitor standing before a painting elsewhere in the gallery was overheard saying "Now that's art, not like that TV in a pot!". Whilst we were pleased that the piece engendered reflection and indeed debate elsewhere in the gallery the sentiment of the discussion was not exactly what we had designed for.

For the piece to work well, it relied on the possibility for remote interaction. Unfortunately there were rarely enough people in place to support this. Even when strangers were in the appropriate locations, they often either did not notice that the images on screen were live images of others in the gallery, or they simply did not want to engage with them. The pair that worked the best in many ways was the viewing box and portrait, as people walked through the room that contained the portrait immediately prior to encountering the viewing box. Also whilst standing just to the side of the viewing box, one could still see the portrait. Therefore, it seemed much easier for visitors to discern the relationship between these two pieces. However, due to the low numbers of visitors, groups would often simply wave their hands in front of the viewing box and watch their hands appear in the eyeholes of the portrait. In the instance illustrated in Figure 17, Brian does this to show his companion, Jackie, how the viewer-portrait pair interconnects.

Brian has noticed that when he looks into the viewer he can see into the adjoining room where the portrait hangs. So he begins to explore the connection between the rooms by waving his hand in front of the viewer whilst looking at the painting. When he waves his hands, they appear in the eyeholes of the painting. Once identifying the connection, he turns to his companion, who is inspecting some glassware alongside him and calls to her, “Jackie”. As she steps towards him he points at the painting in the adjoining room and says “See his eyes up there”, she says “yeah” and he begins waving in front of the viewer. A moment later Jackie begins to laugh and Brian joins in. After pausing briefly he then waves across the viewer again and makes a strange sound to accompany it, “eorrerrr”, to accentuate his humorous presentation of the effect. After further laughter, Brian turns to his companion and says “(that’s) made my day”.

There are a number of similar instances in the corpus where visitors discover the connection between the viewer–portrait pair whilst standing



Figure 17. (a) Brian points to the painting as he says “See his eyes up there” to Jackie; (b) Brian waves his hand in front of the viewer to show Jackie the effect in the painting; (c) Brian then makes a strange sound “eorrerrr” to accompany further waving; (d) Brian ends the sequence by saying “(that’s) made my day”.

around the viewer. However they tend to observe the effects and demonstrate the link between the pair whilst remaining at the viewer. They do not attempt to configure the experience of strangers as they inspect the portrait, nor do they then recognise the connection between the other pair in the gallery (the vase–keepsake pair). So whilst visitors visibly enjoyed the discovery of these connections, they were not moved to return to earlier objects to explore the connections further. Nor did the pieces succeed in its attempt to spark interaction between visitors in different parts of the gallery. More seriously perhaps, large numbers of visitors did not recognise connections between the pairs at all.

8. Thinking Beyond the 20" Cathode Ray Tube...

8.1 INTERACTIVE EXHIBITS IN MUSEUMS AND GALLERIES

Deus Oculi and *Ghost Ship* provide relatively successful examples of interactive craftworks that encourage interaction and co-participation between visitors. Whilst *Keepsake* was somewhat less successful in its environment, it also helps identify a number of issues and challenges which will inform our own future research and more generally perhaps the design and development of mixed media, 'interactive' exhibits for museums and galleries.

One of the more successful aspects of *Ghost Ship* is its ability to engender collaboration and to encourage people to creatively engage with the piece. Surprisingly perhaps, this is no trivial matter. Many interactive artworks and exhibits fail to engage people in collaborative exploration and activity. For *Ghost Ship*, opportunities for co-participation revolved around the curiosity of the work, the questions it raises, the asymmetrical organisation of resources, the public display of images of people in the domain and the possibilities to be creative and surprise or 'confront' others. One of the ways that individuals are able engender surprise and kindle laughter was through their use of the physical props of the assembly. Stepping out of sight, ducking under openings and the like provide opportunities to undertake the unexpected. They would pop up from behind partitions and pop into video views. Thus, *Ghost Ship* provides ample opportunity not only for a brief exchange, but occasions and opportunities for a sustained collaborative exploration and the creation of aesthetic experience.

Our interest in interaction and co-participation demands a radical re-consideration of the concept of 'interactivity' that ordinarily pervades the design of interactive exhibits for museums and galleries. The majority of interactive exhibits on display in museums and galleries embody a rather meagre concept of interactivity. Interactivity for most in the museum world concerns an individual's participation in, and engagement with, the exhibit (see Heath and vom Lehn, forthcoming). Interaction *between* visitors is less

of a concern, if a concern at all. When designers do consider the participation of 'others', they are often treated as passive observers.

