Creating Assemblies in Public Environments: Aboard the *Ghost Ship*

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This paper examines the use of an interactive artwork that was designed by members of the research team and exhibited at the Sculpture, Objects and Functional Art (SOFA) Exposition in Chicago, USA. The artwork is relatively low tech, but is used to explore the ways in which people encounter and explore technological exhibits in museums and galleries. The study uses audio-visual recordings of interaction with and around the work to consider how people make sense of the 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 accomplished in and through social interaction. 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.

Keywords
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 Brown and Chalmers, 2003; Crabtree et al. 2003; Esbjörnsson 2003; Fraser et al. 2003; Grinter et al. 2002). This re-orientation of the

CSCW agenda raises numerous challenges to design and study, challenges unique to each new domain that demand novel development within the social and technical work of CSCW. This paper[1] 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.

In recent years 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 the design and evaluation of a technological artwork that was exhibited at the Sculpture, Objects and Functional Art (SOFA) Exposition in Chicago during October 2001. Whilst the paper does present an exhibit that we hoped would stimulate novel forms of collaboration and co-participation, it does *not* aim to present novel technical work. The design of the exhibit was intended as a heuristic device to help to explicate the organisation of visitor action and interaction around interactive exhibits more generally. In this regard, the paper uses the relatively low tech exhibit as part of a field study 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 Büscher et al. 2001; Ciolfi et al. 2001; Heath et al. 2002; Hemmings et al. 2000) and also inform an associated body of work concerned with the design of novel technologies to support multi-participant engagement in museums and galleries (Grinter et al. 2002; Omojola et al. 2000; Woodruff et al. 2002). In doing so the paper develops some 'design sensitivities' that will be used to inform design and development of future low and hi tech exhibits that encourage interaction and co-participation between visitors. It also suggests various ways in which the study has more wide-ranging relevance for the areas of media space research and ubiquitous computing.

[1] This is a revised version of paper presented at CSCW2002 (see Hindmarsh et al. 2002). This piece tries to engage more fully with some of the issues that arose in the interesting debate about the presentation in New Orleans and also attempts to situate the piece within a broader context of the relevance of 'non-workplace studies' for the CSCW community. Indeed in the light of the panel on 'Working out Work - Computer-Supported Cooperative What?' at ECSCW in September 2003 and other recent discussions regarding the CSCW agenda, this piece seemed to us a rather timely submission to the journal.

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 2002). 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 headphones 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 assemblies 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 with the artist and craftmaker, Jason Cleverly.

3. *Ghost Ship*

Jason Cleverly has a background in creating artefacts and simple automata that provoke surprise, curiosity and laughter. Our collaborations with him have focused primarily on attempts to 'encourage' interaction between visitors using relatively simple technologies and 'interfaces', most notably video cameras and monitors. The substantial body of research concerned with media spaces is particularly pertinent in this context, 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. Heath and Luff 2000; Jancke et al. 2001; Tollmar et al. 1999), 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.

Our first collaboration, *Deus Oculi*, was exhibited at Chelsea Crafts Fair (see Heath et al. 2002) and following the analysis of its use, we identified various issues to explore further. They concerned the assembly of technologies and objects; the character of occasions in which interaction arose and the nature of interaction between different combinations of individuals and groups. Fortunately we had the opportunity to develop these interests. Following the exhibition of *Deus Oculi*, the Crafts Council approached us to explore the possibility of developing a new exhibit for an annual international fair in Chicago.

Figure 1: The SOFA Fair, 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 (see Figure 1). Each year the 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 re-present and reconfigure conduct and interaction to the spectator, the visitor. We were provided with a substantial area at the Fair approximately 15 x 20 feet; an area which provided a unique opportunity to create a room-sized assembly of artefacts and images in which visitors became 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 WIT group, 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).

