Christian Heath, Hubert Knoblauch and Paul Luff

Technology and social interaction: the emergence of 'workplace studies'

ABSTRACT

Despite the substantial body of literature concerned with the ways in which digital media are transforming contemporary society and institutional life, we have relatively little understanding of the ways in which new technologies feature in day to day organizational conduct and interaction. There is however a growing corpus of empirical research which places the situated and contingent character of new technologies at the heart of the analytic agenda, but as yet, these studies are relatively little known within sociology. They include ethnographies of command and control centres, financial institutions, the news media, and the construction industry. They address the ways in which tools and technologies, ranging from paper documents through to complex multimedia systems, feature in work and collaboration. In this paper, we discuss these so-called 'workplace studies' and consider their implications for our understanding of organizational conduct, social interaction and new technology.

KEYWORDS: Work; interaction; technology; organization; information society

INTRODUCTION

In recent years we have witnessed the emergence of a growing corpus of sociological studies concerned with work, technology and interaction in organizational environments. They include studies of air traffic control, emergency dispatch centres, control rooms on rapid urban transport networks such as London Underground, international telecommunication centres, financial institutions, news rooms, construction sites, law firms and hospitals. These studies address the social and interactional organization of workplace activities, and the ways in which tools and technologies, ranging from paper documents through to complex multimedia systems, feature in day to day work and collaboration. They explore the ways in which artefacts are 'made at home' in the workplace, and demonstrate how the use of even the most seemingly 'personal' computer rests upon a complex social organization; an indigenous and tacit body of practice and procedures

British Journal of Sociology Vol. No. 51 Issue No. 2 (June 2000) pp. 299–320
 ISSN 0007 1315 print/1468-4446 online
Published by Routledge Journals, Taylor & Francis Ltd on behalf of the LSE

through which tools and technologies gain their occasioned sense and relevance within workplace activities. These studies, with their interest in the social and interactional character of organizational activities, represent perhaps a reflowering of the sociology of work, unparalleled save perhaps by the pioneering initiatives of E. C Hughes (1958) and his colleagues in Chicago following the Second World War (see also Heath 1984). As yet however, this burgeoning body of empirical research, commonly known as 'workplace studies', remains relatively unknown within sociology and there has been little attempt to chart its bearing upon contemporary issues and developments within the discipline.

Whilst drawing on analytic and methodological developments in sociology, and in large part undertaken by sociologists, these workplace studies have emerged in the light of debates within disciplines such as Human Computer Interaction (HCI) and Artificial Intelligence (AI) rather than sociology per se. In many cases they involve close collaboration between social and computer scientists, and between academia and industry, and have been facilitated by research programmes in the UK, Europe and North America which have encouraged 'blue sky' technical research with a social or organizational dimension. Whilst often involving industry or the public services, these workplace studies are not primarily concerned with short term practical contributions but rather rethinking, even reconfiguring, the relationship between the 'social and the technical'. Essays and papers are widely presented and published at conferences and in journals more associated with newly emerging disciplines such as Computer Supported Cooperative Work (CSCW), not from any attempt to distance sociology, but rather to find forums which facilitate interdisciplinary collaboration between social and computer scientists. In this paper we wish to briefly give a sense of these 'workplace studies' and explore their implications for contemporary research and debates within sociology. In particular, beginning with a wide-ranging discussion of the provenance of this growing body of ethnographic work, we wish to reveal some of their principal substantive and methodological concerns, and chart their implications for our understanding of work, technology and organizational conduct.

BACKGROUND: COMPLEX SYSTEMS AND 'SITUATED ACTION'

Over the past decade or so the enthusiasm which greeted the emergence of new digital technologies has been increasingly replaced by a growing scepticism amongst both the general public and system designers and engineers. It is increasingly recognized that the financial and organizational benefits of new technologies, especially information technologies, have been widely exaggerated and that many tools and technologies fail to enhance the activities for which they are designed. Dramatic failures such as TAURUS, the system designed to replace paper-based trading in the London Stock Exchange, provide a locus for this dissatisfaction. As the

system development neared to its completion it was found that it would not meet the needs of its users. The system was cancelled, but this was after an estimated total 400 million pounds had been spent on the development. It is widely accepted that such dramatic failures are the tip of the iceberg, reflecting widespread difficulties that often arise when new technologies are deployed within organizations. The official report on the difficulties which arose with the introduction of computer-aided dispatch into South West Thames's London Ambulance Service, is interesting in this regard. It will be recalled that this relatively sophisticated technology caused chaos for the emergency services until it was replaced by the traditional paper-based system. The report suggests that there is a widespread, though mis-founded, assumption amongst both management and engineers, that work practices will naturally and unproblematically adapt to the new technology, enabling personnel to take advantage of the 'obvious' benefits afforded by new computer based systems.

> Management were misguided or naive in believing that computer systems in themselves could bring about [such] changes in human practices. Experience in many different environments proves that computer systems cannot influence change in this way. They can only assist in the process and any attempt to force change through the introduction of a system with the characteristics of an operational 'straight jacket' would be potentially doomed to failure. (London Ambulance Service Inquiry Report (Page et al. 1993: 40))

The difficulties which sometimes accompany the deployment of new technologies into organizations have led to an array of academic and more practical initiatives concerned with how we can improve the design, evaluation and deployment of complex systems (Collins and Bicknell 1997; Neumann 1995; Norman 1988; Norman 1998; Wiener 1993). For example, in a field known as 'requirements engineering', there is a growing debate concerning how the 'needs' of users can best be identified and how these can be 'translated' into software (see for example Davis 1993; Jirotka and Goguen 1994, Sommerville 1989). In a field which has largely been concerned with developing models to identify the so-called functional or technical requirements of complex systems, in contrast to the so-called 'nonfunctional', the human and the user, there is an emerging interest in developing methods which 'capture' the organizational and social needs of a system, and in drawing on more naturalistic approaches to understanding work, including various forms of ethnography. As yet however, there is some debate as to how such methods could be used in requirements engineering, and how they might inform software development and design (Anderson 1994; Button and Dourish 1996; Potts and Newstetter 1997; Sommerville et al. 1993).

The growing recognition of the shortcomings and fallibility of new technology has not been accompanied by a substantial body of sociological research concerned with how people, both alone and in concert with each

other, use various tools, artefacts and technologies. Indeed, it is increasingly recognized that sociology, in general, has tended to disregard the artefact, and to some extent failed to consider how tools and technologies feature in social life, social relations, or in the practical accomplishment of social actions and activities (Latour 1996; Button 1993). Consider for example the document. As Weber and others demonstrate the document is central to the emergence of the modern organization from the mid-nineteenth century onwards, and is the artefact, *par excellence*, which has been transformed by digital technology. Curiously however, we have relatively little understanding of the ways in which documents are assembled, read, and exchanged within the developing course of practical activities; still less of the ways in which documents feature in interaction and collaboration within organizational environments. For those with an academic or practical interest in documents, there is little research within the social sciences to which they can turn to discover how documents are embedded within organizational activities, or how the technical transformation of such seemingly mundane artefacts resonates with indigenous work practices and procedures.

