

# **An Investigation into Contextual Approaches to Requirements Capture**

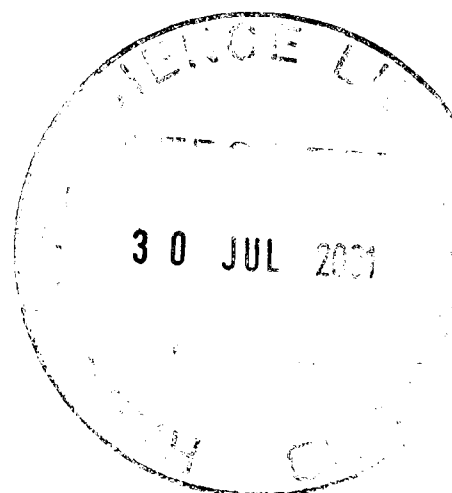
**Submission for DPhil**

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**18th April 2001**



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*Hilary Term 2000*

## **ABSTRACT**

Designing innovative computer systems is no longer simply a technical issue. There is now a growing awareness that a grounded understanding of the social and organisational context into which these systems are to be deployed, until recently overlooked, may be critical, particularly in the early phases of design. It is in these stages, known as requirements elicitation, capture or analysis, or more generally Requirements Engineering, that researchers have begun to acknowledge both social and technical concerns in the requirements for systems.

This thesis aims to mediate between a detailed appreciation of the social organisation of the workplace and the technical structure of information technology. In order to do this, we explore the relevance of recent developments in the social sciences, principally ethnomethodology and interaction analysis, for providing an alternative analytic orientation for requirements capture. In particular, we outline the principal characteristics of an approach that takes into account the details of the moment-to-moment production of work activities and communicative practices. It is argued that attendance to such interactional features will improve requirements practice, and hence will ultimately lead to more sensitive designs for supporting collaborative work.

To illustrate this approach, we take as an example the development of particular technologies for a complex work setting – financial trading rooms. Results of the analysis are then used to discuss requirements for systems to support trading. In particular, we consider how issues emerging from this analysis, developed from an ethnomethodological orientation, could inform requirements analysis. In this regard,

we investigate approaches to modelling interactional resources, including the use of formal notations developed for sequential and communicating processes, and provide requirements analysts with sensitivities by which to consider naturalistic settings. This forms the basis for mutually dependent investigations: on the system design side, drawing on the model to allow consideration of conflicts introduced by technological choices; and on the social science side, providing an agenda for renewed investigation into the domain. We conclude by discussing the pre-requisites necessary so that approaches in this thesis could be integrated within the software development process.

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# Acknowledgements

This thesis is the result of several years' part-time work. As such, my research activities have been supported by British Telecom and the Centre for Requirements and Foundations at Oxford University Computing Laboratory. The Centre was established by British Telecom as a University Research Initiative, with the aim of developing new methods for requirements capture and analysis capable of delivering results of industrial strength. I had the good fortune to work with Martin Aylett and Radmila Mihajlovic from British Telecom, with whom I had many interesting discussions related to the topics in this thesis. More recently, some of the work at the Defence Evaluation and Research Agency (DERA) has provided various opportunities to extend my research into different domains and settings. I would like to thank the participants of these studies, particularly Graham Dean and Peter Houghton.

I am grateful to colleagues at Oxford University Computing Laboratory for their support and tolerance over the years. I also wish to thank Jim Woodcock and Jim Davies and the students on the Software Engineering Programme who have attended the Requirements Engineering module. Running this module has allowed me to discuss and refine many of the ideas presented in the thesis. I am indebted to those members of the Centre for Requirements and Foundations, past and present, with whom I have collaborated over the years, including Joseph Goguen, Lincoln Wallen, Bernard Sufrin, Matt Bickerton, Olly Gotel, Richard Tolcher, Christian Greiffenhagen, and Jason Brown. I am also thankful for having had the opportunity to discuss issues related to the work in this thesis with various visiting researchers, including Leigh Star and Eric Livingston. I would particularly like to thank Frances Page for her unerring support and enthusiasm.

I am also indebted to my supervisors: Joseph Goguen, Lincoln Wallen and Bernard Sufrin, for their encouragement and assistance. Many thanks also to Jim Davies for his advice on modelling, and to Professor Shapiro and Mr Joe Stoy for their insightful comments and careful reading of the thesis.