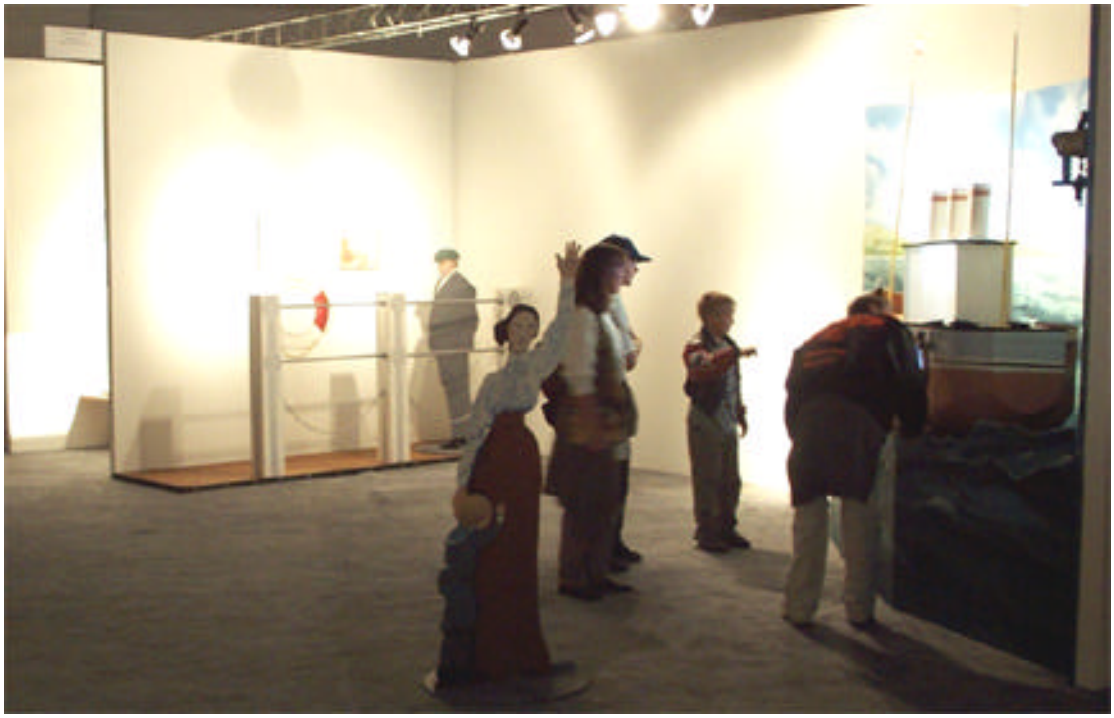

Figure 2: *Ghost Ship*

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. Life-size wooden figures were used to inhabit the space. In Figure 2, you can see that the ship is to the right and the deck to the left. On 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.

Through a series of subtly positioned cameras, monitors and displays, visitors are transposed into the installation. They become part of the art work 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 Figures 3). The central camera displays an image into the central porthole. However, to make it a little more surprising, 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, appear on a large projected display on the painted ship (see Figure 4). 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 in the cabins below, by these rather ghostly figures, who of course consist of the very people looking at the exhibit itself.

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 progressively discovered, and toyed with, the installations 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 cooperation and collaboration.

Figure 3: Visitors displayed on the projected deck area and in the video portholes

