DESIGNING INTERACTION SPACES TO SUPPORT SUCCESSFUL PARTICIPATION AND COLLABORATION

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ABSTRACT
We discuss our work in progress on analysing collaborative activities across a range of domains including Accident and Emergency and veterinary surgery. We summarise our current theoretical developments in accounting for the use of supporting artefacts and systems in collaborative activities. We indicate our future direction in developing design principles for collaborative systems.

Keywords
Interaction space, participation framework.

1. INTRODUCTION
As the interest of HCI is increasingly focussed on whole work systems, we need to understand – and to design for – complex human activities involving multiple participants, collaboration and shared resources. Central to the successful performance of such activities are effective communication and coordination. Diverse artefacts and representations are typically used to support these communication and coordination functions. In installing computer-based systems, we are introducing to the mix new artefacts and representations. We must design these artefacts to support effective and efficient collaboration.

Each artefact used as a shared resource to support a collaborative activity defines an interaction space within which the artefact is usable. In a previous paper [1] we described collaboration between users and developers in a participatory design setting where a prototype design representation defined an interaction space within which the participants collaborated. In our subsequent work, we have been developing the concepts of interaction spaces, participation frameworks and the artefacts that help to define them. This short paper outlines briefly our ongoing research across a range of domains, including Accident & Emergency (A&E) care, veterinary surgery and game-playing.

2. SPACES FOR PARTICIPATION
Our original work on collaboration in participatory design settings drew on Goffman’s [2] notion of participation frameworks through which participants in interaction use bodily alignment vis-à-vis other participants, eye contact, tone of voice and other resources provided by the situation to maintain and to display shared task orientation and attentional focus. In a participatory design situation described in [1], a shared representation of a prototype design defined an interaction space within which participation frameworks shifted fluently and frequently amongst the participants (see Figure 1).

Scope of participation frameworks:

All participants had access to the interactional resources within the interaction space, such as mutual gaze, body alignment and the resources.
provided by the prototype and other physical objects. In a second participatory design situation, however, developer 1 sat across the table, outside the interaction space defined by the supporting artefacts. The behaviour of developer 1 frequently suggested a lack of engagement with the prototyping activity. The active participation framework almost always involved the other participants. Maintenance of participation frameworks in the second situation was hampered because a participation framework which included developer 1 had to cross the boundaries of the interaction space defined by the prototype representation. Developer 1’s position outside the interaction space denied him effective access to the resources provided by the model and its associated objects and it was difficult for developer 1 to remain engaged with the collaborative activity.

Thus, we developed our initial concept of the crucial relationship between effective participation frameworks and interaction spaces in the context of user-developer collaboration in software design. For a collaborative activity supported by a shared artefact or representation, successful collaboration requires that the participation frameworks used in the collaboration are contained within the interaction space defined by the supporting artefact. Our twin goals since have been (i) to refine and to develop our theoretical understanding of these concepts and (ii) to validate our growing theoretical account through examining the evidence for these concepts and their significance in other collaborative activities and domains.

3. COLLABORATION IN THE WORLD

In addition to the participatory design domain, we have examined domains including hospital A&E departments, veterinary surgery and game-playing. In each of these domains, the relationship between effective participation frameworks and interaction spaces has proved to be a useful analytical tool. As in our participatory design studies, these analyses were based on the results of a range of participant-observation, interviewing and recording techniques. In the space available here, we present some examples from the A&E and veterinary surgery domains.

3.1 A&E by the board

We note here two examples of collaboration from A&E. The first illustrates effective and efficient collaboration, the second less so. In each case, success of the collaboration may be related to the relationship between the participation frameworks required for the interaction and the interaction space defined by the artefacts provided to support the interaction. Our first example concerns the allocation of patients to specific locations and members of staff within the A&E department. Central to the department is a large whiteboard on which is a schematic plan of the department and various lists of available doctors and waiting patients. A nurse is in charge of this board and consequently holds a great deal of authority. When a patient arrives, she or he is directed to a cubicle and the board is updated. Whenever a doctor is free, she or he approaches the board and the nurse directs the doctor to a particular patient in a particular cubicle, providing brief details of the patient's complaint. Again, the nurse updates the whiteboard. Staff can also use the board to check with the nurse on the distribution of patients and staff and on patient waiting lists. As in the first participatory design situation, the shared representation – in this case, the whiteboard – defines an effective interaction space within which participation frameworks shift fluently and frequently amongst the participants.