Unfortunately, the relative absence of sociological research concerned with the ways in which tools and technologies feature in mundane organizational activities, has allowed our understanding of computers and more generally complex systems to be largely dominated by cognitive science and in particular AI and HCI. In HCI, studies of the use of computers are largely experimental and driven by a concern with developing cognitive models of the users' activities. Underlying the analysis is the idea that human action is governed by rules, scripts and plans, and that through manipulation of symbols and the development of representations, individuals are able to execute intelligent action and interaction. The operation of the computer serves therefore both as a metaphor to characterize human reasoning and conduct, as well as a substantive domain, in which to discover cognitive processes. The approach is perhaps best exemplified in the influential study of human–computer interaction by Card, Moran and Newell (1980 1983) where they develop 'GOMS': a model which differentiated system use with regard to the 'goals' of the user, the 'methods' for achieving those goals, the cognitive process of their 'selection', and their 'operation'. Underlying these analyses is the assumption that by looking at how individuals use or 'interact' with technology, one might be able to discover the 'grammar of the head' (Payne and Green 1986) or the 'structure and process of a person's mind' (Carroll 1990). It is also suggested that by studying the use of technology in terms of the mental models of the user, it is be possible to design a system which 'mirrors' the cognitive processes of its user (Norman 1988).

This general approach has been subject to sustained criticism over some years, and these debates have increasingly led to the emergence of a variety of methodological developments. For example, Dreyfus (1972), Coulter (1979), Winograd and Flores (1986), Searle (1985) and the contributors to Still and Costall (1991) in very different ways, build a wide-ranging critique of the pretensions of cognitive science and the idea that it provides suitable

models, or can even reflect intelligence and practical reasoning. However, it is perhaps Suchman (1987) and her monograph *Plans and Situated Actions* which has had the most profound impact on the prevailing approach to human–computer interaction and in facilitating the emergence of a distinctive body of naturalistic studies of technology and social action, namely workplace studies. Drawing on ethnomethodology and conversation analysis, in particular the writings of Garfinkel (1967), Suchman suggests that the goal oriented, plan-based models of human conduct which form the basis to HCI and cognitive science have a number of shortcomings. In the first place, they diminish the importance of the immediate context of conduct, and in particular, the ways in which plans and schemas have to be applied with regard to the contingencies which emerge during the execution of practical action. Secondly, she shows how the meaning of plans, scripts, rules and the like, are dependent upon the circumstances in which they are invoked; they do not determine conduct, but rather provide a resource through which individuals organize their own actions and interpret the conduct of others. Thirdly, she argues, that by ignoring how individuals use and reason with plans and scripts in actual circumstances, human agency and the array of common-sense competencies on which it relies, are cast from the analytic agenda. She demonstrates that formalisms, however detailed, are subject to the contingencies which arise in actual 'practical situations of choice', and that rules, plans scripts and the like depend upon the ordinary common-sense abilities and reasoning of individuals for their deployment and intelligibility. The implication of Suchman's argument, is that we can only understand technologies, and the various formalisms which may be involved, by considering how they feature within practical action and with regard to circumstances in which mundane activities are produced. The methodological consequences of Suchman's thesis are clear; it is necessary to turn away from the experimental, the cognitive and the deterministic, to the naturalistic, the social and the contingent.

The growing debate concerning how we should understand the use of complex systems has arisen during a period of rapid technological and organizational change. The emergence of computer networks and electronic mail, developments in telecommunications and broadcast technologies, and the growing ability to interweave different media, are leading to a growing interest in developing systems to support new forms of co-operation and collaboration. Alongside these technological developments, it is widely accepted that we are witnessing the emergence of new organizational arrangements, which are replacing traditional bureaucratic models and even flexible arrangements such as the matrix organization based on project teams and the like with relatively loose networks of association with business function performed by independent cells which form temporary alliances (see for example Miles and Snow 1986). It is suggested that the decomposition of vertically integrated firms is leading to 'hybrid organizational forms', and in consequence that there is an increasing necessity for organizations to be flexible and responsive to a constantly shifting and

unpredictable market. It is argued that we are witnessing a convergence between technological innovation and organizational change; complex systems and infrastructures will emerge to interweave telecommunications and computing to support and enhance new forms of co-operation and collaboration. These substantive developments, both technical and social, are also serving to render more traditional models of human–computer interaction problematic, and directing attention towards the social, the interactional, and the contingent.

In response to these technical and organizational developments, coupled with the growing dissatisfaction with more conventional research within HCI, we have witnessed the emergence of a new, interdisciplinary field of research and innovation, namely Computer Supported Cooperative Work (CSCW). The expression was first coined by Grief and Cashman in 1984 following a small symposium which brought together a disparate collection of participants involved in such areas as distributed information systems, computer mediated communication and hypertext (see Bannon and Schmidt 1991). Since these early beginnings, CSCW had become a forum for some of the more innovative developments in computing, ranging from early attempts to develop systems for group decision making, through to the implementation of media spaces which provide a vehicle for real time collaborative work amongst distributed personnel. Despite the development of cutting edge technologies, it is acknowledged in CSCW that systems have not met with a great deal of success, and there has been some debate as to how technical innovation needs to be interleaved with a more thorough understanding of workplace activities. For example, Galegher, Kraut and Egido (1990) suggest that the relative failure of systems derive from their insensitivity to 'what we know about social interaction in groups and organizations'. Robinson (1993) argues that the use of even most basic procedure and technology requires 'articulation work'; bodies of practice and routine through which the formal procedures embodied in a particular systems can be applied with respect to contingent and indigenous demands of doing the work. And, adopting a rather different approach, Schmidt and Bannon (1992) argue for an understanding of co-operative work which radically departs from the narrow conception of the group and group behaviour which has informed many CSCW systems; they suggest that we need to consider the ways we can support 'multiple individuals working together in a planned way in the same production process or in a different but connected process'. In the light of these debates, CSCW has increasingly become a forum for co-operation between the social and computer sciences, and indeed it is formed the principle disciplinary arena for the development and discussion of these new and emerging workplace studies.

It is important, very briefly, to mention two other areas of contemporary research which bear upon our understanding of technology and social organization. First, there is a burgeoning body of studies that has emerged in large part from within the sociology of scientific knowledge, and which

has generated some of the most exciting and innovative research concerned with tools, artefacts and technologies. In different ways these studies attempt to reconfigure the relationship or distinction between the social and the technical (see for example Bijker et al. 1990; Woolgar 1985; Mackenzie 1996; Grint and Woolgar 1997). Various analytic commitments have been brought to bear on, and developed with regard to, our understanding of artefacts ranging from the 'empirical programme of relativism', through to actor network theory. Such studies provide a rich and rewarding body of analysis, which in diverse ways 'looks into what has been seen as the black box of technology' and powerfully demonstrates how people, even particular groups, ascribe, dispute, exclude, and cohere the sense and significance of objects and artefacts. Despite the important contribution of such studies to our understanding of technology and the shortcomings of the 'spurious boundaries' between the 'social and the technical', to a large extent they have not been concerned with the ways in which objects and artefacts feature in the practical accomplishment of mundane activities in working environments (see for example Button 1993).