Interestingly, one would imagine that the design of 'multi-user' exhibits would necessitate a concern with interaction between visitors. However, most multi-user systems displayed in museums and galleries merely provide opportunities for multiple 'simultaneous' engagement with a piece. They provide opportunities for individuals to use an exhibit *in tandem* with others. Thus they often fail to engender collaboration at the exhibit-face and to interweave people's contributions such that they are creatively engaging with others through the piece; something that *Ghost Ship* begins to support.

This paper points to a clear need to broaden out the notion of 'interaction' invoked in designing museum interactives. We have already mentioned that the notion of 'interactivity' provides an impoverished sense of how museum exhibits are encountered and explored. Moreover, the notion of social interaction used when designing museum exhibits often focuses on trying to engender verbal interaction or discussion. However, our studies of visitor behaviour reveal the broad range of forms of (co-)participation involved in the organisation of action at the exhibit-face. Gaze, bodily orientation, gesture, the visible manipulation of artefacts and the like are critical to the ways in which participants organise their collaborative appreciation of exhibits and constitute the sense and significance of the exhibit. Moreover, people who happen to be in the same space at the same time pay intimate regard to the actions of others in order to organise their looking and indeed to learn how to use and how to appreciate (features of) exhibits. Thus, in considering the design of interactives that support social interaction, it seems highly relevant to design for the flexible and highly contingent ways in which visitors co-ordinate conduct with others.

One of the issues raised in the introduction was that there is a growing concern amongst museums professionals to enhance the learning environment by stimulating discussions and interaction between visitors. In terms of learning, *Ghost Ship* was not designed with a specific learning objective in mind. However it might be worth reflecting on some of the failures of contemporary technological 'interactives' in museums and galleries, many that do have specific learning objectives. Often the measures used to evaluate these exhibits focus on the length of time that people stop at the exhibit and they often indicate that people are at technological exhibits for long periods. However our studies of many touch screen exhibits, for example, reveal how even for seemingly simple exhibits people spend the majority of their time engaged in discussions of *how to use the technology* rather than discovering or much less engaging with the underlying educational message(s). In contrast, and despite the complexity of the *Ghost Ship* assembly, many people not only quickly worked out aspects of its functionality, but moreover began to engage with the possibilities of the assembly and indeed its underlying nautical

thematic. Thus, they spent the majority of their time creating novel images on the screens, enacting moments of life aboard ship and invoking images of wildlife above the ship or in the sea beside. Such engagement with the overall theme was a very positive outcome when seen in contrast to many contemporary technological interactives in museums.

8.2. MEDIA SPACE AND INFORMAL INTERACTION

The three craftworks discussed utilise some simple technologies, but nonetheless technologies that strongly resonate with the core concerns and technologies of media space research in CSCW. As we noted earlier, one of the primary motivations for the development of media space was to foster informal interaction between remote researchers. Whilst research on media space has been primarily concerned with developing support for focused collaboration in office environments, more recently there has been a revitalisation of interest in creating media spaces that enable multiple participants within more public arenas to communicate and interact. As with earlier experiments, much of this work has been concerned with enhancing informal interaction within distributed work environments. For example, Jancke et al. have audio and video linked three kitchens in two buildings of a single organisation (Jancke et al. 2001). Similarly Tollmar et al. connected two research labs, again using their ‘public’ kitchen areas (Tollmar et al., 1999). Even though in both cases the participants have a range of familiarity with one another, it was observed that “use is limited” (Jancke et al., 2001, p. 534) and “it was actually quite hard to initiate conversations over the link with people you don’t know” (Tollmar et al., 1999, p. 19).

Similarly with *Ghost Ship* and *Keepsake*, there are very few occasions on which seeming strangers begin to play with the piece together, despite the ample possibilities for it. The spatial arrangement of *Deus Oculi*, coupled with the area in which it was displayed and the large numbers of people at the Crafts Fair, seemed to engender numerous opportunities in which strangers would (at least peripherally) participate in the conduct of others. In part the discovery of the character of the assembly by virtue of the unwitting actions of others coupled with the common puzzle at hand seemed to provide an opportunity to open interaction. The rare instances of similar co-participation amongst strangers in the case of *Ghost Ship* tended to involve people in co-orientation to the screen in similar configurations to the cases of *Deus Oculi*. Meanwhile for *Keepsake* visitors were often unable to interact or collaborate remotely.

Encouraging interaction between strangers should not be seen as a central aim of this work, rather our interests in ‘strangers’ reflects our recognition from our earlier studies of museums that visitors are intimately sensitive to the actions of others in the space – visitors often

approach, explore and appreciate exhibits with intimate regard to the actions of others within perceptual range of the piece (vom Lehn et al., 2001). However, we are also interested in providing opportunities for strangers to engage with each other both visually and verbally through, with and around the exhibit.