I am also extremely grateful to have been able to collaborate with members of the Work Interaction and Technology Group at King's College, London, including Christian Heath, John Hindmarsh and Paul Luff. The exciting and innovative research in which this group are engaged has greatly influenced the work in this thesis.

The case studies described in this work were undertaken in three financial dealing rooms and I would like to thank all the participants in these settings. In particular, I wish to express my appreciation to Tom, Richard and Peter who, with great tolerance and good humour, answered all my questions and made the experience of fieldwork very rewarding.

Writing a thesis is a unique challenge and I have been most fortunate to have had the strong support of family and friends, who have endured both moments of crisis and exhilaration as the research took shape. I owe deepest gratitude to Deniz and Oliver Case, Matthew, Tom and Jessica Wallis, Polly Minett-Powell, Charlotte Courtney, Claire Hughes, Allegra Wint and Barbara Gorayska.

There are no words to express my gratitude to my dearest friend Paul Luff whose patience and quiet strength have encouraged me through some very difficult moments in the course of producing this thesis.

Finally, there is one person to whom I owe everything – my mother. Sadly, she did not live to see this work completed. Her courage, wisdom and love are greatly missed. I dedicate this thesis to her.

# Chapter 1

## Contextual Approaches for Requirements Engineering

### 1.1 Introduction

Increasingly over the last decade, major technological innovations seem to be touching almost all areas of our lives; at work, at home, or socially. On the one hand, these great technological advances are foreshadowed by press releases; we read reports of new technological capabilities available on smaller and smaller devices that work faster and faster. With these technologies, work or social activities no longer seem to be tied to a specific location or indeed be the reserve of any particular profession. Yet, on the other hand, we read tales of technological problems and disasters; expensive systems that are not completed on time and that, despite grand promises, fail to accomplish even the most straightforward of tasks. When these systems are introduced into various work settings, they may require more work or may be rejected as not being what was requested and specified. Indeed, popular and professional literature abound with such technological failures and risks (Collins and Bicknell, 1997; Neumann, 1995; Wiener, 1993).

These problems may be due in part to the particular way computer systems are developed; a certain rigidity in the process means that initial design decisions are too hard to modify yet, the later on in the software development process various errors are discovered, the more expensive they are to change (Boehm, 1981). Hence, research has begun to focus on the early stages of design, when the actual requirements for the system are laid out, suggesting that ‘getting the requirements right’ will lead to better systems. The first critical step has been to identify these concerns as an explicit development activity, and then to consider how to make practices more systematic.

These concerns are now reflected in design practices and in academic disciplines through the field of Requirements Engineering. Though not all development methods stress the importance of requirements, currently in industrial system development practice, the requirements specification is often seen as the contract between the developer and customer that details what a system will do. Thus, as practice orients to the phase of requirements for contractual and organisational reasons, and is likely to continue to do so, it is in this field that topics will be addressed by this research.

In the thesis we explore the issues surrounding the analysis of social and collaborative work for the purpose of eliciting requirements. We examine the relevance of a particular approach from the social sciences, principally ethnomethodology and interaction analysis, for providing the basis for an analytic orientation for requirements capture. This approach takes into account the details of the moment-to-moment production of work practices and communicative activities. We argue that, by attending to these interactional features, requirements engineers may greatly improve their analyses of work domains and hence lead to more sensitive designs for systems to support collaborative work. In order to do this, we draw upon naturalistic analyses that use materials gathered through fieldwork and video-recording in three financial dealing rooms. From these materials, we identify issues of concern for the development of systems to support traders, and examine ways of characterising the outcomes of ethnomethodological analyses as relevant for the requirements more generally.

A recent issue focuses on the problem of conveying what emerges from the analysis of complex domains for the purposes of system design. Recent debates have been concerned with how analyses can be organised, structured and communicated. This is a critical issue when we consider the complexity of analysis drawn from the social sciences. What is considered important from the analysis may not be conveyed, as apparently subtle points may be lost when transformed into models drawn from an engineering approach for example. We investigate suggestions on how modelling the subtle and critical features of such analyses might be achieved. We argue that a modelling approach may be chosen for its ability to reflect the concerns and orientation of analysis. In this regard, we discuss the potential use of CSP with its concern for modelling and reasoning about sequential and parallel processes. We consider how the issues that emerge from the modelling exercise can be used in the requirements and design process. These issues, that we draw upon in the workplace analysis, are grouped into key sensitivities designed to provide an alternative means of communicating tacit and interactional practices to requirements engineers. This may be done either through the modelling process or in reflecting on the critical analysis and observations. By using this approach, we are attempting to preserve the analytic orientation through which the observations are derived. It is a sensitivity to particular aspects that we argue is critical for informing system design appropriately,

and thus it is important that we attempt to provide access to the orientation to designers as well as to specific interactional features.