Secondly, in sociology, and to a lesser extent economics, there is a substantial body of research concerned with the impact of computing and telecommunication systems on contemporary society and organizational life. The significance of these technologies on social organization are characterized in various ways. Bell's 'post-industrial society' has been replaced with a host of different terms, ranging from the 'knowledge society', to the 'science society' and the 'communication society'. It is argued by Castells (1996) however, that the term 'information society' and its counterparts such as the 'information economy', lead to more confusion than clarification and there continues to be wide-ranging debate as to the changes that are taking place and how they should be conceptualized. As Aldridge suggests, little attention has been paid to the semantic content or the quality of information, rather 'theorists have leapt from quantitative measurements of the volume of information and the velocity of its circulation to sweeping conclusions about the qualitative changes in culture and society' (Aldridge 1997: 389). More recent attempts to define the information society in terms of work and occupational structure have not added much light to the concept. As Hensel (1990), Webster (1995) and Knoblauch (1997) suggest, the idea of 'information work' has generated an array of seemingly ad hoc distinctions concerning the character of particular occupations, and said little about the ways in which 'information', and the tools and technologies which purvey and preserve information, feature in the accomplishment of organizational activities.

EXAMINING TECHNOLOGY IN ACTION

The successive failure of complex systems, the growing criticism of HCI, the development of CSCW, have had an important influence on the emergence

of workplace studies, and in particular the growing concern with social and situated character of technology. A burgeoning body of empirical studies has arisen which is concerned with the analysis of how tools and technologies feature in social action and interaction in organizational settings. In large part these studies are ethnographies, involving extensive field studies of work settings, in some cases augmented by detailed video-based analyses of particular activities. The studies serve as a foundation with which to consider how artefacts, ranging from seemingly mundane tools such as pen and paper, through to highly complex systems, feature in the production and co-ordination of social actions and activities. In some cases they are also used to inform the design and development of new technologies and to consider how innovative systems might be exploited and deployed. In general however the substantive and, in some cases, applied concerns of these workplace studies, their interest in technologies in action, and their commitment to the naturalistic analysis of human conduct, serve to mask the diversity of these ethnographies. Before considering the substantive and conceptual contribution of workplace studies to sociology, it is perhaps worthwhile giving a sense of their analytical diversity which derives from the diverse provenance of this growing body of empirical research.

For example, the growing debate within cognitive science concerned with the plan-based, individualistic conception of human conduct has led to the emergence of naturalistic and more socially oriented forms of cognitive science, variously characterized as 'situated cognition' or 'distributed cognition'. The term 'distributed cognition', for instance, is increasingly used to demarcate a concern with (socially) shared representations and the co-ordination of action by individuals in organizational environments. There is some debate as to the provenance of the term distributed cognition, and some disagreement as its domain of relevance, but Salomon (1993) provides a useful characterization

> The thinking of these individuals might be considered to entail not just 'solo' cognitive activities, but *distributed* ones . . . In other words, it is not just the 'person-solo' who learns, but the 'person-plus,' the whole system of interrelated factors. (Salomon 1993: xiii, author's italics)

Despite the ambivalence surrounding the definition of distributed cognition, it informs a broad range of interesting ethnographic work, much of which has been concerned with work and technology in organizational environments. Some of the most illuminating and influential research has been undertaken by Hutchins whose studies of ship navigation, described in his monograph 'Cognition in the Wild' provide a flavour of the ways in which tools and technologies feature in situated cognition and the co-ordination of workplace activities (Hutchins 1995). It is interesting to note that alongside the commitment to explicating 'human cognition as a cultural and social process', Hutchins and others retain elements of models and metaphors which permeate more conventional research in cognitive science and HCI. So, for example, the idea of representation infuses

the analysis of both individual and distributed cognition(s), and the computational metaphor not infrequently informs the characterization of tool-based cognition. Notwithstanding this curious mixture – the language of the cognitive peppered with the social – distributed cognition has provided the vehicle for a body of ethnographic work and an array of findings concerning the ways in which tools and technologies feature in individual and co-operative activity in organizational settings (see for example Agre 1988; Gaver 1991; Norman 1988; Rogers 1992).

With regard to these developments, it is important to mention a parallel body of work which emerged in Europe over the past decade or so. Commonly known as 'course of action' analysis, a number of researchers in ergonomics in France developed an approach which has certain similarities with to distributed cognition. The approach, emerging in the light of the work of Pinsky and Theureau (1982) and Theureau (1992) is naturalistic, and is principally concerned with explicating the use of tools and technologies from within the courses of action in which they are embedded. The approach preserves a commitment to the cognitive, whilst explicating the ways in which individuals interweave distinct courses of action, in and through tools and technologies. Like certain forms of distributed cognition, course of action analysis preserves the primacy of the individual and individual cognition, but powerfully demonstrates how representations and action are assembled and disassembled through co-operation and co-ordination. These developments are paralleled by related initiatives both in France and elsewhere, in which a commitment to the cognitive is being refashioned to include a conception of the' social', and in particular an interest in the indigenous and communal organization of workplace activities.

Putting to one side, the ways in which cognitive science is developing a stronger commitment to indigenous social organization, we find a range of more or less conventional sociological orientations informing these workplace ethnographies. For example, symbolic interactionism, which appears to reflect (and pre-date) a number of the central analytic assumptions of distributed cognition has begun to inform a range of studies of technology in organizations, and once again is demonstrating its unique ability to conceptualize organizational processes and interaction. As in other fields, such as education and literary criticism, there has also been a growing interest in drawing on, or revitalizing, activity theory as a methodological and conceptual framework for the analysis of workplace activities (see, for example Kuutti 1991; Engeström and Escalante 1996; Nardi 1996). Unlike other approaches, it is seen perhaps as offering a solution to the vexed problem of the 'micro and macro', a conceptual vehicle for interweaving the 'fine details of interaction' with the 'broader' organizational constraints and circumstances.

However, it is ethnomethodology and conversation analysis, more than other analytic orientations, which have had the most prevailing influence on workplace studies and more generally, social science research in CSCW. This is hardly surprising. Suchman's (1987) original critique of cognitive

science and HCI drew on ethnomethodology and conversation analysis, and these analytic commitments have informed the development of a number of workplace studies facilitated by Suchman at Xerox and Rank Xerox research laboratories in the USA and Britain. Like other workplace studies, this body of research is naturalistic, concerned with building, as Geertz (1973) suggests, 'thick descriptions' of human activities, based an extensive field studies, and in general addresses the ways in which tools and technologies feature in social action and interaction. The analytic focus however shifts from the interest in meaning, representation and the social construction of tools and artefacts, to a concern with the practical accomplishment of workplace activities and the ways in which participants themselves constitute the sense or intelligibility of tools and technologies in and through their conduct and interaction. It reflects a more radical conception of 'situated action', which places the emergent and reflexive character of practical action at the forefront of the analytic agenda. The concern therefore is to examine the practices and procedures, the socially organized competencies, in and through which participants themselves use tools and technologies in the emergent production and co-ordination of social action and activities; practices and procedures which give objects and artefacts their occasioned and determinate sense. This central concern, with the occasioned and accomplished sense of technology in action, has in some cases led to particular interest with social interaction, talk, visual and material conduct, and the ways in which tools and artefacts feature, moment by moment, in the developing and collaborative production of workplace activities.

