A Foundational Framework for Situated Computing

Paul Dourish

Computer Science Laboratory
Xerox Palo Alto Research Center
3333 Coyote Hill Road
Palo Alto CA 94304 USA
dourish@parc.xerox.com
http://www.parc.xerox.com/dourish

INTRODUCTION

"Context" has become the word of the moment. Context-aware computing is a hot topic, the focus of research grants, workshops, conferences, development programs and a stream of publications. Systems that take advantage of context in different ways are seen as the natural solution to the information explosion, as ways to smooth interaction with an increasingly complicated information infrastructure, and as a way to build service and brand loyalty in commercial information operations. Technically, the incorporation of context into interactive software systems may take many different forms. Contextual information can be exploited in many different ways – e.g. by capturing contextual information for later recall and review, by exploiting contextual factors to customise the interactive experience, by sharing contextual information between collaborators, or by storing context along with data to help disambiguate it at a later date. Similarly, my own work on context has also taken many different forms, from explorations of the role of physical context in multimedia communication [2, 6], to the role of context in information interpretation [1], and most recently the role of context to solve specific problems in collaborative information management [3, 4].

In this position paper, I want to take a step back and consider the elements of a foundational understanding of context. I want to explore some core ideas that underpin a range of work on context – a range, perhaps, broader than is normally considered – and try to understand what implications can be drawn from an exploration of these fundamental issues.

One starting point for this exploration is a conundrum which was, interestingly, raised for me by the call for this workshop. The call coins the term "situated computing" to refer to the set of technologies and usage experiences that make up the burgeoning area of contextually informed system design. The term I use myself is "Embodied Interaction" (for reasons that will become clear. However, I think "situated computing" is an excellent term, because it captures two distinct elements of the area. First, it captures its technological foundations, and the relationship to other, related technological explorations such as the Ubiquitous Computing work spearheaded at PARC in the early 1990s. Weiser [9] set out a vision of a world in which technology supported us more intimately by retreating into the background, one in which the world around us was imbued with computational power that could be called upon intrinsically as part of everyday activity. At the same time, the word "situated" evokes the "situated action" perspective that has played a dominant role in the sociological foundations of Computer-Supported Cooperative Work. Suchman [8], drawing on the ethnomethodology of Harold Garfinkel [5], radically revised cognitivist accounts of natural activity to turn attention to the improvised and contingent nature of the sequential organisation of activity – its situated character.

However, at the same time as using this term to capture the range of areas that contribute to our emerging understanding of what situated computing could and should be, the workshop announcement provides a list of topic areas that are technologically dominated. Augmented reality, ubiquitous computing, wearable, mobile and tangible computing are all current areas of research that are driven primarily by the technological opportunities.

What should we make of this? Certainly, not that the authors of the workshop announcement have little to say about the social; they are each skilled proponents of multidisciplinary approaches to interactive technology. I think, instead, that the imbalance is a more general one. I think that, as a discipline, we are missing the tools to make sense of the relationship between the technical and social in this particular domain. We can understand how the technology works, and how the sociology works; we have a more difficult time putting them together.

FOUNDATIONS

This is the problem that I have been tackling in recent work (and, in particular, in a book currently in progress). I have been attempting to understand the relationship between the different perspectives at work in this new area of research, and to articulate the foundational relationships between them, for various purposes. One is to be able to able to understand the contributions that each domain can make; a second is to explore the opportunities for cross-fertilization; and a third is to develop a unified model for design and analysis.

The argument I have been developing has four parts. First, that the different strands of recent research activity, such as work on augmented environments and tangible media on the one hand and socially-grounded system design on the other, have a common foundation; second, that this common foundation is a notion of embodiment; third, that embodiment is not a new idea, but rather one that has been extensively explored throughout the twentieth century, most particularly in the branch of philosophy called phenomenology; and, fourth, that by turning to phenomenology, we can develop a

set of common understandings that support the design and analysis of situated computing (or embodied interaction) systems. Since this workshop is predicated on part of the first premise, I'll concentrate, here, on the notion of embodiment and its implications.

Embodiment

First, I need to be clear about what I mean by "embodiment." For some, particularly those coming from a technical perspective, it implies some sort of physical reality. To others, particularly those familiar with current debates in the sociology of science and technology, it instead refers to the reconsideration of the role of the body in technology that has been explored in Critical Theory. For my purposes here, embodiment refers to the way in which interactive resources are manifest in an interface. It does not refer simply to physical reality, but denotes a *participative status.* It points to the ways in which we interact as involved participants rather than detached observers. The relevance of embodiment for the tangible media/augmented reality side of situated computing lies in the way that this approach attempts to direct embody computation in the world; that is, it strikes to make computation (rather than computers) directly manifest in the world so that we can engage it using the same sets of skills with which we, as embodied individuals, encounter an embodied world. So, it exploits our physical skills, the ways in which we occupy and move around in space, and the ways in which we configure space to suit our needs. Embodiment, for this side of the research activity, explores the relationship between the environment and the task in hand.

The relevance of embodiment for the sociological side of situated computing is also a question of interaction. What Suchman's work drew attention to was the way that action emerges not as the outcome of disconnected cognitivism, but rather from a direct, reflexive conversation with the setting of its production. Accomplishing the sequential organisation of action is a real-time affair. As a simple example, this approach explores spoken language as social action rather than the verbalisation of internal mental dispositions. Sack's [7] Conversation Analysis reveals everyday conversation to be something that emerges from the real-time, direct engagement of participants in the mutual construction of meaning. So, the conversation, as an activity in which people engage, cannot be separated from its immediate manifestation in and of the everyday world – its embodiment.

What this points to is that the idea of embodiment underpins much of what we currently include under the term "situated computing", and does so in a way that directly addresses the relationship between the social and technical programs. It also hints at a direction for further foundational explorations, because this same notion of embodiment runs through much of the philosophy of the last hundred years or so, most particularly phenomenology.

Phenomenology has its origin in the work of Edmund Husserl. Reacting to, amongst other things, the increasing abstraction of mathematics and the emergence of a variety of challenges to the completeness and consistency of mathematical reasoning, Husserl called for a science to return to a grounding the direct phenomena of human experience. Over time, this developed into a philosophical psychology which emphasised "the things themselves", experiential phenomena, over the abstractions that were often used to explain them. Husserl argued that the phenomena, not abstract knowledge, had to be the primary source of human experience, both physical and mental. Husserl's philosophy was further developed by his students. Where Husserl had explored the mental life of the individual, Alfred Schutz turned to explore the question of intersubjectivity – how two individuals can share an understanding – in phenomenological terms that Garfinkel would subsequently build on. The best known of Husserl's students, Martin Heidegger, reworked phenomenology and incorporated the embodied experience of technology into his explorations of the basis of "being." Meantime, although not a phenomenologist, Wittgenstein, in his later work on the philosophy of language, adopted a perspective similar to Heidegger's in that he placed *practice* at the centre of his account of meaning.

FRAMEWORK

Heidegger's work provided the structure for Winograd and Flores' [10] work. However, embodied interaction goes beyond their focus on language and action. Phenomenology's concern with meaning, in various forms (intentionality, ontology and intersubjectivity), and its connection to practice, runs throughout these accounts of embodiment and provides a critical link to the role that embodiment plays in the development of the different strands of situated computing. It also furnishes us with a set of resources for developing an analytic framework for the design and analysis of technologies for embodied interaction, founded on the way in which embodied interaction places action *on* and action *through* technology within the same frame. This framework is currently under development.

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