Our initiatives and those of Tollmar, Jancke and colleagues have been concerned to both support *and encourage* informal interaction and yet do not provide the grounds for interaction to emerge. Deploying video connections may be a technical solution, but it does not necessarily satisfy social requirements. As Tollmar et al. note, it is more successful in fostering informal conversation between those who already know one another. Our experiences to a greater or lesser extent reveal similar patterns in that even though the visitors were often co-present, strangers rarely engaged in conversation and debate. The challenges of encouraging conversation between these people might be enhanced by providing useful ‘opportunities for interaction’. In workplaces, informal interaction sparked by common events (e.g. leaving a meeting) can often lead to conversations. With *Deus Oculi* (and to a lesser extent *Ghost Ship*) the problem of figuring out the assembly and the unwitting help of others provided such opportunities for interaction. Therefore, in designing technologies to encourage informal co-present or remote interaction it is critical to consider how to provide for the possibility and visibility of *common activities* that might ‘bring in’ others to encourage and sustain interaction.

8.3. ASSEMBLIES AND UBIQUITOUS COMPUTING

The need to design with respect to variable and highly contingent forms of participation presents a major challenge to CSCW. Indeed those concerned to build ubiquitous computing environments may recognise in *Ghost Ship* some of the problems that may face users, especially users in public places. For example, interactive environments in public places will be encountered and used by people in different levels and types of engagement. People will be central/peripheral, active/passive, overhearing/overseeing, watching/glancing; people will be alone, in couples, groups, in the presence of others; and so forth. Recognising and designing for such variable and highly contingent forms of participation with an artefact, or assembly of artefacts, raises different and potentially more complex challenges than traditionally associated with the design of computer interfaces.

For instance, whilst we have argued that the piece is good at engaging companions in interaction, it has also been noted that individuals and pairs or couples tend to have fewer opportunities to notice the interconnections between cameras and monitors. Many CSCW systems are criticised with

regard to the problems of scalability – the difficulties of supporting multiple users rather than simply two or three. Here, we have an unusual reverse. That is to say connections between different parts of *Ghost Ship* seem more readily noticeable when there are multiple people in the scene. With larger numbers present, monitors and projections are more likely to display active images of people. Unfortunately, when smaller numbers are involved there seem to be fewer opportunities for participants to discover assemblies.

In attempting to design a system to encourage collaboration therefore we encounter the problem of *reverse scalability* – designing to accommodate smaller as well as larger numbers of ‘users’. Thus, these sorts of exhibits must equally engage individuals in isolation; collections of individuals; couples alone; collections of couples; groups; collections of groups; an individual and a group; and so on and so forth. All such permutations demand consideration in museums and galleries.

Whilst the assembly and the distribution of the assembly through the exhibition space provides opportunities for multiple engagement, it also raises issues regarding how to manage multiple and variable forms of participation. We need to make concerted efforts to consider the kinds of activity that we want to engage all sorts of visitors in and then explore possible placements of objects to facilitate such activities. Therefore rather than simply thinking of *Ghost Ship* as an assembly of objects, it may rather be worth considering it as a complex assembly of actions. Our design challenge is to more carefully organise that assembly of actions.

Thus, it is necessary to consider how to encourage movements of couples (and individuals) such that they do discover a range of exhibit functionalities. Drawing on understandings of how people explore spaces (together) we could consider ways to encourage people to take different positions within the assembly. Even individuals could be encouraged to stand in specific locations that might reveal the connection between aspects of the assembly.

A key element of this is to consider the relationship between *action points* and *view points* in the assembly. This would allow designers to consider where people make an effect and where they can see that effect. It may be that an asymmetrical relationship between those is prioritised, and yet the exhibit could be configured (spatially or through the use of text) to encourage participants to move to action points and view points. This will not only be critical for displays of human conduct, but any instances where embodied action can creatively shape the display. This may not just be of relevance to museum designers, but to those involved in producing roomware, intelligent environments and even control rooms. Designing such spatial media experiences, critically relies upon an understanding of the organisation of activities that will arise within those spaces. It involves considering how to assemble activities and how to relate action points and view points so that the relevant activities may be interconnected rather than obstructed.

Indeed, these issues seem particularly pertinent to those who are designing ubiquitous computing environments that attempt to respond to the conduct of people in public spaces. Whilst the kinds of simple technologies we have been discussing can provide visible information as to how the system is operating (i.e. through the public display of a video view), many ambient technologies hide the agency of users from the users themselves. This presents additional difficulties in that whilst users may notice differences in the environment, they can have few resources to assess how they might manage them (see also Bellotti et al., 2002).

