

## **EMBODIED ACTIONS IN TIME AND PLACE: THE COOPERATIVE DESIGN OF A MULTIMEDIA, EDUCATIONAL COMPUTER GAME.**

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### **ABSTRACT**

This paper reports a field study of the design of a multimedia, educational software product, from the early articulations about the kind of product to be made, to the production of the prototype used for capital raising. The designers were members of a small distributed company who used computer systems and communication technology, as well as highly developed communication skills and procedures, to enable them to work together over distance. The focus of the paper is the work people did to create and maintain the cooperative design process within a specific organisational framework and in relation to the design of an actual product. The basic conclusion is that the cooperative design of the product was enabled and achieved by the work the designers did communicating with each other. Any future selection of additional CSCW technology by the company will be determined by its contribution to the communicative resources of the designers.

### **KEYWORDS**

Cooperative Design, Distributed Design, CSCW, Embodied Action, Small Company, Women Designers, Personal Communication Skills

### **1. INTRODUCTION**

People have been finding ways to work together for as long as they have been doing anything that could meaningfully be called work. The work of designing is no exception. Likewise, people who are normally geographically separated, have been finding ways to work together over distance for as long as cooperation between geographically separated people has been considered to be, for whatever reason, a good thing. For designers of CSCW systems the work their systems will support is, in a very important sense, always already being done. Their systems will certainly change how that work is done in the future, but they will never be used in a workplace that has not already been shaped by existing work and social practices, and existing technologies. This is why empirical studies of

various kinds of cooperative work have become increasingly important within CSCW research; particularly to those concerned that the systems they design contribute positively to the work practices of the people who use them (for a critique of these studies and their role in the design of CSCW systems see Plowman et al., 1995).

This paper reports a field study of the cooperative design of a multimedia, educational software product. The designers were the members of a small distributed company. They used computer systems and communication technology, as well as highly developed communication skills and procedures, to enable them to work together even though they were geographically separated most of the time. The study concentrated on the part of the process of design that spanned the first articulations about what sort of multimedia educational software product it might be, through to the production of an early prototype that could be used to raise capital for the building of the product. This is the end of an industry-recognised phase in the design and development of these kinds of products.

Cooperative systems to support various practices of design have been a major focus of CSCW research. Twidale et al. (1993) argued that design is illustrative of one of the major problems of developing CSCW systems, in that while it is clear that most designing involves collaboration, 'our understanding of its nature as a cooperative process is limited' (p. 93). Empirical studies of various instances of the design process have already made valuable contributions to building that understanding.<sup>1</sup> But to date, longitudinal studies of non-experimental design projects are rare and the coverage of the range of design activities remains sparse. Research effort appears to have been concentrated on a few limited areas of design where most, if not all, of the work studied is computer-based. These areas include software design done by small teams in large organisations, artificial tasks in quasi-naturalistic environments that have been set up within research environments to test experimental systems, and studies of researchers designing cooperative systems to use as research tools. Within this context, the focus of this study is unique. The company involved is very small and the designers are professionals doing their normal work, over its actual time frame within their usual work environment. While the product being designed will find its material expression as a piece of software, a great deal of non-computer based work was involved in its making.

The first part of this paper establishes the organisational and marketplace context for the company's work. The body of the paper focuses on the unfolding, through time and across space, of a specific cooperative design process within a distributed workplace. It is not a description of the design itself, nor of the development of the creative content of the product. My interest lies not so much in what people were designing but how they were doing it. Suchman (1994, p. 20) argued for the centrality of the support of articulation work to the 'successful workings of technology production and use'. And Schmidt and Bannon (1992, p. 20) regard the problem of 'how to support the ongoing dynamic articulation of

distributed activities and the corporate management of the mechanisms of interaction themselves' as the key issue in CSCW. So my focus here is the actual work people did to create and maintain a cooperative process that is always defined both within a specific organisational framework and in relation to the development of a specific product. This focus is partly to highlight the procedures, skills and techniques used to achieve the cooperative design of a product by people who already have a great deal of experience and expertise in working together over distance. But it is also to recognise that an understanding of these procedures, skills and techniques is valuable for designers of CSCW systems committed to supporting articulation work. It is every bit as important to know what it is not appropriate to attempt to support, as it is to understand where, why and what sort of support would be valued. Moreover, this is a small company and, like most small companies, it uses off-the-shelf software (Robertson, 1996); any new technology must be incorporated incrementally into the existing systems and work practice. This is not a situation where specially written systems, or totally encompassing new systems, are realistic options.

The basic conclusion of this study is that the cooperative design of the product was enabled and achieved by the work the designers did communicating with each other. I mean here communication in its widest sense, people using whatever resources they can to interact with each other to create, negotiate, maintain and review shared meaning, understanding and knowledge. This kind of communication depends on each designer having well-developed and organisationally well-valued interpersonal communication, coordination and relationship-building skills. It requires that the work involved in the achievement of robust communication is acknowledged, valued and rewarded within the organisational culture. In this company, communication was strengthened further by the various design and development processes used being chosen, in the first instance, because they already had, or had the potential to have, communication support embedded within them. When the designers shared a physical space, that space enabled communication work by supporting the mutual perception of their embodied actions, as they talked together and made and used various artefacts within the shared physical workspace. When they were apart, communication work had to be supported by the interplay of specifically evolved work practices, with whatever communication technologies were available.

## **2. THE ORGANISATIONAL FRAMEWORK**

In their discussion of the design of a new feeder for an existing photocopy machine, Anderson et al. (1993) analysed how organisational exigencies shaped the design process itself. They argued that an essential feature of design work is 'the way in which organisational context is played out in the actions and collaboration of design teams' (p. 48). It follows from this that the organisational context has consequences for the way support tools are designed and used (p. 59; see also Jirotko et al., 1992). The company, at the centre of this study, has also evolved a design and development process that reflects its organisation. Its

organisational framework is not a particularly common one in organisation discourse (Morgan, 1986). Ironically, it is a 'small, stable, egalitarian (relatively), homogeneous and harmonious ensemble of people' - the 'group' that Schmidt and Bannon (1992, p. 15) have critically identified as the underlying (and in real life unjustified) assumption in most CSCW research to date. But in other major ways this study's organisational setting differs from the kinds of organisations, the kinds of work and particularly the kinds of corporate mores, that are often assumed as natural in much CSCW research. Most importantly, it is not a small group within a larger organisation and most of the designers are women<sup>2</sup>. There are just the eight company members, all of whom are directly responsible for the economic survival of the company and the continuation of their jobs. Each of them is directly involved in the day-to-day work. There are no external shareholders, or distant and formalised management structures and procedures.