Despite the variety of approaches found within workplace studies, they all reflect a prevailing commitment to the analysis of technology in action, and in particular to the investigation of the ways in which tools and artefacts feature in the accomplishment of practical organizational conduct. They also reflect a concern with the practicalities of technology, and in particular with the design and deployment of advanced systems. These more applied commitments may primarily consist of respecifying our understanding of systems use, and through this respecification, informing how designers and software engineers configure innovative tools and technologies. They may involve a more substantive practical commitment, contributing to the design and assessment of prototype systems (see for example Hughes et al. 1992; Button and Dourish 1996; Jirotka and Wallen in press). In many cases, these naturalistic studies of work and technology necessarily involve close collaboration between social and computer scientists, where, alongside detailed empirical research, there is an underlying concern with the design of complex systems, and how those systems feature, or may turn out to feature, in organizational activities and interaction.

USERS, TASKS AND THE DIVISION OF LABOUR

To give a sense of the range and relevance of these workplace studies to sociology we wish to interweave two distinct themes; on the one hand the range of substantive domains and technologies addressed by these studies, and the on the other, their implications for a number of conventional concepts such as the user, task and the division of labour.

Perhaps the most wide-ranging impact of digital technologies in organizational environments is in recording, storing, and retrieving textual information. The document, in both its paper and digital forms, has formed a central concern of workplace studies, and there is a growing body of research which examines how documents are assembled, used and provide a critical resource in the co-ordination of inter- and intra-organizational activities. For example, Harper's (1998) study of the International Monetary Fund powerfully examines how analyses of indigenous economies are transformed into extensive reports, the conventions of which point to standard policy recommendations and form a vehicle through which a disparate collection of organizational actions are co-ordinated. Button and Sharrock (1994) have examined how both paper and electronic documents feature in the co-ordination of large scale software projects, and more recently considered how various 'formalizations' are embedded in artefacts and used to produce a range of complex activities on the shop floor in the printing industry (Button and Sharrock 1997). Other workplace studies concerned with the ways in which documents feature and are constituted through organizational activities, include analyses of the introduction of information systems into customer service departments of high street banks, (Randall and Hughes 1997), the use of official, computer-based reports in handling calls to emergency dispatch centres (Zimmerman 1992; Whalen 1995a 1995b), and the use of paper tickets for capturing the trading details in financial institutions (Jirotka, Luff and Heath 1993). More generally, Sellen and Harper (1997) have undertaken a range of studies as part of a programme of research with Rank Xerox Research Laboratories concerned with the affordances of paper, and the ways in which paper facilitates practical action and interaction in organizations.

Many of these studies therefore not only consider the use and, in some cases, the design and deployment of computer-based systems, but also examine paper documents and the ways in which they support, enhance, and even replace more seemingly sophisticated media. Indeed, the idea of the paperless office now seems one of the more absurd predictions of the early 1980s. Take for example, the introduction of information systems into primary healthcare in the UK. Over the past decade almost all practices have introduced a computer-based system, which was designed to largely replace the conventional paper medical record card. Some years since the introduction of the system (s), we still find many general practitioners using the paper record alongside the computer. The systems reproduce many of the categories of information found in the paper record, including sections

for documenting the patient's symptoms, diagnosis, and treatment, and there is little obvious reason why the paper record has remained persistent. Studies of the practices through which doctors write and read the paper and computerized record begin to reveal the ways in which it can fail to resonate with the practicalities of the consultation and professional conduct (Heath and Luff 1996). For example, small changes to the ways in which diagnostic information is conventionally documented in the record can serve to undermine the doctor's ability to gain an overall impression of the patient's illness and the sense that a colleague is trying to delicately instill in the notes. By having to formalize the entries in the computer record, designers inadvertently undermined their flexible and contingent character. Even the very introduction of conventional work-station into the consultation has had an impact on the ways in which patients and doctors communicate with each other. For example, it is found that patients, in presenting their signs and symptoms, are highly sensitive to the moment by moment use of the system by the doctor; just as the doctor's use of the computer is co-ordinated with the real time contributions of the patient. The multifarious ways in which medical record cards are used within consultations and how these uses are shaped by the local demands of the setting suggest why the paper document continues to provide an important resource for doctors alongside the new computer system (see for example Greatbatch et al. 1993; Bowker and Star 1991, 1994; and Berg 1997).

These and related studies of the use of documents in organizational activities raise questions concerning the conventional ways in which the 'user' is conceived in studies of human interactions with technologies (see also Woolgar 1991). For example, it is clear from the case of primary healthcare that those who use official documents as part of their daily work rely upon communities of practice and reasoning through which they are able to write and read the contents with regard to the contingencies at hand. These resources, the indigenous practices, conventions, procedures and the like, which inform the production and intelligibility of such records are critical to the use and status of such documents, and yet, such socially organized competencies are not conventionally ascribed to the 'user'. Moreover, whilst doctors might be considered the principle 'user' of the record, the conduct of patients, and their orientation to the document's use, permeates the ways in which doctors read and assemble these textual characterizations of the consultation. By extricating tools and technologies from the circumstances of their use, we not only lose sight of the practicalities which can lead to, and account for, the character of particular documents, but render epiphenomenal the socially organized resources which make the particular tools and technologies what they are. The individualistic and cognitive conception of the user found within certain forms of HCI, and which pervades our current understanding of system use, provides a curiously impoverished image of the ways in which tools and technologies are used; removing the practical intelligence critical to the competent deployment of artefacts in practical circumstances. The seemingly simple use of

paper and screen-based documents, as an integral feature of professional conduct therefore, provides a vehicle with which to reconsider the very idea of a 'user', to challenge the conventional boundaries which circumscribe who features in the production and intelligibility of a record, and to begin to reveal the complex array of social, technical and interactional resources which inform the mundane and accountable use of the artefact.

This concern with both paper and electronic documents in workplace studies has also informed a substantial corpus of research concerned with what Suchman (1993) has characterized as 'centres of co-ordination'. These include studies of air traffic and ground control, in the UK, North America, Scandinavia and France, news rooms at the BBC and Reuters, financial trading centres, network control centres, call centres, the control rooms of London Underground and RER in Paris, 911 centres in California, NASA control centres, and surveillance centres (see, for example, Hughes et al. 1988; Suchman 1993; Fillippi and Theureau 1993; Watts et al. 1996; Whalen 1992; Zimmerman 1992; Heath et al. 1993; and contributions found in Engestrom and Middleton 1996, and Luff et al. 2000). Personnel in these domains are responsible for co-ordinating a complex array of co-located and distributed activities. They have certain common characteristics, a strict division of labour, coupled with the necessity to co-ordinate a complex array of simultaneous and sequential tasks and activities, both within the centre, and between the centre and other domains, a wide range of technological resources, including paper documents (such as flight strips and timetables), information systems (diagrams, schedules, maps and the like), CCTV (of docking bays, platforms, public entrances and walkways), large scale digital or mechanical displays (which display rail traffic, telecommunication lines and the like), and various communication devices (such as touch screen telephones, radio, and alarms). They are 'multimedia' environments par excellence, and provide an opportunity to examine how co-located and distributed personnel are able to draw on such resources to oversee or survey distributed events and activities and develop a co-ordinated response to problems and emergencies.