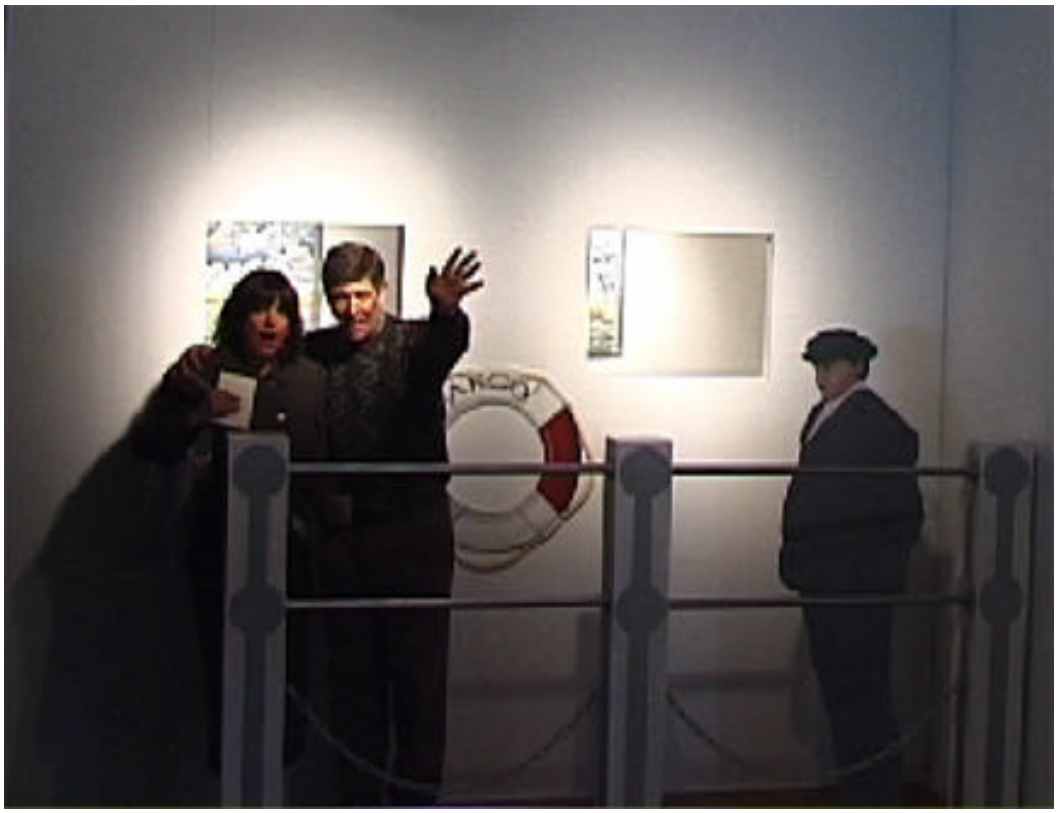

Figure 4: Images are broadcast onto the ship's deck so that visitors can see themselves

4. Aboard the *Ghost Ship*

It was evident that *Ghost Ship* was very much a success as an artwork. 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 facilitate a 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'. The analysis of these materials drew on a tradition of video-based work very familiar to the CSCW community (see Heath and Luff 2000). The analysis revealed various ways in which *Ghost Ship* was encountered and used seem relevant to future design and development work. Here we highlight three of these issues: i. How *Ghost Ship* engendered and sustained interaction between co-located visitors; ii. How visitors discovered the connections between, and affordances of, the assembly of objects and technologies; iii. How problems arose for participants attempting to instruct others of the use and functionality of parts of the assembly.

4.1 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 5). 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 5: 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 try out different things in differing combinations, they step back and around each other, 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 4) 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 down and creeps underneath the windows (see Figure 6). 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.

Figure 6: Mark ducks down underneath one window before in order to appear first the farther one

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 peaks 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 is 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. Reflexively of course 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.

4.2 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.

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 7). 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.

Figure 7: Stephanie (left) steps on deck and 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. However, although strangers could equally interact through the video windows and across the space of the exhibit, they did not so readily. The possibility for interaction alone was not enough. Indeed interaction between seeming strangers was very rare.

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 shear 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 he then reconfigures the deck view by pretending to be a seagull flying around on the edge of the deck (see Figure 8).

Figure 8: i. Rose points out Bob's image on-screen; ii. Bob pretends to be a seagull

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

4.3 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*, the constituent parts of the assembly were distributed over a wider space, the complexity of relationships 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 9). 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.

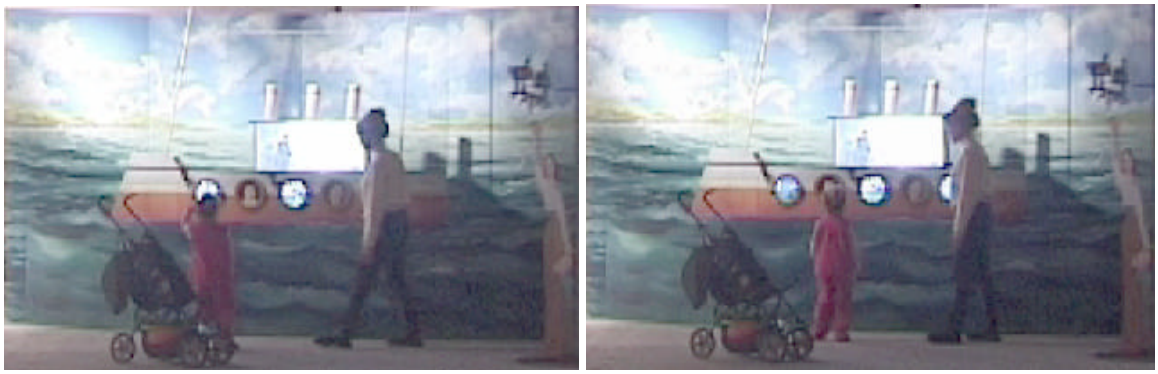

Figure 9: i. Edith is depicted in the right hand monitor; ii. When Jean tries to show her, Edith steps off camera

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 the artwork. To preserve the surprise and joy of the experience for her daughter, Jean attempts to allow her to encounter 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.