The two directors established the company in order to fulfil their specific requirements about ways of working. Its culture and organisational framework reflect these priorities.

We started our company, my partner and I worked for a tiny little company that was working on site, that had, I don't know, a good culture just in being good people to work with ..... That little company was sold out to <company name>, a huge, big company who just robbed over everybody and just treated people like oh, it was dreadful. So we said 'to hell with this, we'll leave and form our own company, we can do it better'. And just from day one we have always said, you know, 'how can we work well and civilised and trust people and do all of those things that this big company just did the opposite?' You know? 'How can we have people enjoying what they're doing and how can we feel ethical about everything we do and comfortable and how can we be honest and all those sort of things?' And that's just the way we determined to work from day one and we continued to work on it.

Sydney director (Susan) - Interview.

Computer systems and communication technology have been central to the successful operation of this company throughout its history. All the company members were competent computer users and several had developed considerable expertise. Training in the use of new applications was a regular part of group meetings. Computers have been used not just as a development tool for its products, but to provide crucial infrastructure support for the company itself, and to support the work of communication between its members when they were working apart. The organisational framework that structures the design work discussed here, combines an ongoing engagement with new and developing technology with the continual engagement with questions of how people can use this technology to control and improve their work lives.

## **2.1. The Company**

There were eight people working with the company when the study reported here was carried out. Each worked in her own home, meeting together in the home of the Sydney director once a week. These meetings are the only regular face-to-face meetings of the whole group and are basic to its functioning. Most members of the company live within a 50 kilometre radius of Sydney, except for the other director who lives in Melbourne (about 900 kilometres away) She is unable to

attend all the weekly meetings but travels to Sydney for a few days each month. All but one of the company members are women. The company has been distributed since it was formed and has been operating for seven years.

As a producer of educational software products the company competes in a market that encompasses training programs for large organisations and government departments, curriculum support for schools and off-the-shelf titles intended for use on home computers. It is a volatile and rapidly changing market that is as much shaped by new technologies and media hype as it is by general economic conditions. Its recent growth has seen the entry of larger companies, including foreign-based multinationals, that can use the power of size to set local prices and standards. Small companies need to be flexible, robust, efficient and sure of their technological support if they are to survive in this market. Inefficient communication within the company can be as fatal to its existence as the loss of a key employee, the failure of core technology or the simple misjudgment of industry trends.

The directors' medium term aim was to divide the company's work evenly between what they describe as 'bread and butter jobs' such as developing corporate training software and the development of their own titles. Generally there are a number of products in progress at any one time, each at a different stage in its development. This ensures a manageable spread of work through time, as well as optimising the cash flow and providing some protection to the company from unforeseen events such as cancelled contracts and economic downturns etc. Most importantly, this way of organising work fits well with a distributed company with limited face-to-face working time. While they are apart, the company members can organise their time so that they can do individual work on a number of products. Work that requires face-to-face collaboration can, if necessary, be put on hold until the next meeting, while they continue working on another project in the interim.

## **2.2. The Roles of the Different Members**

With so few people involved, job specifications are flexible. Each member has her or his main area of expertise and responsibility, but are also regularly involved in other kinds of work and can train in other areas if they wish. Most of the company members can do most of the different kinds of work involved if required. Everyone is involved in the design of products, though not always in every product, or in all stages of a product. Everyone is also involved, again in varying degrees, in research about the content of different products. The company is owned by the two directors and they make the management decisions. The Sydney director described her work as 'being the glue that keeps it all together'. As well, she is responsible for much of the tendering, presentation, project management and liaison with clients. The Melbourne director is responsible for the financial details of the company. She is also the interface designer, and manages projects if clients are based in Melbourne. The other company members' specialties include graphic design, systems operation and

network management, text authoring, coding, instructional design, testing, training and client liaison. At any one time, all would be working in at least two of these areas.

### **2.3. Current Technology**

Each of the company members had a PC in their home. An electronic bulletin board running on a computer at the Sydney director's home provided the main remote communication link and anyone working on a project could use it to send and retrieve files and electronic mail. There was no dedicated network in place at the time this research was done, so company members needed to use modems to connect to the bulletin board. This meant that files and electronic messages could only be sent and received when the parties involved actually logged on to the board. Most people did this at least daily as the board was also used to back up the work people had done at home. This was, in turn, copied to tape each night. A scanner with OCR software was used to transform paper documents into text files and to scan images into graphic files. These could then be distributed via the bulletin board. Several people, including all those who worked intensively with images, used faxes to exchange messages and documents that were not appropriate to exchange via the bulletin board. Telephones were used extensively. Physical objects that needed to be exchanged were generally taken to the meetings. Otherwise Overnight Express post, couriers and normal mail services were used.

When this study was done, there were no real-time CSCW applications in use. Like most small companies, this one relied on off-the-shelf software, with tailoring to fit it to local conditions if the application allowed (Robertson, 1996; Trigg and Bødker, 1994; Rogers, 1994). A dedicated network, and shared viewing and drawing software, were planned for the reasonably near future, and the company was researching commercially available products. Historically, new technology has been incorporated into the company's infrastructure as it has become available within their budget.