Consider for example, the wide ranging and influential project concerned with the operation of a medium size airport by Suchman, Jordan, Goodwin and Goodwin and others (e.g. Goodwin and Goodwin 1996; Suchman 1993). They examine the ways in which various staff, at different locations, co-ordinate the loading and unloading of passengers and baggage from aeroplanes. They show, for example, how ground staff produce various paper documents to deal with the limitations of the central computer system, and how these paper documents feature in the co-ordination of a complex array of co-located and distributed activities. They demonstrate how these documents are constituted in different ways for different purposes, by personnel who stand in various locations with regard to the activities, in which, in some sense, all are engaged. They also show how a variety of tools and technologies come to play in the course of particular activities, ranging from scraps of paper through to computer systems and

closed circuit television. So for example, CCTV images are rendered intelligible in different ways by different personnel, and even those within a particular domain will bring different sets of relevancies to bear on the 'same' image and draw different yet compatible conclusions. The perception of the environment, of aeroplanes, activities and documents, depends in part upon the participants position within the organizational network. As Goodwin and Goodwin (1996) suggest, the individuals perception and relevancies are constituted within the developing course of particular activities. Therefore,

> Neither these networks [of co-operating work-groups], nor the rational organization that sustains both the technology and the bureaucracy of the airline, provides a single all-encompassing view of what is happening in the airline. Instead of a master overview, one finds multiple, diverse local perspectives, each constituted through the combination of a specific array of tasks, an ensemble of tools for performing those tasks, and an entertainment of workers' bodies that encompasses not only their muscles but also phenomena as minute as acts of perception embodied in momentary glances. (Goodwin and Goodwin 1996: 68)

These and related studies of centres of co-ordination pose interesting questions for certain aspects of organizational theory, in particular perhaps for our understanding of 'task' and the 'division of labour'. Take for example tasks. Tasks are conventionally either conceived 'cognitively', as deriving from the application of a specialized body of knowledge through mental processes which involves the implementation of particular skills (both cognitive and motor); or as a by-product of particular roles and their associated competencies, dispositions and expectations (Benyon 1992). In addressing centres of co-ordination, it is increasingly recognized that the practical accomplishment of individual tasks not only rests upon an indigenous and tacit body of practice and procedures, but on the participants' abilities to systematically co-ordinate the production of tasks, as they emerge, through interaction with regard to the real time contribution of others.

Consider, for example, our own studies of the Line Control Rooms on London Underground; a complex multi-media environment involving large scale displays, numerous CCTV and computer monitors, and various communication devices including telephones, train radio and public address systems (Heath and Luff 1992; 1996). Here we find a domain which involves a strict division of labour with a clear cut allocation of tasks, skills and responsibilities between the various personnel, namely line controllers, information assistants, and signal assistants. These personnel are responsible for overseeing the day to day operation of the service and dealing with problems and emergencies if and when they arise. So for example, if a 'suspect package' is discovered at a particular station, it may well be necessary to evacuate passengers, de-train vehicles, cut off a section of the line, and reschedule traffic and crews. Each member of the control room will be engaged in distinct activities, using (and providing) different forms of

information, and communicating with particular personnel, such as station supervisors, drivers, crew managers, and passengers. In such circumstances, personnel have neither the time nor the resources to explicitly inform each other of what they are doing, when they are doing it and with whom, and yet it is critical that they preserve a mutually compatible version of the developing events, and co-ordinate their activities with each other (as well as those outside the control room). In consequence, personnel rely upon a tacit and indigenous body of practices and procedures through which they produce tasks or activities whilst simultaneously participating in the actions and activities of others. For example, in making requests to drivers over the train radio, they will articulate particular words or sentences to enable others within the local milieu to overhear potentially relevant information; or, in rescheduling traffic, an activity delightfully known as 'reformation', controllers talk out loud through the changes they are making to render the activity 'visible' to others. In turn, in the performance of their own activities, personnel will participate in the actions of others, enabling them to retrieve critical information and events. These seemingly individual responsibilities and tasks therefore are shaped and accomplished, moment by moment, with regard to the concurrent interests and contributions of others; the activities' competent and accountable performance is inseparable from the emerging interaction and shifting forms of co-participation it demands. The numerous screens, display and documents which provide personnel with information concerning the current state of traffic, passenger flow and the like, are only intelligible by virtue of their ability to participate in the actions of others and systematically, yet implicitly render aspects of their activities visible. In such settings tasks (and the tools and artefacts which inform their performance), emerge in and through highly complex forms of interaction; they are dependent upon an array of practice and practical reasoning, which is largely unexplicated, even unacknowledged, within certain forms of organizational analysis (see for example Suchman 1987; Silverman 1997; and Heath and Luff forthcoming).

As Anderson, Sharrock and Hughes (1989) point out, these issues also bear upon our understanding of the division of labour. Despite growing debates concerning new forms of the division of labour emerging within contemporary developments in organizational arrangements, it remains an important heuristic in the analysis of work and organizations. Workplace studies have begun to explore the ways in which participants themselves orient to, use, and rely upon, the division of labour within the practical accomplishment of their daily activities. So for example, in their ongoing project concerned with air traffic control, Hughes and others (Hughes et al. 1988; Harper et al. 1991) show how the division of labour is not encountered as a coherent and integrated totality, but rather as a stream of differentiated and discrete tasks. The differentiation of work activities, as a hierarchy of responsibility, is an ongoing and contingent allocation, of both self and others. Seen from within, the division of labour is a fluid gestalt

and is evidenced in innumerable locally produced ways, known in common and seen at a glance (Anderson et al. 1989). In air traffic control this includes routine 'silent hangovers' during which responsibility for particular aeroplanes is passed on to colleagues without comment; where a division of labour can, if necessary, be found in the sky or at least on the computer screen or radar which 'stands' as the sky for all practical purposes.