## 1.2 Themes and Issues

Requirements engineering is concerned with various issues that include: eliciting requirements from customers and users; analysing these statements, perhaps with the use of various modelling techniques; and producing a specification to be used by others in the development process. A critical concern, but one often neglected methodologically in the field, is the earliest part of the requirements process, the elicitation stage. Various methods and practices either view this stage as relatively straightforward and provide few or no guidelines on how to elicit requirements, or suggest that eliciting requirements may be accomplished using standard observation or interviewing techniques. Some may even leave this problem to other disciplines, particularly social scientists, as it may not be viewed as part of their technical expertise. Nevertheless, this is a key concern, and eliciting requirements for systems is not at all easy. It is commonplace to hear that potential users find it difficult to say what they require or, moreover, that users may not be able to articulate what they currently do in order to provide information for the types of activities the system is meant to support. There are techniques and methods utilised in social sciences that may assist here; but the selection and use of these may be difficult for the purposes of software engineering. There are debates and methodological issues within the social sciences concerning the appropriateness of techniques and methods given the research questions addressed, and on the relevant analytic orientation given the data collected. However, the issues raised by those concerned with Social Science Research Methods may not immediately be seen to be of relevance to system designers.

Utilising various methods from the social sciences, be they interviews or more sophisticated techniques, requires the point at which the information gathered is transformed into technologically relevant requirements. At present, it is unclear how this is best addressed, whether in the initial analysis, through communication techniques, or by the software engineers themselves. It is also unclear when such transformations should take place. Thus, they could shape the initial analysis, be transformed when they are communicated to designers, or following extensive requirements analysis. Furthermore, conceiving of the potential relationship between computer and social scientists as one of communicating information between each other may not be the most appropriate way forward. Considering the relevant methods for analysis and how best to utilise insights from their use is a major concern of this thesis.

It is perhaps not surprising that recent attention in the early stages of system development has turned towards attempting to understand the social and organisational features of the workplace, a critical domain where many technologies are deployed. These features may involve such issues as: determining organisational structures; identifying organisational goals and objectives; and understanding work activities, processes and products. In addition, new technologies drawing upon recent developments in networks and distributed systems, augmented with other multimedia capabilities, have been focused on supporting collaboration (or 'group work'). This feature of organisational work does not seem to have been addressed (systematically) by fields concerned with 'human factors' or ergonomics. Consequently, in recent years there has been a shift in these fields and in Human Computer Interaction (HCI), where the research has been concerned with understanding the user's actions with the computer, to incorporating and understanding social and organisational issues. In addition, a new field of research has also emerged that is concerned with such issues, Computer Supported Cooperative Work (CSCW). By investigating ways of understanding collaborative, social and organisational work, researchers attempt to design and develop more appropriate technologies from that understanding.

Within Requirements Engineering, a similar concern has been raised to understand the domain in which technologies are to be placed. This overlaps with concerns in HCI and the interest in individual user requirements, and CSCW's concern to determine requirements for systems to support collaboration. A distinguishing feature of requirements engineering seems to be its relationship to the software engineering approach; thus it has been particularly influenced by and is tied into the software development process. Particular concerns include: a focus on the production of a clear specification for the next phase of design; tracking the changing requirements throughout the process; and how best to understand and model the requirements of a problem domain for use later on in the software development process.

In order to explore issues that emerge from considering how naturalistic analysis may assist requirements capture in analysing a domain, we will focus on one particular setting. From this domain we will consider ways of analysing workplace settings that are relevant to design and we will consider how to convey the issues that emerge to others in the design process. The setting used in this investigation is a dealing room - a financial trading room. This is a particularly complex domain 'saturated' with technology. Dealers' work practices are particularly complex, being accomplished by participants coordinating their use of technology with each others' talk and bodily conduct. We will briefly investigate these practices and consider the consequences of the analysis for system design.