## **3. BACKGROUND TO THIS STUDY**

This study focuses on just one part of the work of the company over a relatively short period of its history. There were approximately 12 months between my first meeting with the Sydney director and the completion of the prototype. In the initial months, workplace interviews were conducted with those company members who were most involved with the visual design of the products and with the coordination of that particular work.<sup>3</sup> These interviews, combined with telephone conversations and various other meetings, provided an understanding of how the company defined and structured the various stages in the design and development of their products, as well as how they organised themselves to do the work involved (Robertson, 1994). Most importantly, they also identified very clearly that there was no interest in, and in fact strong opposition to, any kind of process-defined CSCW system. Extreme flexibility of process and organisation

were crucial both to the company's functioning over distance and its survival in the marketplace, and had been embedded, over time, in the company's work practices. The company members did not eschew formalised work processes. On the contrary these were relied on to carry already established meaning, leaving the designers free to devote their conscious efforts to other issues. But any process, formalised or not, always had to be reviewable and changeable. The company members were competent, indeed highly skilled, in organising how they did their work and their agency was a defining aspect of the organisational culture. The most pressing concern for increased CSCW support was clearly stated to be the difficulty in maintaining robust and flexible communication between the company members when they were working apart.

We have fax into the computers, and phones and, and we have as much technology as we can.  
Sydney director (Susan) - Interview.

Well anything is a help. I mean, well anything. Anything that will make it easier.  
Graphic designer (Gemma) - Interview.

### 3.1. The Design Project

At the beginning of this study the company had already produced one title of its own. That title, developed for adolescents, was designed to support an important area of the secondary school personal development curriculum. For some time the company members had been building up the resources they would need to carry them through both the initial design stage as well as capital raising for their second product. These resources were financial, as well as group knowledge of existing multi-media products and development applications. Preparation included spending time in weekly meetings looking together at different multi-media titles that were already on the market. This process of preparation for the new product was used to maintain the social cohesion of the group; awareness of what other people were doing (Dourish and Bellotti, 1992; Gaver, 1992), what was happening in the company generally, and also to train all the members of the company about the kind of product they would be building. It was described by the Sydney director, in an early interview, within the context of the kind of work that gets done in the weekly meetings (my emphasis).

Susan. Every week we have project meetings where people come in from outlying areas to here, and that's where we do the sort of group training and discussion and we often have lunch. It's important that people are actually contacting each other as human beings and seeing each other and catching up with the news and all those sorts of things. So project meetings cover things like project tasks, group designs of things where we are using the group to design things, group resolution of problems where there are things, um briefings on what's happening ..... We are going through a training program at the moment looking at various CDROMs that are produced because we are producing our own and we're just going through a program of looking and understanding what works well on CDROM and what doesn't. <CDROM Title> was the CDROM we had this time. *So we looked at that and talked together.* We usually start off with some group facilitating-type things as opposed to straight into projects or resolutions.

Toni. Is that because you're separate all the rest of the time?

Susan. Mm. Mm.

Toni. You just chat for a while?

Susan. Yeah. Yeah, we just get together and get back in contact with each other and focus as a group on something sort of external to what we're doing.

The field study that informs the remainder of this paper focuses on the design of the company's second product. It began with the first briefing about what sort of product they hoped to make and ended with a prototype product that could be shown to potential investors. At this stage it is normal in the industry for any further design of the product to be put on hold until the capital required for the next stage of its development is gathered. The prototype is generally needed to generate further investment. So the span of the current study is a phase, in the design of multimedia educational software, that is determined by the logic of the product and its market context, rather than any formal design model.

The sections of the weekly meetings devoted to the project were recorded using two video cameras and an audio recorder. Each of the company members was given a folder and asked to keep meeting notes, research notes and any other 'used' pieces of paper. The Sydney director audio taped parts of telephone conversations with the Melbourne director that were relevant to the project. All bulletin board messages from the period were kept as were any shared text and graphic files related to the project. Both the graphic designer and the interface designer kept copies of the different stages in the development of their images. Company members were visited and interviewed in their homes during the period the design was in process. I spoke to some members regularly by telephone; they, in turn would telephone me if anything relevant to the product's design was occurring, or if something else had happened that they thought might be of interest<sup>4</sup>.

#### **4. WHAT HAPPENED WAS . . . .**

Looking back, what happened was that over a period of seven months, eight people working together, designed and built the prototype of a multimedia, educational computer game. While people were designing though, what happened in practice was that in a purposeful way they met together and talked, rang each other on the telephone and talked, sent each other written messages and faxes, looked at various kinds of pictures together and alone and talked about them, played educational computer games they had access to and carefully watched others playing and then talked about these, talked to other people who happened to be around - like children, partners and friends. They spent time browsing in local libraries and bookshops gathering together a number of books that were then carefully read, deliberately shown to others, talked about and swapped. They planned their work, allocated their time, discussed the work they had done through the week, made decisions about what work to do next, negotiated who would talk next, wrote notes, drew pictures, talked about the notes and pictures, produced computer files and put some of them on the bulletin board. They used computer files that others had put on the bulletin board, thought about different parts of the project either deliberately, or unintentionally when, for example, they were reminded of it by something else like a television program or



something they walked past on the way somewhere, or for no reason they could identify. They made notes about what they thought about so they wouldn't forget and often, using these as prompts, talked about what they had thought about with others.

The point is that the design of the product was achieved, over time, by people interacting with others to work together and to share and plan the work they did apart. This was done in a work environment where geographical constraints restricted the time they could all be in the same physical space. At the same time, there were major physical and technical constraints on the ease and effectiveness of communication when they were not in the same space. Time and place, as they were lived by the designers, were defining dimensions of their cooperative design practice. At the intersection of both, the coordination of this design project through time and across space, was achieved by the embodied actions of the company members. People physically moved from one place to another, found objects, deliberately carried these around with them to other places at certain times, used their hands to exchange them with others and to make various kinds of representations. Most importantly, they talked to each other. When the designers were together, sharing a physical space, these actions were trivial in the physical 'doing' of them, and the communication was robust and flexible. But when they were apart, these embodied actions were not naturally perceivable by others. Any interaction, in as much as it could be done at all, was enabled, defined and constrained by the limited technological support available. What happened was that the embodied actions of the designers structured and supported the work of communication. This work, in turn, enabled the coordination of work though time and across space, to achieve the cooperative design of a software product.