ORGANIZATIONAL INTERACTION

Over the past decade or so there has been a burgeoning interest within various disciplines, concerned with language, discourse and communication in organizations (Keenoy, Oswick, Grant 1997). Some of this work has undoubtedly emerged in the light of the programmatic relativism that Silverman (1997), and others such as Reed (1992), suggest pervades organizational theory, but in some cases, it has encouraged the development of a wide range of empirical studies. Various approaches have been brought to bear on understanding organizational action through studies of language and communication ranging from discourse analysis through to activity theory, but it is perhaps conversation analysis which has made the most pervasive and significant contribution (see for example, Boden 1994; Boden and Zimmerman 1991; Drew and Heritage 1992; and in rather a different way Edwards and Potter 1992). Workplace studies can be seen to complement these developments. Whilst preserving a commitment to the interactional accomplishment of workplace activities, workplace studies consider the ways in which the visual, the vocal, and the material, feature with talk, in the production and co-ordination of organizational conduct. In particular, they have begun to reveal how tools and technologies, and other features of the local environment are brought to bear, and are reflexively constituted in action and interaction within the workplace. Perhaps most importantly, they have also begun to address rather different forms of interaction and communication in organizations. In control rooms, for example, communicational activities do not necessarily involve 'focused interaction', but rather highly variable forms of emerging and contingent participation in which individuals, who may be co-located or dispersed, more or less participate in the performance of a number of concurrent, interdependent activities. In various ways workplace studies powerfully demonstrate how the fine details of interaction lie at the heart of broad range of organizational activities, and that discourse, talk and interaction are embedded in the material environment. These analytic and substantive developments demand methodological innovations which still leave a number of key questions unanswered.

The concern with the contingent and interactional character of organizational conduct, contributes to related developments in organizational theory (Reed 1992; Knoblauch 1997). There is a growing recognition that globalization, changes in the nature of the market and the emergence of

new communication technologies are generating new forms of organizational arrangement and conduct, which require flexible and temporary forms of co-operation within and between firms and the components of disaggregated corporations. As yet however, there is little research concerned with the ways in which different forms of collaboration emerge, coalesce, evolve, and fragment, and how individuals in concert with each other use various tools and technologies to assemble temporary forms of co-operation, so as, for example, to develop a particular product for a niche in the market. Workplace studies may provide a conceptual and empirical vehicle for addressing these new forms of organization and co-operation, allowing us to reconsider institutional forms and their associated baggage of roles, rules and goals. Such concerns have strong parallels with 'new institutionalism' (DiMaggio and Powell 1991), but as Silverman (1997) suggests workplace studies provide an opportunity to build fine grained, empirically grounded studies of institutional conduct alongside the more programmatic and theoretical work found increasingly within some areas of contemporary organizational analyses.

In a recent and important collection of workplace studies, Engeström and Middleton suggest that these new forms of organizational analyses provide a vehicle for interweaving

> 'microsociological analysis of locally constructed and negotiated work activities' with 'macrolevel discussions of the impact of technological development on the skills and the organization of work'. (see Engeström and Middleton 1996: 1)

Whilst we have reservations concerning the so-called 'micro-macro' distinction, we can begin to see how the analysis of technologically informed work may provide a vehicle for reconsidering some of the key concepts in our understanding of such concepts as information, information work and the information society. At their most basic, we can see how workplace studies provide the possibility of recovering 'information' from its reified status as a theoretical construct, by considering how participants themselves, in the course of the organizational actions and activities, orient to, use, and disseminate information. So, for example, a range of studies have begun to examine how individuals collect and constitute particular types of information, how they configure facts and findings, reports and descriptions, how such information is managed and what occasions and for what purposes it is retrieved, and how information is deployed within practical action and interaction. In this regard, information as a blanket term, to encapsulate a disparate and unbounded array of materials, matters, and the like, becomes untenable, as we turn analytic attention to the ways in which particular organizationally relevant information gains its significance and determinate character in actual courses of action and interaction. Information is inextricably embedded in practice and practical action.

Alongside their empirical and conceptual contributions, workplace studies are having an increasing influence on the design and development

of advanced technologies, in particular systems to support co-operative work. Whilst it is unlikely, impractical, and probably undesirable, that we will witness the emergence of a practical ethnography for technology, akin to the methods and guidelines we find in HCI and cognate disciplines, it is perhaps heartening to note that naturalistic studies of work and interaction, sometimes derided for being insignificant, if not trivial, are found to have important implications for such seemingly practical matters as the design and deployment of advanced technology. By turning attention to the details of work, and in particular the tacit, 'seen but unnoticed', social and interactional resources on which participants rely in the practical accomplishment of organizational activities, we can begin to (re)consider how particular tools and technologies might support, enhance even transform what people do and the ways in which they do it. Moreover, shifting attention from the cognitive to the social, from the individual to the collaborative provides a vehicle for exploring more innovative ways of supporting action and interaction in the workplace, and in particular the new forms of synchronous and asynchronous co-operation increasingly demanded by fragmented disaggregated organizations. More importantly perhaps, these newly emerging workplace studies provide a distinctive body of sociological research which directs analytic attention towards the ways in which tools and technologies feature in practical action and interaction and help expose an important, yet largely unexplored, realm of social organization.

(Date accepted: December 1999)

Christian Heath
King's College, London

Hubert Knoblauch
Universitat Konstanz and King's College, London

Paul Luff
King's College, London

ACKNOWLEDGEMENTS

We would like to thank Jon Hindmarsh, Dirk vom Lehn, and David Greatbatch for their wide-ranging contributions to the discussion of many of the issues and materials addressed here, and the editor and anonymous referees of the *BJS* for insightful comments on an earlier version of this paper.

REFERENCES

Agre, P. E. 1988 *The Dynamic Structure of Everyday Life*. Unpublished Ph.D. Dissertation, AI Technical Report 1085. Department of Electrical Engineering and Computer Science, Massachusetts Institute of Technology, Cambridge, Mass.

Aldridge, A. 1997 'Engaging with Promotional Culture', *Sociology* 31 (3): 389–408.

Anderson, R. 1994 'Representation and Requirements: The Value of Ethnography in System Design', *Human-Computer Interaction* 9 (2): 151–82.

Anderson, R., Hughes, J. and Sharrock, W. 1989 *Working for Profit*, Farnborough: Avebury.

Bannon, L. J. and Schmidt, K. 1991 'CSCW: Four Characters in Search of a Context', in J. Bowers and S. D. Benford (eds) *Studies in Computer Supported Cooperative Work. Theory Practice and Design*, Amsterdam: North-Holland.

Benyon, D. 1992 'The role of task analysis in systems design', *Interacting With Computers* 4 (1): 102–23.

Berg, M. 1997 'On Distribution, Drift and the Electronic Medical Record: Some Tools for the Sociology of the Formal', in *Proceedings of ECSCW '97*, Lancaster.

Bijker, W. E., Hughes, T. P. and Pinch, T. (eds) 1990 *The Social Construction of Technological Systems*, Cambridge MA: MIT Press.

Boden, D. 1994 *The Business of Talk: organizations in action*, Oxford and Cambridge, MA: Polity Press.

Boden, D. and Zimmerman, D. H. (eds) 1991 *Talk And Social Structure: Studies in Ethnomethodology and Conversation Analysis*, Cambridge: Polity Press.

Bowker, G. and Star, S. L. 1991 'Situations vs. Standards in Long-term, Wide-scale Decision-making: The Case of the International Classification of Diseases', in *Proceedings of Twenty-Fourth Annual Hawaii International Conference on System Sciences*, Kauai, Hawaii, January 7–11.

—— 1994 'Knowledge and infrastructure in international information management: Problems of classification and coding', in L. Bud-Friedman (eds) *Information acumen: The understanding and use of knowledge in modern business*. London and New York: Routledge.