9. Design sensitivities for interactive assemblies

Our programme of work, bringing together social scientists from the CSCW community with a contemporary craftmaker, has proven valuable in scoping out the design space within museums and galleries. It has afforded us opportunities to inform the design of low tech exhibits and assemblies and to undertake analytic work on the use of those assemblies by visitors as part of their commonplace visits to museums, galleries and fairs. To move the design further on we are building on findings both from our studies of these interactive craftworks and from a range of other studies that we have undertaken regarding visitor conduct and social interaction in a number of museums and galleries (see Heath and vom Lehn, forthcoming; vom Lehn et al., 2001). We are using these studies to develop a catalogue of ‘design sensitivities’. It should be noted that these are not to be treated as strict design guidelines or recommendations. We have found that best practice guidelines tend to have limited utility in the museum world, because each new exhibit raises different issues and demands. As a result, any tightly defined ‘recommendation’ tends to become rather strained when faced with practical situations with specific content, design aims and learning objectives. We would rather not constrain practitioners into focusing on particular topics or into using particular combinations of interface or display technologies and would rather sensitise them to some of the critical issues to consider if interested in engendering or encouraging social interaction between visitors and around assemblies of artefacts. As our programme of work progresses we hope to interrogate and elaborate these design sensitivities further. The most relevant for this discussion can be grouped into two broad categories, ‘interaction and co-participation’ and ‘organising assemblies’.

9.1. INTERACTION AND CO-PARTICIPATION

- Providing opportunities for sustained interaction with and around the exhibit by providing resources for participants themselves to creatively

shape and configure the experience of others, either by changing aspects of the display or by other means. This stands in contrast to many interactives in museums and galleries that follow a stimulus–response model in which the visitor is expected to press a button or go through a series of tasks in order to trigger an effect. Rather, here, we are encouraging the design of exhibits that facilitate transformation of the exhibit which supports real-time, collaborative exploration and indeed could leave an ‘activity trace’ for future visitors;

- Recognising and designing for the presence of seeming strangers. The actions and activities of individuals are often produced with intimate regard to the actions of others in perceptual range. This may involve providing ‘opportunities for interaction’ between both companions and strangers, whether they are in the same physical space or indeed remote spaces. It may also call for ‘designing in’ opportunities for ‘chance discoveries’ where the design might be weighted to facilitate particular phenomena being noticed ‘as if by chance’;
- Recognising and designing for variable and highly contingent forms of interaction and co-participation around the exhibit. This includes sensitivity to different degrees and combinations of verbal and non-vocal conduct amongst individuals and groups, companions and strangers – passive/active, central/peripheral, etc. It is tempting when considering ways of supporting social interaction to focus exclusively on engendering discussion between visitors. However, social interaction, in various other forms, is an unavoidable aspect of visitor behaviour. Therefore, these variable forms of (co)-participation should be recognised in design, even if simply to note that strangers often oversee how someone is using or appreciating an exhibit and to explore how an exhibit assembly could exploit that.

9.2. ORGANISING ASSEMBLIES

- Organising the assembly of objects with regard to the visibility of displays and actions at different points of the assembly; in particular this may involve carefully organising the relative placement of *action points* and *view points* in the assembly. Also it may involve considering how an individual may potentially see the ‘output’ of their actions and the response of others. This should enable visitors to more readily organise their conduct *for others* when shaping their experience of, and encounters with, the exhibits;
- Taking into account matters of *reverse scalability* by recognising and designing for variable numbers of people within exhibition spaces. This should ensure that individuals in isolation as well as groups in more

inhabited spaces are able to make some sense of the assembly and engage with it at some level;

- Recognising and designing for the difficulties participants face in inter-connecting aspects of an assembly of digital and physical artefacts spread across an exhibition space. This may include opportunities for ‘observers’ to establish how others are physically engaging in the piece by avoiding ‘input’ mechanisms that conceal the character of actions. In making observable the physical engagement with a mechanism, it may help to expose the interconnection between aspects of an assembly.

As we note above, we do not see these sensitivities as strict recommendations, indeed their form does not lend them to work in such a way. However, we have begun to work with them in the design of further installations in the programme of work.

The new installations provide opportunities to explore the design sensitivities, to try to use them to organise the design of the assembly and the lay-out of the assembly. In addition the new work marks a shift in the trajectory of our use of the low tech assemblies. They are now being used to direct attention to the objects displayed within museums and galleries and to provide exhibits that encourage visitor reflection and engagement with those objects.