#### **4.1. The Role of Lived Time and Place in Structuring Cooperative Design**

Ethnomethodological studies of work practice (Suchman, 1991, 1987; Heath and Luff, 1991) seek to uncover the spatio-temporal ordering of human action and interaction that is usually, for the participants, nothing other than a unremarkable means to getting their work done. People working in a distributed environment rely on the spatio-temporal ordering of their interactions as much as anyone else does. But while assuming this moment-to-moment ordering, I want to focus on a broader level of spatial-temporal ordering that was exploited as a resource for organising the coordination of shared work.

The development of the product was shaped by the organisation of the design work to fit the regular temporal and spatial pattern of working together at weekly meetings, then working apart, alone. Weekly meetings always offered a fundamental, periodic ordering to the way in which the design work was, and could be, organised. They were used to provide a clear and obvious measure for the beginning and end of different chunks of work and stages of the process. Weekly meetings also provided a resource not just for the regular coordination of

the cooperative design process but for its regular and frequent review. At the same time that work was being divided into weekly chunks, the scarcity of meeting time meant that the work of designing also had to be divided into work that was done together, and work that was done apart, in ways that were determined both by the geographical distribution of the company as well as the kind of work involved.

I definitely do not mean to imply that if the company was not distributed people would work together all the time. Periods of individual work interspersed by meetings and shared work are normal practice in any cooperative process (Harper and Carter, 1994; Murray, 1993; Schmidt and Bannon, 1992; Schwab et al., 1992; Reder and Schwab, 1990). This is not something specific to distributed companies but is, in fact, a characteristic of the work that makes working over distance possible in the first place. The difference in distributed companies is that individual work *also* entails geographic separation. That is, any communication or work structuring resources implicitly available in a shared workspace, like passive monitoring, opportunistic meetings, easy, ongoing social interaction, or the simple exchange of physical objects are not available to people working apart<sup>5</sup>. The work that was done apart had to be doable apart and any communication required between people had to be supported by whatever means were available. Otherwise the work had to be done during the weekly meeting. There were no shades of grey and the work of designing had to be structured and coordinated accordingly.

While the periodicity of the meetings defined the size of each chunk, that is, a week's worth of work, the fact that this work had to be carried out in physically separate spaces determined the kind of work, and the current stage of the specific design process determined what it actually was. The designers, in practice, achieved the articulation of all of this remarkably smoothly through their embodied actions of talking together and writing on individual pieces of paper or the whiteboard during the meetings. But the inflexibility of the dimensions of time and place not only fundamentally structured how the work could be done. It also demanded specific articulation work to organise both the particular cooperative design process, and the actual work of designing and communicating that achieved the process. Over time, support for some of this articulation work had become embedded in the work practices of the participants. This is why both the flexibility and constant reviewing of the company's work processes are so important; they provide a counter to the inflexibility of time and place. The increased technological support for communication over distance was seen as offering another.

#### **4.1.1. Defining the week's work**

This field study began at the point where the design process shifted from preparation to specific designing. This was marked by a long briefing in meeting time. The Sydney director spent about 40 minutes, standing in front of the whiteboard, introducing and listing on the board what she referred to as the 'ingredients' the new product would have. Some of these had obviously been

prepared informally beforehand, others were added because someone suggested them during the discussion. By the end of that time some 16 ingredients had been talked about and loosely grouped into three categories. The first category included elements defined as 'internal to the company', such as the products they had made before, the company model of multimedia design, the knowledge they had gained from studying other products, the particular style of graphics that the graphic designer excelled in and the kind of interactivity that would be provided. The second category covered external factors, such as what was selling in the marketplace and where the gaps were, the contents of school curriculums and the results of research they had done on the preferences and practices of their own children and their friends. Finally, the product had to have a story that would support the other elements that were to be included.

These ingredients were the focus of the free-ranging discussion over lunch that constituted the remainder of the meeting and immersed the group into this new stage of design. Finding a story that would enable the group to link the product to the suggested domain was acknowledged as the priority. The discussion was structured round possible storylines, or parts of stories, either existing or spontaneous, that were suggested by various group members. These were then discussed in terms of how they would support the other listed ingredients. This work together ended with the discussion and allocation of the week's work for the time when the group would be working apart.

- Susan. In terms of what I'd like you to do, physically is just for the next week, just mull it round, mull it over. But the real focus would be the story line (spoken slowly, with emphasis and while gesturing towards the board). OK? Unless we can get one that works that will give us everything then we're stuck. So mull it over, the story line and how we. . . I feel we will have no troubles bringing this sort of stuff in.  
(pointing to list of things on board)
- Group. 'Oh no', 'Definitely not', 'mm'. (general head nodding, laughter etc.)
- Susan. Once we've got a story line, we'll be able to go for it.

Meeting 1. (74.39)

The week's work was then put in the context of the longer term process of designing the product.

- Susan. I think we do our usual thing of like, coming up with everything. You know? A story line ends up being the skeleton of it (turns round and draws a horizontal line on board) and sure you know, (starts drawing a wavy line over the horizontal skeleton line) we've got so much flesh we can put on it. Once we've thought through all the flesh we can make the best decisions about what works and what we can achieve. But as usual don't be restricted in your thinking at all. Go for it. Right? And we'll pull it in as we need to, as, as the coverage of the idea and the budget and time and all the rest of it come in ..... I want you to take 4, 5 hours over the next week to physically do some mulling over in which ever way you do it best.

Meeting 1. (75.30)

#### **4.1.2. Periodicity as a resource for planning**

At each meeting, the week's work was defined in terms of what it would enable the group to do together at the next meeting, as well as where it would fit within the wider process. Defining the work to be done apart on the basis of what had

already been done together at a meeting, *as well as* in anticipation of what would be done together at a future meeting, provided a technique for both planning and coordinating the individual and shared work of cooperative design over time and place. Suchman (1987, p. 39) observed that 'our imagined projections and our retrospective reconstructions are the principal means by which we catch hold of a situated action and reason about it'. Minneman (1991, p. 113) defined framing future action as one of the responsibilities of design communication.

The Melbourne director, Dorothy, was able to attend meetings only monthly. Her attendance pattern was used as another measure of time to plan and structure stages in the design process.