Button, G. 1993 'The Curious Case of the Disappearing Technology', in G. Button (ed.) *Technology in the Working Order*, London: Routledge.

Button, G. and Dourish, P. 1996 'Technomethodology: Paradoxes and Possibilities', in *Proceedings of CHI'96*.

Button, G. and Sharrock, W. 1994 'Occasioned Practices in the Work of Software Engineers', in M. Jirotka and J. Goguen (eds) *Requirements Engineering: Social and Technical Issues*, London: Academic Press.

—— 1997 'The Production of Order and the Order of Production', in *Proceedings of ECSCW '97*, Lancaster.

Card, S. K., Moran, T. P. and Newell, A. 1980 'Computer Text-Editing: An Information Processing Analysis of a Routine Cognitive Skill', *Cognitive Psychology* 12: 32–74.

—— 1983 *The Psychology of Human-Computer Interaction*, Hillsdale, NJ.: Lawrence Erlbaum Associates.

Carroll, J. M. 1990 'Infinite Detail and Emulation in an Ontologically Minimized HCI', in *Proceedings of CHI '90*, Seattle, Cambridge MA: ACM Press.

Castells, M. 1996 *The Information Age: Economy, Society and Culture. Vol. 1: The Rise of the Network Society*, London and New York: Blackwell.

Collins, T. and Bicknell, D. 1997 *Crash: Ten Easy Ways to Avoid Computer Disaster*, London: Simon and Schuster.

Corbin, J. M. and Strauss, A. 1993 'The Articulation of Work through Interaction', *Sociological Quarterly* 34 (1): 71–83.

Coulter, J. 1979 *The Social Construction of Mind: Studies in Ethnomethodology and Linguistic Philosophy*, London: Macmillan.

Davis, A. M. 1993 *Software requirements: Objects, Functions and States (Second Edition)*, Englewood Cliffs, NJ: Prentice-Hall.

DiMaggio, P. J. and Powell, W. W. 1991 'Introduction', in W. W. Powell and P. J. DiMaggio (eds) *The New Institutional in Organizational Analysis*, Chicago and London: University of Chicago Press.

Drew, P. and Heritage, J. C. (eds) 1992 *Talk at Work: Interaction in institutional settings*, Cambridge: Cambridge University Press.

Dreyfus, H. L. 1972 *What Computers Still Can't Do: A Critique of Artificial Reason: 2nd Edition*, Cambridge, MA: MIT Press.

Edwards, D. and Potter, J. 1992 *Discursive Psychology*, London: Sage.

Engeström, Y. and Escalante, V. 1996 'Mundane Tool or Object of Affection? The Rise and Fall of the Postal Buddy', in B. A. Nardi (eds) *Context and Consciousness: Activity and Human-Computer Interaction*, Cambridge, MA: MIT Press.

Engeström, Y. and Middleton, D. (eds) 1996 *Cognition and Communication at Work*, Cambridge: Cambridge University Press.

Filippi, G. and Theureau, J. 1993 'Analysing Cooperative Work in an Urban Traffic Control Room for the Design of a Co-ordination Support System', in *Proceedings of ECSCW '93*, Milan, Italy.

Galegher, J., Kraut, R. E. and Egido, C. (eds) 1990 *Intellectual Teamwork: Social and Technological Foundations of Cooperative Work*, Hillsdale, NJ: Lawrence Erlbaum Associates.

Garfinkel, H. 1967 Studies in Ethnomethodology, Englewood Cliffs, NJ: Prentice-Hall.

Gaver, W. W. 1991 'Technology Affordances', in *Proceedings of CHI '91*, New Orleans.

Geertz, C. 1973 *The Interpretation of Cultures*, New York: Basic Books.

Goodwin, C. and Goodwin, M. H. 1996 'Seeing as a Situated Activity: Formulating Planes', in Y. Engeström and D. Middleton (eds) *Cognition and Communication at Work*, Cambridge: Cambridge University Press.

Greatbatch, D., Luff, P., Heath, C. C. and Campion, P. 1993 'Interpersonal Communication and Human-Computer Interaction: an examination of the use of computers in medical consultations', *Interacting With Computers* 5 (2): 193–216.

Grint, K. and Woolgar, S. 1997 *The Machine at Work: Technology, Work and Organization*, Cambridge: Polity.

Harper, R., Hughes, J. and Shapiro, D. 1991 'Working in Harmony: An Examination of Computer Technology and Air Traffic Control', in J. Bowers and S. D. Benford (eds) *Studies in Computer Supported Cooperative Work. Theory Practice and Design*, Amsterdam: North-Holland.

Harper, R. H. R. 1998 *Inside the IMF: An Ethnography of Documents, Technology and Organizational Action*, London: Academic Press.

Heath, C. C. 1984 'Everett Cherrington Hughes (1897–1983): a note on his approach and his influence', *Journal of Health and Illness* 6 (2): 218–37.

Heath, C. C., Jirotka, M., Luff, P. and Hindmarsh, J. 1993 'Unpacking Collaboration: the Interactional Organization of Trading in a City Dealing Room', in *Proceedings of ECSCW 1993*, Milan, September 13th–17th.

Heath, C. C. and Luff, P. 1992 'Collaboration and Control: Crisis Management and Multimedia Technology in London Underground Line Control Rooms', *CSCW Journal* 1 (1–2): 69–94.

—— 1996a 'Documents and Professional Practice: 'bad' organizational reasons for 'good' clinical records', in *Proceedings of CSCW '96*, Boston, MA, November 16–20.

—— 1996b Convergent activities: collaborative work and multimedia technology in London Underground Line Control Rooms. in D. Middleton and Y. Engeström *Cognition and Communication at Work: Distributed Cognition in the Workplace*, Cambridge: Cambridge University Press.

—— (in press) *Technology in Action*, Cambridge: Cambridge University Press.

Hensel, M. 1980 *Die Informationsgesellschaft: Neuere Ansätze zur Analyse eines Schlagwortes*, Munich: Fischer.

Hughes, E. C. 1958 *Men and their Work*, Glencoe: Free Press.

Hughes, J.A., Shapiro, D. Z., Sharrock, W. W., Anderson, R. A., Harper, R. R. and Gibbons, S. C. 1988 *The Automation of Air Traffic Control*, Final Report, Department of Sociology, Lancaster University.

Hughes, J.A., Randall, D. R. and Shapiro, D. 1992 'Faltering from Ethnography to Design', in *Proceedings of CSCW '92*, Toronto, Canada, Oct 31–Nov 4.

Hutchins, E. L. 1995 *Cognition in the Wild*, Cambridge MA: MIT Press.

Jirotka, M. and Goguen, J. 1994 *Requirements Engineering: Social and Technical Issues*, London: Academic Press.

Jirotka, M., Luff, P. and Heath, C. 1993 'Requirements for Technology in Complex Environments: Tasks and Interaction in a City Dealing Room', *SIGOIS Bulletin (Special Issue) Do users get what they want? (DUG '93)* 14 (2): 17–23.