Our second example from A&E illustrates less effective and efficient collaboration. A doctor and patient engage in the collaborative activity of diagnosing what is wrong with the patient. The doctor decides that an analysis of the patient's blood is required to enable this activity and wants to share the blood test results with the patient to help their discussion. The doctor sends the patient's blood sample off for analysis and leaves the patient waiting in a cubicle. Some time, often several hours later, the doctor's pager indicates that there is a telephone message for the doctor. The doctor goes off to find a phone and is told that the blood test results are ready. The doctor must then go off to find a computer – on one of several separate networks – from which the results are accessible. At this point, the doctor has access to the information needed to support the collaboration with the patient but the patient is waiting back in the cubicle. This is an extreme example of the interaction space defined by the artefact – in this case, the blood test results presented on a computer display – failing to support the participation frameworks required by the collaborative activity. Similar to the second participatory design situation, maintenance of participation frameworks in the doctor-patient collaboration was hampered because a participation framework which included the patient had to cross the boundaries of the interaction space defined by the supporting artefact. The patient's position completely outside the interaction space denied him effective access to the blood test results and hampered the collaborative activity.

3.2 Collaborating on Cats

In this example, from veterinary surgery, we observed participation frameworks and interaction spaces which were complex, evolving and overlapping. The surgery involved the repair of the hard palate of a cat...
which had been injured in a road traffic accident. This is an intricate procedure which involves the wiring together of the two separated halves of the hard palate to enable them to knit together. This case had been assigned to a young veterinary surgeon (Alice) who had not carried out this procedure previously. Alice was uncertain how to proceed and had therefore consulted a surgical manual and other textbooks which she placed beside the cat. She was also attempting to discuss the case with colleagues. These initial discussions were conducted around the textbooks (particularly the surgical manual) and the line diagrams contained therein. The anaesthetised cat, which was lying on the operating table alongside the surgical manual, and had been placed on its side by Alice in an attempt to match the orientation of the cat in the book, was largely peripheral to this initial interaction space. Two interaction spaces were defined: the (very small) interaction space defined by the cat, particularly the inside of its mouth, and a larger one defined by the surgical textbooks.

Alice’s initial attempt to effect the repair using the method described in the surgical manual was unsuccessful. At this point, a more experienced colleague, Ben, entered the room, and Alice asked his advice. They first consulted the surgical manual together. However, Ben then turned away from the book, apparently rejecting the method that it showed, towards the cat itself, and turned the animal over so that it was now lying on its back. Alice’s activity was initially disturbed by the change in the orientation of the cat (and thereby the interaction space which it defined), since she had carefully and deliberately mapped the cat’s orientation to the diagrams of the operation in the textbook. However, abandoning the textbooks (and the corresponding interaction space which they defined), she found that the cat’s mouth was now more accessible. By manipulating the orientation of the object of their activity, in this case the cat, Ben had created a larger, more usable interaction space in which to perform the surgery. From this point, the book played no further part in the performance of the surgery, and with Ben’s help, Alice successfully repaired the hard palate.

The books, which had been moved to the far end of the operating table, defined a separate interaction space in which other collaborative activities developed. A number of other surgeons came to watch this ‘interesting’ procedure. However, it was not the actual surgery which formed the focus for their discussions, but the pictures in the books. Once the procedure was well underway, and it became clear that Alice could complete it unaided, Ben turned back to the books, and became involved in discussions with the onlookers about the procedure, justifying his use of the alternative method he had chosen over the one in the surgical manual. Ben enlarged this second interaction space, introducing new images, radiographs that he retrieved from another room, laying out the books and the radiographs on the operating table and on the adjacent worksurface so that all of the relevant pictures were available for comparison and discussion. In his manipulation of both the cat and the books, Ben adjusted the boundaries of the respective interaction spaces better to accommodate the relevant collaborative activity.

4. CURRENT DEVELOPMENTS

Our initial, somewhat simple, claim in [1] was that, to avoid breakdowns when a collaborative activity relies on a supporting artefact, the participation frameworks used in the activity must be contained within the boundaries of the interaction space defined by the artefact. One of the most important developments on which we are currently working is clarifying the nature of an interaction space, how it is defined and the characteristics of its boundaries. Much of this discussion is beyond the scope of a short paper, but we outline here the direction of our developing work in this area.