Susan. But just for a little while this is gardening, gardening. All right? And I want, in about a month, perhaps next time you're here (to Dorothy), to say OK, what is the broad scope of what we're going to achieve, and agree on it and what have you. But up to that let's all put some time aside at all the other meetings, to chat it through and come up with ideas.

Meeting 1. (49.02)

The value of the regularity of meetings was that it enabled the organisation and modularisation of the design work so that it could be done in a distributed environment. It provided something 'solid', in the sense that it could be assumed without explicit and continual negotiation, and was used to support the structuring of the work, irrespective of where that work was actually done. People can organise their individual work, wherever they are working, if they understand how it will be used and shared in the future.

## **4.2. Working Together, Working Apart**

The time spent on the project in each meeting followed a regular pattern. Members of the company would take turns talking about the work they had done apart. Each person's work was discussed as it was presented. If it included pictures these were looked at together. Then the whole group would talk about all the work presented in relation to the design of the product. Discussion revolved on testing whether a particular story or idea would work in the game, whether the idea would provide information to make the game valuable as a teaching support, whether the pictures worked and, most importantly, whether the designers could imagine themselves physically playing the game they were building. Finally, the work to be done apart was negotiated and allocated. Meetings were never just a series of reports and the allocation of further work. There was always some constructive work done together so that regular steps in the progression of the design were achieved collectively. Quite apart from any benefits to the design itself, this way of organising the work done together meant that each of the designers, just by participating in the meetings, was regularly immersed in the development of a shared understanding of the ongoing progress of the design. This is another example of what I mean by building robust communication into the work practices.

#### 4.2.1. Maintaining shared understanding

When they gathered together next, the designers presented the ideas they had developed while 'mulling them over' in the intervening time. These ranged from quite concrete stories to ideas about how the user might be able to interact with the program to move through the game and what the product might look like. The Sydney director listed the different ideas and suggestions on the whiteboard as they were made and discussed. By the end of the meeting there were enough ideas to make many products. These had been organised into two broad themes that were used to define the work for the intervening week.

Susan. Go away and bring it to another level so we're starting to be able to decide what we got here. (laughter) In other words go away and subject it to some rigour of can you visualise this on screen? Can you answer for yourself what you, as a user, would be physically doing, you know, what are you there to do? Try and view both these streams from that point of view, as well as maybe expanding on some of the content and other bits.

Meeting 2. (69.10)

This process of 'bringing it to another level' while apart, then presenting the week's work to begin the next meeting, continued until the fourth week when one of the designers, Sarah, presented an idea for a story that was immediately acclaimed by the rest.

Jackie. Wonderful!  
Susan. My hairs standing on end, it's right. It is, and you're right.  
Jackie. And they could do it and you can see yourself doing it (keeps talking but drowned out on all tapes by someone squealing)  
Susan. No it's true. I've got goose bumps. (holds out her arm, pointing to the goose bumps)  
Sarah. They're all um, they're great looking people and  
Susan. I've got to go to the whiteboard! (Gets up and moves to board. Jackie, who is still sitting in front of the board after presenting her ideas, laughs and goes back to her original seat. Others keep talking among themselves)  
Sarah. So the idea is that when they find the < > they are given a cryptic message about < > and so they go and click  
Dianne. It'd be wonderful. I'd love to play it.<sup>6</sup>

Meeting 4. (33.06)

The group's response to the idea was immediate and physical. The rest of the meeting was spent questioning and testing whether the story could support all the things that had been listed as ingredients for the design in the first meeting. Sarah had worked out her idea while working alone at home. Like the others she had gathered books from various sources over the preceding weeks and read stories and histories, and looked at pictures. All the various aspects of the idea were included in previous work that she and the others had done, presented and discussed at length at previous meetings. There is even a strong pointer to it in the dialogue of the previous meeting. It did not come from nowhere. Its presentation required little prior explanation or justification to the group because they had shared so much of the work of defining and understanding the context of the design in previous meetings. This group had no need of any decision support tools.

This was a significant moment in the developing design of the product. A decision had been made about the story, and that provided a concrete realm of information, stories and pictures that would be used in the product. From this point, while people continued to research and develop ideas, the focus of designing narrowed as the boundaries of the new product were decided. The actual content of the prototype could be planned.

- Susan. Because I think maybe our next step, no, our, well let's talk a little bit about the next step. I'm happy to like put all that together in a thing, right? Do . . . do . . . do . . . in a thing (Spoken slowly and jerkily while looking at and gesturing to the board)
- Jackie. In a thing?
- Susan. In a document, you know like
- Jackie. Oh right. OK. (laughing)
- Susan. And I think we should each pick a character and do some research. Become the character and work out how we could use it. Work out all of that and where the hooks might be.
- Reg. OK. I'll get stuck into < >

Meeting 4. (60.36)

#### 4.3. Enacting the Developing Product

Throughout the design process, the designers physically acted out the playing of the game, or even some aspect of the behaviour of the developing product. Enactment was sometimes organised in relation to a text or drawing of some part of the product. At other times the designers would pretend to be some imagined character in the game, or a player, and act out for the others, some aspect of their projected behaviour. Tang (1989) observed similar behaviour in his study. He argued that 'gesturing out a sequence of actions is a convenient way of demonstrating behaviour, either of the prospective design or of the interactions of people with the design . . . These gestures provide a representation of the ideas that allow the group to perceive and develop those ideas' (p. 76). In their study of interface designers, Wulff et al. (1990, p. 242) identified enacting sequences of events, while creating and using the developing interface, as one of the ways the designers shared knowledge. They claimed that the process of enacting the use of a product can contribute to developing products that are intimately connected with the way they will be used, the people who will use them and the contexts in which they will be used.

In this study, enactment constituted a lived experience for the actor that was at the same time watched and reacted to by the others. Enactment was invariably part of the constructive design work done at meetings. The designers could construct and immerse themselves in a temporal representation of the game by physically pretending to play it. In turn, this immersion enabled decision making that was always situated in the projected lived experience of the user.