Dealing rooms are also domains where there is considerable interest in developing new technologies. As profits are made depending on the speed with which participants mobilise their resources and trade, technology has the potential of

increasing the speed of trading, providing more information to dealers, and reducing the need for dealers to carry out seemingly irrelevant tasks. Novel computer systems, in particular, offer the potential for improving the speed of transactions, reducing errors, identifying critical features about the market, and making these apparent to dealers. However, they also have the potential to disrupt the activity of dealing, providing too much information so that matters of interest (indicating potential problems) are difficult to discern. They may also introduce additional activities to be performed by users and in other ways disrupt the accomplishment of dealing. This is a setting where technology developers frequently report that the system they have designed has been rejected, left unused or 'thrown out the window'. Therefore, it has been seen to be a particularly problematic domain for system development. Moreover, the practices of dealing seem particularly obscure, relying on unseen strategies, on strange gestures and language, and on curious practices relying on such things as overhearing and the so-called 'third ear'. In this thesis we will consider such practices, how they can be subjected to analytic scrutiny, and how this analysis can be made relevant for requirements for new technologies.

In order to begin this investigation we draw from recent developments in the social sciences, in particular from an orientation drawing from ethnomethodology and conversation analysis. These developments emerged from a concern in the social sciences with the organisation of everyday activities, arising principally from sociology, but also from linguistics, jurisprudence and psychology. Rather than initiate an analysis of social actions drawing from a framework, either in terms of a particular social theory or set of assumed to be relevant categories that were provided *a priori*, this orientation seeks first to unpick the social organisation of social action from the perspective of the participants through an analysis of their mundane conduct.

A concern for ethnomethodology is that conventional sociological analyses take as given certain aspects of social life, such as power, gender or class, and from these categories begins an analysis in terms of such sociological topics. In a radical departure, ethnomethodology does not take these topics *a priori*, but rather explores how everyday conduct is organised, produced and rendered intelligible for others. It could therefore be of interest to explore how that conduct characterised by conventional sociologists is itself a product of skilled work, common sense resources and practical reasoning. The topics of sociology such as 'gender', 'power', or 'rules', are themselves utilised by members of society. Such topics found by sociology are thus the outcome of the skilled work of members and are accomplished in interaction. Ethnomethodology is concerned with these practices, the methods of the participants themselves or 'ethnomethods'. In particular it is concerned with those 'seen but unnoticed' practices, those tacit practices through which social conduct is organised and that also underpin the organisation of social action.

Recently, such a concern has also become of interest in system development, particularly as technologies began to be explicitly developed to support collaborative work. It was recognised that the fields concerned with developing systems that were appropriate to the needs of users were principally focused on the individual, drawing upon an experimental and largely psychological paradigm. These fields seemed to have little to say to developers requiring techniques for supporting remote communication, coordinating distributed activities or designing shared tools. Moreover, there were limitations to the appropriateness of the experimental paradigm. At the most fundamental level, in an experimental set up, it seemed impossible to control for all of the criteria that could be relevant for a proposed technology. Practitioners, informed in part by concurrent debates in the academic disciplines, began to seek for alternative resources to support the early phases of the design process. Of relevance seemed to be those that drew upon naturalistic analysis of everyday conduct, particularly those that utilised observations of everyday settings - ethnographic orientations. The concern of the ethnomethodological orientation with the tacit and with members' own practices seemed particularly apposite; especially as it was an interest in the mundane, moment-to-moment accomplishments of everyday conduct - features the technology should resonate with.

Hence, a body of work emerged within CSCW called workplace studies that looked at the details of various domains and considered their relevance for system design, both for specific designs and for more general collaborative technologies. Workplace studies, utilising, audio and video recordings coupled with fieldwork, revealed the details of work practices in the moment-to-moment production of actions. This research also focused on how talk is produced and recognised and the ways in which talk is critical for the accomplishment of intelligible action. In particular, for some at least, drawing from ethnomethodology, conversation and interaction analysis offered the potential for developing a systematic analysis of conduct, one that was visible and accessible to others, both when undertaking the analysis but also at later stages of design. In particular, it made available, at least in part, the resources through which tacit practices are achieved. This focus on the tacit practices, what is 'seen but unnoticed', seems particularly problematic for requirements, as such practices may be unrecoverable from the kind of techniques such as interviews and questionnaires utilised by requirements engineers to elicit aspects of work practice.