Jirotka, M., and Wallen, L. (in press). Analysing the Workplace and User Requirements: Challenges for the Development of Methods for Requirements Engineering,

in P. Luff, J. Hindmarsh and C. Heath (eds) *Workplace Studies: Recovering Work Practice and Informing System Design*, Cambridge: Cambridge University Press.

Keenoy, T., Oswick, C. and Grant, D. 1997 'Organizational Discourse: Text and Context', *Organization* 4: 147–57.

Knoblauch, H. 1996 'Arbeit als Interaktion. Informationsgesellschaft, Post-Fordismus und Kommunikationsarbeit', *Soziale Welt* 47 (**3**): 344–362.

—— 1997 'Die kommunikative Konstruktion postmoderner Organizationen. Institutionen, Aktivitätssysteme und kontextuelles Handeln', *Österreichische Zeitschrift für Soziologie* 22 (2): 6–23.

Kuutti, K. 1991 'The Concept of Activity a Basic Unit of Analysis for CSCW Research', in *Proceedings of ECSCW '91*, Amsterdam, Netherlands, 25–27 September.

Latour, B. 1996 *Aramis or The Love of Technology*, Cambridge. MA.: Harvard University Press.

Luff, P., Hindmarsh, J. and Heath, C. (eds) (in press) *Workplace Studies: Recovering Work Practice and Informing System Design*, Cambridge: Cambridge University Press.

Mackenzie, D. 1996 *Knowing Machines: Essays on Technical Change*, Cambridge, MA: MIT Press.

Miles, R. E. and Snow, C. C. 1986 'Organizations: new concepts for new forms', *California Management Review* 34 (2): 53–72.

Nardi, B. A. 1996 'Some Reflections on the Application of Activity Theory', in B. A. Nardi (ed.) *Context and Consciousness: Activity and Human-Computer Interaction*, Cambridge, MA: MIT Press.

Neumann, P. G. 1995 *Computer-Related Risks*, Reading, MA: Addison Wesley.

Norman, D. A. 1988 *The Psychology of Everyday Things*, New York: Basic Books.

—— 1998 *The Invisible Computer*, Cambridge, MA: MIT Press.

Page, D., Williams, P. and Boyd, D. 1993 *Report of the Inquiry into the London Ambulance Service*, South West Thames Regional Health Authority.

Payne, S. J. and Green, T. R. G. 1986 'Task-Action Grammars: A Model of the Mental Representation of Task Languages', *Human-Computer Interaction* 2 (2): 93–133.

Pinsky, L. and Theureau, J. 1982 *Activité Cognitive et Action dans le Travail. Tome 1: Les Mots l'Operatrice*, Paris: C.N.A.M.

Potts, C. and Newstetter, W. C. 1997 'Naturalistic Inquiry and Requirements Engineering: Reconciling Their Theoretical Foundations', in *Proceedings of Third IEEE International Symposium on Requirements Engineering*, Annapolis, Maryland.

Randall, D. and Hughes, J. A. 1995 Sociology, CSCW and working with customers, in P. Thomas (ed.) *The Social and Interaction Dimensions of Human-Computer-Interfaces*, Cambridge: Cambridge University Press.

Reed, M. I. 1992 *The Sociology of Organizations*, New York:

Robinson, M. 1993 Computer Supported Cooperative Work: Cases and Concepts, in R. M. Baecker (ed.) *Readings in Groupware and Computer-Supported Cooperative Work*, Hillsdale, NJ: Lawrence Erlbaum Associates.

Rogers, Y. 1992 'Ghosts in The Network: Distributed Troubleshooting in a Shared Working Environment', in *Proceedings of CSCW '92*, Toronto, Canada, Oct 31–Nov 4.

Salomon, G. (ed.) 1993 *Distributed Cognitions: Psychological and Educational Considerations*, Cambridge: Cambridge University Press.

Schmidt, K. and Bannon, L. 1992 'Taking CSCW Seriously Supporting Articulation Work', *Computer Supported Cooperative Work* 1 (1–2): 7–40.

Searle, J. R. 1985 *Minds, Brains and Science*, Cambridge MA: Harvard University Press.

Sellen, A. and Harper, R. H. R. 1997 'Paper as an Analytic Resource for the Design of New Technologies', in *Proceedings of CHI'97*, Atlanta, Georgia, 22nd–27th March.

Silverman, D. 1997 'Studying Organizational Interaction: Ethnomethodology's Contribution to the "New Institutionalism"', *Administrative Theory amd Praxis* 19 (2): 178–95.

Sommerville, I. 1989 *Software Engineering: 3rd Edition*, Norwood, NJ: Addison-Wesley.

Sommerville, I., Rodden, T., Sawyer, P. and Bentley, R. 1993 'Sociologists can be Surprisingly Useful in Interactive Systems Design', in A. Monk, D. Diaper and M. Harrison (eds) *People and Computers VII*, Cambridge: Cambridge University Press.

Still, A. and Costall, A. (eds) 1991 *Against Cognivitism: Alternative Foundations for Cognitive Psychology*, London: Harvester Wheatsheaf.

Suchman, L. 1987 *Plans and Situated Actions: The Problem of Human-Machine Communication*, Cambridge: Cambridge University Press.

—— 1993 Technologies of Accountability: On Lizards and Aeroplanes, in G. Button (ed.) *Technology in Working Order*, London: Routledge.

Theureau, J. 1992 *Le Cours D'Action: Analyses Sémio-Logique*, Berne: Peter Lang.

Watts, J. C., Woods, D. D., Corban, J. M., Patterson, E. S., Kerr, R. L. and Hicks, L. C. 1996 'Voice Loops as Cooperative Aids in Space Shuttle Mission Control', in *Proceedings of CSCW '96*, Cambridge, MA.

Webster, F. 1995 *Theories of the Information Society*, London: Routledge and Kegan Paul.

Whalen, J. 1995a 'Expert Systems vs. Systems for Experts: Computer-Aided Dispatch as a Support System in Real-world Environments', in P. Thomas (ed.) *The Social and Interactional Dimensions of Human–Computer Interfaces*, Cambridge: Cambridge University Press.

—— 1995b 'A Technology of Order Production: Computer-Aided Dispatch in Public Safety Communications', in ten P. Have and G. Psathas (eds) *Situated Order: Studies in the Social Organization of Talk and Embodied Activities*, Washington: University Press of America.

Wiener, L. R. 1993 *Digital Woes: Why We Should Not Depend on Software*, Reading: MA: Addison Wesley.

Winograd, T. and Flores, F. 1986 *Understanding Computers and Cognition: A New Foundation For Design*, Norwood, NJ: Addison-Wesley.

Woolgar, S. 1985 'Why not a sociology of machines? The case of sociology and artificial intelligence', *Sociology* 19 (4): 557–72.

—— 1991 'Configuring the user: the case of usability trials', in J. Law (ed.) *A Sociology of Monsters: Essays on Power, Technology and Domination*, London: Routledge.

Zimmerman, D. H. 1992 'The interactional organization of calls for emergency assistance', in P. Drew and J. Heritage (eds) *Talk at Work: Interaction in institutional settings*, Cambridge: Cambridge University Press.