Work to be done apart was also described in the language of pretending to be the user, or even, as in the quote that ended the last section, of 'becoming' one of the characters in the game.

- Susan. We need to get to these issues of, you know, the balance of activity and what's happening. We also have to think about the screen devices. Are *you* typing

answers or are *you* rather just putting clues in a notebook of *your* own? Or are *you* given some information and then *you* have to go off and explore, and then *you*? You know these sort of things? I want you to be quite literal. Try and be very literal about what *you* are seeing on screen as it happens, and literally what *your* next click might be after that.

Meeting 7. (54.29) (My emphasis)

Enactment enabled the constant, central focus during the entire process of design, on what the user would physically be doing at each stage. Insisting on the continuity of this focus, no matter where the work was being done, was another technique for embedding the coordination of cooperative design within the work practices.

#### 4.3.1. Designing by playing

In the weeks following Sarah's idea, people researched stories, images and information from different parts of the game. The prototype was planned after this work had, in turn, been shared. People enacted playing the game and as they reached certain points decisions were made about what could be happening there. These decisions were represented on the whiteboard as they were made. By the end of this part of the meeting there was a map of the prototype on the whiteboard. It consisted of boxes, bits of text and numerous joining arrows and lines. Decisions were made together about what would be on the opening screen, what could happen after that, how the players would be motivated to learn, how the various parts of the product would connect, how the player would move through the game and finally, which parts of all of this would be included in the first prototype.

From this point, the work done apart was no longer the same for each participant. Several of the group no longer worked on the product during the week at all. The graphic designer and interface designer produced the first pictures and two of the others concentrated on gathering the resources for detailed story telling. Less time was spent working together on the product during meeting time and stopped completely when the different elements necessary for the prototype had all reached a sufficiently concrete stage for the interface designer to begin to combine them into a piece of software.

Susan. OK. So we've got, we have somewhere < >. We have your one (to Sarah) cos you've mostly done all that.

Sarah. Yeah.

Susan. Heaps there (To Dianne) and heaps there (to Jackie). So I think. Yep. We'll even hold the pictures for now until Dorothy has a chance to like sit with it all and you know put some stories together and start putting some screens around some things. And then I think we use that as a springboard to carry on. So I think it's time for Dorothy to be able to sit and play and contemplate that without any more data and information at this stage.

Meeting 8. (36.33)

It was several months before Dorothy was able to complete sufficient work for any shared designing to continue. Only she and Susan participated in the final design meeting before the prototype was completed. Even though the actual

screens were available on the computer, they sat together at the table and played through the prototype using drawings of screens on paper to ground their actions and decisions.

- Dorothy. So . . . . quiz (pointing with her pen to various parts of the screen sketches as she talks) . . . . in . . . . dong . . . . everything stays down the bottom (draws a box on top screen and then uses pen to pretend to click it) . . . . click . . . . So really, do we need this little section? (pointing to a screen on her prepared notes). Like I know I've got to mark it up on the (pointing to another screen) screen anyway. But I sort of had it like panel of buttons, graphic and stuff happening down here (pointing to another screen on the top page), but we don't necessarily need that. We just have the whole screen and just stick a window on it.
- Susan. As long as we just stick. If, as I watch people using <the-company's-first-product> again, what they really like is the lack of any sort of long dark tunnels, and windows over things.

Meeting between Susan and Dorothy. (18.39)

#### **4.4. Working Apart, Working Together**

Although work was shared at meetings, the work apart while carefully defined and allocated, was not without problems or changes. Some of the work of coordinating the design process, exchanging work and even working together, had to be done between meetings. At these times telephones, the bulletin board, couriers, faxes, and the communication support embedded in the work practices that had evolved in relation to the use of those technologies, were used to support cooperation between the designers. There appeared to be little need or desire to share or exchange work between meetings during the first weeks of designing, when people were researching possible stories and ideas. This did not mean the designers were not communicating with each other at all through this time, merely that the communication was not motivated by this particular product. But there are traces in the meeting dialogue that indicate that the product was discussed opportunistically when people were talking by phone for some other reason.

##### **4.4.1. Coordinating the sharing of objects**

Preparation, for the sharing in meetings of the work done apart, generally involved the deliberate gathering of various physical objects, and then physically carrying them to the meetings. These actions meant that the objects themselves were selected and then used, looked at and exchanged as communicative resources in the design process.

- Toni. What sorts of things do you take with you to the meetings?
- Gemma. Everything (laughter)
- Toni. Which includes what?
- Gemma. Well the work obviously that you're working on at the moment . . . The paperwork . . . There's always stacks of stuff, like books, for resources to put into the program. Anything like that. Of course the work on disk goes, even though they might have it on the bulletin board. Notebooks.
- Toni. And what do other people bring?
- Gemma. The same.
- Toni. Do you have a set place here where you gather together the things you need to carry around with you to meetings?



Gemma. Well I've got an office in there, and it's usually on the table, all over the floor or in my bag . . . I pack it the night before. Make sure I've got everything.

Interview at graphic designer's home.

#### **4.4.2. Talking on the telephone**

The two directors talked and worked together by telephone for about a hour nearly every day. The timing of the phone calls was continually negotiated and totally flexible, but they always happened. The timing of the next call was always planned before the current one ended.

Susan. It's a quarter past three so I've got to go. Do you want to talk again after this?  
Dorothy. Ah. Mm.  
Susan. After school?  
Dorothy. OK.  
Susan. Yeah OK. I'll go and I'll talk to you soon.  
Dorothy. OK. Bye.

Phone call between directors.

Some of work of designing the new product was done during these phone calls. In the weeks when Dorothy was unable to attend the weekly meetings, Susan would summarise what had happened in the meeting when they talked together next. Just as in the weekly meetings, some design work would be shared and Susan would report back on this work to the next meeting.

All the company members spoke to each other by telephone between meetings. These conversations may or may not have been motivated by work but were nevertheless used to share work with others as required. Some exchanged faxes, particularly of drawings and notes that had not been produced on computers. These were often discussed by telephone, while each person looked at their own copy. Files were sometimes exchanged via the bulletin board and the company members would each look at a separate copy of the same file on their screen, while they discussed them by telephone.