As we attempt to further engage with the contemporary museum agenda there is an increasing need to consider ‘informal learning’. Museum professionals are not simply concerned with social interaction in the museum context for its own sake, but rather to create more fertile learning environments. As works of contemporary craft, *Deus Oculi*, *Ghost Ship* and *Keepsake* have no pedagogical concerns. They more or less successfully encourage play, and although play is seen as a useful learning motivator, we are keen to progress the work by encouraging visitors to reflect further on their experience and action. Thus, we have turned towards exploring ways to encourage visitors to reflect on key issues or themes whilst interacting with and around the piece. We have started to move towards the design of assemblies that attempt to encourage visitors to engage with objects on display elsewhere in particular museums and galleries, rather than making the spectators part of the work.

We hope to encourage visitors to question the sense and significance of objects and displays by engaging the visitors themselves in the work of *producing* exhibit assemblies. So we are building a series of pieces that focus on the interpretation of objects and most notably curatorial work, the work of assembly and so forth. The first work, *The Universal Curator*, was initially exhibited in The Hunt Museum, Limerick as part of the 2nd SHAPE Living Exhibition (see www.shape-dc.org). However we have since taken it around the country to different domains, tailored in each case for the distinctive local character of the host institution. We have deliberately decided to produce a piece that is re-configurable in order to allow us to

explore specific sensitivities in more depth, so we are able to make small changes to lay-out and the design of the visitor experience. There will be three of these versions of the piece in total. The second has recently been exhibited in Shipley Art Gallery (Gateshead, UK) and the third instantiation will be exhibited in the Potteries Museum (Stoke-on-Trent, UK). In due course, we plan to undertake and report significant analytic work to compare and contrast visitor conduct and experiences as well as the relative successes and failures of the installations.

Whilst this provides the core thrust of the development of our programme of work, it hopefully does not delimit the potential ways in which the spirit of the design sensitivities could be instantiated. Indeed, we will continue to pursue our interests in these design issues through a series of further activities with both low tech and more hi tech assemblies. For example, we have had some preliminary opportunities to explore the creation of complex *mixed reality* assemblies, that feature novel technologies, such as 3D graphics, 3D soundscapes, haptic devices, and various sensor technologies, as well as more commonplace objects and artefacts (see for example Fraser et al., 2003). We hope to extend these developments and more thoroughly work the design sensitivities through the design of mixed reality assemblies. Of course, the challenges of creating coherent assemblies that facilitate interaction and co-participation are heightened as we introduce a more complex array of technologies, where the visitors often do not understand how they work or what they might do.

10. Discussion

Whilst we have focused upon the key design implications of the analysis presented here, there are also some methodological issues that are raised by this research and that reflect emerging trends with the studies of work to be found in the CSCW literature. As cutting edge research within computer science and technology design steps into the worlds of mobile computing, ubiquitous computing, and the like, various challenges arise for those who undertake studies within the field. Many of the key papers in the workplace studies literature (see Luff et al., 2000) focus on co-located working environments – control rooms, service encounters, offices and so forth. However, recent projects are beginning to undertake studies of mobile work, in domestic settings and in public places. Each type of research domain raises distinctive challenges to the researcher – practical, analytic and ethical. In our case, for example, the quality of audio and the clarity of image were rather poor and constrained potential analytic foci. Increasingly it may call for further attention to the research practices and technologies that might usefully

support data collection and analysis in such domains. Whereas in the past, we might have been able to draw on innovations in the social sciences, many of these settings are underexplored or unexamined. CSCW has opportunities to innovate in research method as well as technology.

Finally it is worth noting the key, pervasive concern underlying our developing strategies of work. Despite the substantial contribution of CSCW over the last decade to our understanding of co-operation and collaboration, we still know relatively little of the ways in which conduct and interaction is accomplished, in and through, (occasional features of) the material environment. Behaviour in public, whether in museums and galleries, railway stations or city streets, remains surprisingly disregarded, not just in CSCW but throughout the social sciences; indeed despite a little enthusiasm in the early 1970s it has almost disappeared from the sociological agenda. With the development of mobile technologies, changing forms of organisational relations, and the growing ability to interconnect objects, tools and artefacts, interaction between people in public and semi-public arenas will become of increasing relevance to CSCW and the tools and technologies we design. Small-scale experiments coupled with studies of interaction and collaboration between visitors to museums provide a microcosm with which to explore behaviour in public and to begin to unpack the ways in which people collaboratively explore, discover, encounter and experience the material environment and the objects and artefacts, tools and technologies of which it consists.

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