Unlike the distinct boundaries in Figure 1, the boundaries of an interaction space are fuzzy. Towards the edges, breakdowns and errors are more likely, for example through misinterpretation of what is represented through or on the shared artefact. Towards the edges, maintaining successful collaboration requires more effort by a participant. Resources which may be employed to ‘stretch’ the boundaries include physical, virtual and cognitive resources. For example, a participant could devote additional cognitive effort to reading upside down a paper held by a collaborator, effectively extending the boundaries of the interaction space within which that paper is usable, albeit at some resource cost to the participant. The effective boundary of the interaction space is at the threshold where the participant either gives up or is unable to use the shared artefact for its intended purpose regardless of the extra resources which she or he might devote. Again, this will vary across settings: with high motivation, a participant will be more likely to commit greater resources to the collaboration.

In [1], we considered artefacts and representations that support collaborative activities both as delimiters of interaction spaces and as shared, external models. The latter perspective on these artefacts contrasts with, and complements, the participants’ private, internal (or mental) models. The common ground [3, 4], i.e. shared understanding, knowledge, beliefs etc, developed by the collaborators through their collaboration is constituted in the set of models, both external and internal. For example, an A&E patient may initially have an internal model that his foot hurts. The attending doctor initially has an internal model of...
potential diagnoses. Patient and doctor collaborate in coming to a shared understanding that the patient has broken the second metatarsal bone in his left foot. In developing this shared understanding, or common ground, the participants refine their respective internal models and use an x-ray display as a shared, external model that supports their collaboration.

Another difficulty for our simpler initial account of the relationship between interaction spaces, participation frameworks and successful maintenance of collaborative activities is the observation that when a participant is outside the effective interaction space defined by a shared artefact, she or he typically still has access to many of the interactional resources (eye contact, voice communication etc) and still maintains his or her own internal models and understandings established through the prior interaction [1]. Through exclusion from the interaction space, she or he has lost access only to the external shared artefact or representation which comprises just a part of the participants’ common ground.

The shared external artefact or representation is only one facilitator of the collaboration. Participants may also use the other available resources such as eye contact, voice communication etc that are maintained within a participation framework and are not lost outside the boundaries of the interaction space. With strong common ground amongst the collaborators, a participant’s internal models are often enough to sustain the collaboration. The external, shared model may be unavailable, at least for short periods, without breakdowns in the collaborative activity, provided once again that other resources are available and deployed to make up the shortfall. And once again, the participant must be motivated to commit those additional resources. The resources in this case are primarily cognitive. A participant may have stored in memory what was in the external, shared model before it became unavailable. Thus, that information is maintained in the participant’s internal model. Since, as noted above, the collaborators’ common ground is constituted in the complete set of models, that information remains in their common ground and, therefore, is available to support their continuing collaborative interaction. Hence, the boundaries of the effective interaction space are defined by the collaborators' common ground, of which the external, shared artefact or representation is just one important part. Grounding [5], or the process of developing common ground, in turn, is the accumulation of information, knowledge etc that is or has been within the collaborators’ interaction space.

5. Future Developments

Our ongoing work in this area includes further theoretical development and extended studies of collaborative activities in a range of domains. Features of an artefact which we have considered in defining interaction spaces include size, orientation, affordances and what the artefact can represent. Thus, we have considered primarily visual perceptual characteristics of artefacts and the interaction spaces which they help to define. We are working on extending this theoretical side of our work. A major area for investigation here is the definition of auditory interaction spaces. Their boundaries and characteristics are typically very different from those of the visual interaction spaces on which much of our earlier work has concentrated.

We also intend to develop further our analysis of the relationship between participation frameworks, interaction spaces, common ground and the artefacts which are designed to support collaborative activities. In particular, we are moving towards design principles for collaborative computer-based systems to support activities such as those in A&E. This requires further field studies of the relevant domains and development of the theory base to deal with collaborative interactions that may be collocated, distributed or a combination of the two, and that may be supported by a range of physical and virtual resources. Clark’s [3, 4, 5] and Goffman’s [2] work concentrated on face-to-face synchronous interaction. Increasingly, we need to explain, and to design systems which support, interaction that is not only synchronous face-to-face but may also be distributed across time and location and which may use both physical and virtual settings and resources. Furthermore, it is not enough simply to extend and to develop the theory base. We then need to move on from the theoretical accounts to develop concrete, operationalised design principles that can be applied and tested in the production of systems to support collaborative activities.

6. References