#### **4.4.3. Exchanging files by the bulletin board**

Bulletin board use motivated by the sharing of work for the project increased, as the prototype was built and as the kind of work done apart could be easily shared this way. The graphic designer and interface designer exchanged graphic files via the bulletin board. Their visual images had to fit together on a single screen, even though they were working in different cities. Procedures to prevent loss of files and other kinds of communication breakdown were continually evolving and again were embedded in the work practices. Prior to this study, difficulties had been experienced alerting different members to the fact that they had been sent a file and where that file was stored. Bowers (1994) reported a similar problem when the use of the new CSCW network to facilitate report writing was undermined because the manager who would be writing the reports did not know when material had been posted (p. 293). In this company, a practice had evolved where the procedure of sending a file included sending an accompanying mail message that the file had been sent and where it was. To further buffer the communication against breakdown the file name was made up of the initials of

the person sending the file, followed by the initials of the intended receiver.

Hi Dorothy- your stuff for the new project is in GWDR129.zip. Have fun! -Gemma.

Bulletin board message.

Whoever received the file sent an reply to acknowledge receipt.

GW> your stuff for the new project is in GWDR129.zip.

Dear Gemma - hi, thanks, those piccies were useful. I haven't had a chance to work on the <> interface as I've got another small job to do for the <>. Anyway, better get on with it - love Dorothy

Bulletin board message.

These procedures meant that the bulletin board was used both to exchange files between meetings and to support the articulation work of coordinating the exchange of files. This is another way that cooperation was enabled by the company's work practices. In this case, work practices had evolved to exploit potential communication support provided by the technology.

#### **4.5. The Role of Physical Objects in Cooperative Design**

The shared use and exchange of physical objects was part of the work done at weekly meetings. Harrison and Minneman (1995) reported that in all their design studies, designers always 'used different kinds of representations on widely varying media at different times'. These representations are crucial resources for designers because they enable the inclusion of the subject matter, or meaning of the representation, into their conversations. In this study, media used to make or display representations included computers, paper, other CDROMs and the whiteboard. But books played a crucial role. The pictures in books provided a valuable aid to the designers for several reasons. They showed the look and style of pictures associated with the product's story that would be recognised by potential users. This visual vocabulary was then available to the designers to articulate their own product. As well, the written information in books provided the historical background for the story and material for the databases. Most importantly though, they contributed to the design communication and made it more robust (Harrison and Minneman, 1994).

But books could be used as a central resource because they were the kind of physical objects they are. That is, they could be found, used, carried somewhere else and physically shown or given to others. Latour (1986, p. 7) argued that the value of books and other similar inscriptions is that they can be gathered and displaced 'without withering away'. In turn, Seeley Brown and Duguid (1994) marked the motility and immutability of books, as physical objects, as essential border characteristics that support their sharability. They maintained that ignoring the border characteristics in the design of technology-defined and supported replacements can remove resources, like motility, that are an essential condition for their usefulness in the first place (p. 21).

##### **4.5.1. Using objects to support communication**

Books were used throughout the design process, but especially after the realm of

the new product had been decided. Looking through books, showing each other pictures, and physically exchanging books to be taken home between meetings, became a pattern of meeting activity. But the judgement about what information, what pictures, and hence what books were relevant and which were not, was made in the context of the particular design. Books were collected from different local libraries, bought from bookshops, or chosen from those belonging to various children of group members or their friends. Books were gathered purposefully, yet opportunistically, from wherever the designers found them during the weeks the prototype was being designed. One that eventually provided much of the basic historical information for the prototype had been found by the Sydney director while browsing the second-hand book stall at her daughter's school fete. There were always piles of books on the meeting table and people referred to them continuously. Eventually several proved to be particularly useful and copies of those were purchased. The two designers responsible for the visual part of the product regularly sat in meetings browsing through whatever books were there while attending to whatever else was going on. When Gemma was explaining her first lot of pictures to the group she also used pictures in books to provide the context for those she had drawn. Others referred to books as they looked at her pictures.

- Dorothy. Using that as our icons (pointing to picture on screen), sort of solid stuff, and then fade into (points to a picture in a book)
- Gemma. (Holding out another book) That's the style it was taken from.
- Dorothy. (Gesturing to screen) I mean that's the stuff that (gesturing out and away from screen) and they just go (more sweeping gestures)
- Susan. Yeah.
- Dorothy. And then you have the (moves upper half of body around making a big sweep with her arm) and then you have the (making vertical gestures in the air along the sweep she has just done) around the (makes round sweep with both arms)
- Susan. That size though. Have a look in there. (gestures from the screen towards book Dorothy is holding)

Meeting 7. (16.26)

The images on the screen and in the books, Dorothy's gestures, and the words that are spoken are all components of the language used here to build shared meaning and knowledge about the design.

#### **4.5.2. Capturing the resources of objects for future use**

During the final design meeting before the prototype was built, the people who had worked on specific aspects of its content presented these to the group. As each person completed their discussion, Susan explicitly checked that their work had been put on the bulletin board.

- Susan. (to Jackie) Yeah. Lovely. OK, so yours is all typed up. Can, um, is the file on the board?
- Jackie. No, I'll put it up. I'll put it up.
- Susan. Do that. Lovely. Because we'll, we'll go the next step and Dorothy needs to do it. And then she feels, you know, like she's really involved. She'll need to collect all the stuff that we have. So we, is there anything we need to make copies of that we should scan in while we're here?
- Jackie. Well I gave, I brought this book (getting a book out from under her notes) for

- Gemma, but I don't know if it's any help (shows book to Gemma and they discuss it).
- Susan. (Dianne hands her an open book that Gemma had given her earlier.) That one? Reg could you scan that? (hands it to Reg who had moved to the scanner)
- Trish. Here's some of mine. (hands several sheets of paper to Reg). The rest is already up.