Workplace studies and related analyses seem to provide resources that should be relevant to system design, and at a general level have been used and drawn upon. However, the link between social science and computer science remains unclear. Various issues have been debated regarding this link, including: whether and how to focus the social scientific analysis so that it is relevant for system design; how to ensure that requirements reflects what has been revealed in the analysis; who should

do the analysis, i.e. social or computer scientists; whose concerns should be reflected in the analysis; how long an analysis should take and whether it can be made shorter; and, particularly, whether the analysis and communication for system design may be systematised in any way. This last issue is explored and other aspects reflected upon in this thesis. Through an analysis drawing upon ethnomethodology and conversation analysis, we reveal features of the setting, features that are critical for informing system development appropriately.

We then suggest, in relation to technological proposals, how and why the analysis may be consequential. The type of features of interest may seem trivial or mundane: how a body orientation or turn of talk accomplishes an action; how a number is abbreviated; how writing is related to talk; and the use of technologies. But work relies on the skilled accomplishment of these mundane practices. It is critical to understand this so that technological development resonates with these practices or, at the very least, developers have an understanding of the practices that the technology is likely to transform. Attendance to these features will improve requirements practices and the results of the system design process, thus leading to more sensitive systems for supporting work.

System development, therefore, is concerned with how best to convey such analysis for system designers. A variety of approaches has been suggested and we shall review in detail a few of these proposals. However, there has been a tendency to consider the problem of communication in terms of structured representations and models reflecting the practices of engineering and software engineering in particular. Modelling is perceived as a clear and concise way of seeing implications of certain design choices, and reasoning about their consequences. Unfortunately, though this may resonate with current practices in system development, these approaches may not be the most appropriate way of best representing analyses that emerge from workplace studies. Analyses from these studies focus on the moment-to-moment, delicate and, above all, tacit practices of participants in the setting under investigation. Formalising these may transform the nature of what has been revealed. Even if this could be addressed, it is not clear that the approaches considered so far by researchers have been selected for the most appropriate reasons. Modelling notations have been chosen for pragmatic motivations for example, they are commonly used in industry or they reflect the design of a particular type of technology (e.g. databases). It would be interesting to consider approaches that reflect, in some ways, the concerns revealed in the analysis; or, at the very least, explore the requirements for ways of conveying such concerns.

In this regard, we will focus on various issues that seem to recur in workplace studies and are critical to informing system design appropriately. These include: tacit practices, those activities that are ‘seen but unnoticed’; the openness of actions and activities to interpretation (both in design and production): how activities are tied to

the moment-to-moment situated resources for understanding and producing everyday actions. We will draw from the analysis of dealing rooms to reveal the nature of these actions and the practices through which they are achieved. We will also explore how these features may be conveyed or be drawn upon in models of everyday conduct.

Of significant interest is the nature of sequentiality drawn from conversation analysis; the moment-to-moment production of social actions accomplished with respect to the local and immediately prior context; the interactional context where a turn of talk is understood principally with respect to the prior turn of talk and provides resources for the next. Such an orientation draws upon the turn-by-turn (sequential) unfolding of context. More importantly, social actions are collaborative, they involve other participants: thus the production of action is understood from moment to moment by others and for others. Intelligibility is produced through talk and visual conduct, and includes activities such as overhearing and monitoring others' activities in the domain. Often these activities are related to and occur in parallel with other actions and may not appear to be the prime focus of the action. It would seem hard to convey such features using some modelling languages, and may even undermine the use of modelling if they unduly constrained what was trying to be considered. There may be other ways of considering the relationship (without needing resort to guidelines or frameworks). However, it may also be relevant to investigate more appropriate modelling languages than have been considered so far. A modelling language may imply a structure for analysis *a priori*, and may require much effort to transform the naturalistic analysis into a model that may unduly emphasise features of the modelling language at the cost of the analysis. Thus, we may wish to choose a modelling language that resonates with the features of the analysis we are seeking to describe. In this respect, we will consider a modelling language the constructs of which seem to reflect the underlying conception of activity that resonate more directly with the orientation underpinning the analysis. We will explore CSP with its interest in sequential and concurrent activities and, from the preliminary investigation, discuss to what extent it may help convey the analyses for the purposes of system design.

It may be that modelling is not the most appropriate way in which to consider the relationship between naturalistic analysis and requirements analysis. But taking this approach does allow for more than the simple communication of a framework or guidelines. Certain features have emerged from naturalistic analyses, such as the importance of talk and visual and bodily conduct and the ways in which activities are produced and recognised in the ongoing course of the action, that are reflected in the modelling exercises. Attending to these sensitivities is critical for system designers and, indeed, some research is already beginning to take account of them.