5. Thinking Beyond the 20" Cathode Ray Tube…

5.1 Interactive Exhibits in Museums and Galleries

Ghost Ship provides a relatively successful example of an interactive artwork that encourages interaction and co-participation between visitors. 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. 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.

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.

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 coordinate conduct with others.

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, 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.

5.2 Media Space and Informal Interaction

Ghost Ship utilises 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 in the case of *Ghost Ship*, there are very few occasions on which seeming strangers begin to play with the piece together, despite the ample possibilities for it. 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. *Ghost Ship* reveals similar patterns in that even though the users were 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. 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 *activities* that might encourage and sustain interaction.

5.3 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, leads to far 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.

6. Design Sensitivities for Interactive Assemblies

This study points towards a number of research trajectories that we will explore in close collaboration with designers, curators and museum managers as well as colleagues in the CSCW community. This programme of design, exhibition and analysis will be shaped with an eye to enhancing our understanding of concepts such as 'participation', 'collaboration', 'affordances', 'mobility' and 'interactivity'. We are using the study of *Ghost Ship*, in concert with our studies of interaction in a range of museums and galleries (see Heath et al. 2002; Heath and vom Lehn 2002; vom Lehn et al. 2001), to develop a catalogue of 'design sensitivities'. These design sensitivities will be interrogated in our future work as we use them to structure the design and evaluation of a series of collaborative technologies for museums, galleries and other public spaces. The most relevant for this discussion can be grouped into two broad categories, 'interaction and co-participation' and 'organising assemblies':

6.1 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;
- 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;
- 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.

6.2 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 (though not necessarily easily) see the 'output' of their actions and the response of others;
- 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 sense of the assembly;
- Recognising and designing for the difficulties participants face in interconnecting 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.

We are pursuing our interests in these design issues through a series of activities. A key feature of these activities are their focus on the development of new forms of exhibit which, in different ways, encourage co-participation and collaboration.

Firstly, we are engaged in working with designers, artists and curators to create relatively 'low tech' exhibits to enhance how people experience more traditional exhibits as well as continuing to engender curiosity, surprise and exploration. In particular, a concern for museums, especially museums with large or complex spaces, is to provide new visitors with a sense of the geography of the space and to encourage them to explore more remote or less readily accessible domains and collections. Therefore we are continuing our collaboration with Cleverly in an attempt to inter-link remote spaces in galleries and provide visitors with the opportunity to discover, by chance, how others are exploring and experiencing particular exhibits and areas. To this end we have been exhibiting a low tech assembly commissioned by the Beatrice Royal Arts and Crafts Gallery in Eastleigh. A key design challenge is to encourage remote interaction in public places.

We are also working with Cleverly to develop interactive exhibits that can facilitate

'informal learning'. As *Ghost Ship* is an interactive craft work, the piece aims to provoke exploration, surprise and humour. However, our aims drive us towards a museum agenda concerned with learning through interaction. 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 a work of contemporary craft, this piece has no pedagogical concerns. If we are to more fully engage in the concerns of the modern museum, we will hope to explore the potential to encourage visitors to reflect on the piece. *Ghost Ship* encourages play, and play is seen as a useful learning motivator, but we need to encourage the visitors to reflect on their actions.

In addition, and in collaboration with colleagues at KTH and the Universities of Nottingham and Limerick, we will continue our exploration of object 'assemblies' (see also Fraser et al. 2003). In particular our design sensitivities will be combined with various technological and practical concerns to produce a design space for the creation of a range of complex *mixed reality* assemblies. We aim to create coherent interactive environments that feature novel technologies, such as 3D graphics, 3D soundscapes, haptic devices, and various sensor technologies, as well as more commonplace objects and artefacts. These will be deployed within museum environments that will enable us to develop and evaluate mixed reality experiences in everyday contexts. 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

7. 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, (occasioned 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 1970's 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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