Meeting 8. (33.21)

Ensuring that everything needed for the construction of the prototype would be available via the bulletin board, was done quite explicitly during this meeting. Reg spent the last part scanning pages of books, research notes, and various other documents that different people handed to him. These were mostly reference material for the graphic and interface designers, but also included information, press clippings etc. that could be included in the prototype's database. Documents, or more accurately what they contained, were deliberately selected to be kept by the designers only after they had been examined and found useful. As with the coordination of the sharing of files, the collection of resources on the bulletin board was done explicitly. There was nothing on the board that did not have a meaning attached to it that had, in the first instance, been negotiated by the company members as part of their work. Sharing the selection of material that would be available on the bulletin board is another example of how cooperation was enabled by the company's work practices.

## 5. CONCLUSIONS

I have argued here that the cooperative design of a multimedia, educational software product was enabled and achieved by the work the designers did communicating with each other. That work unfolded moment by moment, through time and across space. In practice, it was always achieved by the embodied actions of the designers that were available for the perception and further action of the actor and the others. My focus in this paper has been to show how support for communication and coordination defined, and were consistently embedded within the work practices of the company. The designers used resources provided by the spatio-temporal structure of their working environment. They regularly shared constructive design work, as well as the articulation work required to negotiate and allocate individual work, and to create the shared resources they would need to build the prototype. Irrespective of where they were working, they consistently focused on the projected actions of the user. When they were apart, they exploited available communication technologies, along with the communicative potentials embedded in the mechanisms for their use. Physical objects were used throughout the process to make the design communication more robust. Above all else, the designers talked to each other. Their skilful use of a range of techniques and resources for interpersonal communication made it possible for them to coordinate their work, even though they were geographically separated most of the time.

For designers of CSCW systems, a consideration of the procedures, skills and techniques used to achieve the cooperative design of the product highlights the constant interplay between organisational and technological solutions to working

over distance. Defining and maintaining this interplay is an important part of the articulation work required in cooperative design. Most importantly, the links between organisational solutions and technological ones are not fixed. They vary according to the specific work being done, the place where that work is being done, the technology that is available to support it, the communication and technical skills of the designers and the organisational priorities and culture of the company. If we are to take the support of articulation work seriously, then technology designed to support cooperative design needs to be as flexible as the processes used to achieve it. Moreover, if we recognise the centrality of robust and flexible communication to the achievement of a cooperative design process, then technology that can increase the communication resources of the designers needs to contribute to the ongoing negotiation of shared meaning and understanding.

But the robust and flexible communication that the designers, in this study, achieved depended on their personal communication skills and the responsibility they each took to ensure their work was shared. The company culture respected and affirmed the agency of the designers to organise for themselves a great deal of their work. In this work environment, that agency was produced and maintained by the company's work practices. These are the practices that will be used to incorporate any new CSCW technology into the workplace. And it is these practices that will, in turn, be changed by the new technology. The technology itself contributes to the definition of the agency of the people who use it.

The crucial factor in this study is that the culture of the organisation explicitly acknowledged and valued the importance of robust communication *as well as* the work the designers did to achieve it. The company wanted CSCW technology that would enlarge the options for achieving flexible and robust interpersonal communication across distance, without compromising the agency of its members by forcing them to work in ways not of their own choosing. That is, technology that supported the mutual perception of the embodied actions of the designers, or at least the results of those actions, without enforcing the inflexible or otherwise unacceptable proceduralisation of communicative work. The members of the company were perfectly capable of negotiating meaning and creating shared knowledge themselves when the perceptual information they needed to inform their interaction was available to them. It was precisely their willingness and ability to exploit the flexible communicative potential of whatever resources were available, wherever they happened to be, that enabled them to coordinate the work of cooperative design while spending most of their time working apart.

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## NOTES

<sup>1</sup> See for just some examples, Twidale et al. (1993), for a study of cooperative software design; Bucciarelli (1994) and Minneman (1991), for studies of cooperative engineering design; Scrivener et al. (1993); Gidney and Robertson (1993); Tang (1989); Minneman and Bly (1991); Tang and Minneman (1991) and Bly (1988), for studies of cooperative design that utilise drawing; Olson et al. (1993) for tool supported design; Harrison and Minneman (1994), and other papers from The Delft Protocols Workshop for uses of protocol analysis in empirical studies of industrial designers.

<sup>2</sup> In a paper that is concerned with the central role of communication in the cooperative design process, the fact that this company is owned and managed by women, and all but one of its employees are women, needs to be acknowledged. I have chosen not to highlight gender, in this context, because my focus is the unfolding of the cooperative design process. An analysis of the implications of the gender of the designers for that process requires a paper of its own. For specific discussions of gender and the design of CSCW systems see Birkenes and Fjuk (1994) and Green et al. (1991). See also Green et al. (1993).

<sup>3</sup> Eric Gidney also participated as an interviewer in some of these early interviews. This project forms part of a larger body of research on remote collaboration between visual designers. Interviews were also conducted during this time with a number of other small design companies and individual designers.

<sup>4</sup> Obviously a distributed study like this would not have been possible without the active participation of the designers, who I should emphasise were always free not to record, copy or give me some file, tape or other artefact. I am extremely grateful for their efforts and their trust.

<sup>5</sup> CSCW research at least partly motivated by supporting the mutual perception of others' embodied actions is a response to this defining characteristic of geographically separated work. This includes media space research, see for example Gaver et al. (1993); Dourish and Bly (1992); Heath and Luff

(1991) and Bly et al. (1993), which also includes a review of related media space research. Support for shared viewing and drawing is another response. See Peng (1993) for a survey of available support tools and Gidney and Robertson (1993); Scrivener et al. (1993); Ishii and Kobayashi (1992); Minneman and Bly (1991); Tang (1989), among many for studies of their use. See also Benford et al. (1995) and Greenhalgh and Benford (1995) for considerations of user embodiment within virtual environments.

<sup>6</sup> It was blatantly obvious through this entire process that the designers were also, and perhaps primarily, designing a game for themselves. Unfortunately, it is not my concern here to pursue this observation further, other than to state the obvious value this has in maintaining group definition and cohesion. But if it is indeed generalisable across other areas of design, it does have interesting implications for explaining why other artefacts and systems take the forms they do.