The view of the relationship as one of communication, passing information between social and computer scientists, is perhaps more in accord with a collaborative design process, where analyses are given to requirements engineers who must

interpret and see the relevance of such information. This may be a lengthy and possibly unfocused process. But modelling may provide resources for doing more than communication where, in an iterative manner, requirements analysis can begin to reason about the consequences of particular choices and reflect back to analysis of domain early on in the process. In a fairly transparent fashion, the consequences of the initial analyses are considered and inform further work in the field. The innovative aspect of this approach is that we are not just using the two approaches, modelling and naturalistic analysis together, nor as a collaboration between two disciplines, but one where the development of one analysis can inform the development of the other. We are not utilising an existing method from each discipline. The two areas of research progress much as they have done, but some of the analytic practices of each discipline may be transformed by this orientation. Chapter 8 discusses the relevance of such an approach.

## 1.3 Structure of Thesis

This thesis develops themes and issues relating to several disciplines, both in the social sciences and in software engineering. Chapter 2 briefly reviews recent work that has sought to develop a 'social approach' to support the development of technology. We focus on Requirements Engineering but also consider the fields of Human Computer Interaction (HCI) and Computer Supported Cooperative Work (CSCW), where there has been a longstanding concern for user requirements and requirements to support collaboration. Many issues from these fields overlap and it may not be appropriate to divide up their interests. Nevertheless, requirements analysis seems to have an overall concern with 'fitting in' with the design process in general. We review recent work in requirements analysis that reflects on social and organisational issues and is concerned with understanding features, such as identifying organisational goals and objectives, and understanding work activities and processes. Within these approaches, being able to reveal 'tacit' practices, those that are 'seen but unnoticed', is problematic. To elicit this kind of information demands a particular analytic orientation for understanding social action.

In Chapter 3 we consider how we might meet these demands. We discuss recent developments in the social and cognitive sciences and their relationship to system design. It has been suggested that a focus of research that draws upon cognitive science may be too narrow, and thus analyses should be broadened to incorporate social and organisational issues. This has raised concerns regarding the reliance on predominantly psychological and cognitive conceptions of users' actions and interactions with the computer. This reveals a growing concern with the social within cognitive science, and an interest in mundane activities from social science. We consider the importance of an analytic orientation for looking at the social, and

introduce ethnomethodology and the cognate approaches of conversation analysis and interaction analysis. We discuss features of a naturalistic orientation such as fieldwork, video recording, and materials that are subjected to analysis. We outline the approach used in the investigations in this thesis, describing the analytic orientation and techniques used in the analysis. For example, we draw upon a transcription system from conversation and interaction analysis to assist in revealing the sequential nature of activities. This transcription system is reproduced in the Appendix.

As mentioned above, the thesis draws on extensive fieldwork and analysis of financial dealing rooms. Through the course of the analysis, three types of dealing rooms were studied: a provincial dealing room of a large high-street bank; a derivatives trading room; and an equities floor. We focus the analysis on the equities trading room where we conducted a longitudinal study that provided access to a setting with great technological demands. In Chapters 4 and 5 we look at the particular detailed practices of trading. Chapter 4 considers some recurrent features of dealing such as how a deal is done, what the significant features of a deal are, and the interactional practices through which the deal is accomplished collaboratively. Chapter 5 looks in greater detail at the interactional production of dealing and deal recording, and the ways in which these two activities are interrelated. Dealers appear to orient to an economy of speech when trading, achieved through what seem to be systematic practices of using abbreviations and complex ways of saying numbers. These may at first appear confusing and hard to distinguish but are produced and recognised by participants. We also look at how dealers write out the details of the deal on paper tickets. In order to do this, numbers must be understood and easily distinguished one from the other. The analysis also suggests that numbers are produced for others, not only so that they can be distinguished, but also for particular purposes, perhaps for doing calculations or more importantly so that they can be written down. This analysis has important consequences for the development of technologies to support the recording of deals, and implications more generally for technologies for record keeping. We discuss the consequences for requirements in a preliminary way in these chapters, and later with respect to particular proposals for technology.

Chapter 6 considers how to convey such an analysis to developers and requirements engineers. This has been a recent concern of these kinds of interdisciplinary work. We consider several suggestions on how to communicate the details of social and organisational analyses for the purposes of requirements analysis. In particular, we draw upon a recent suggestion for modelling situated action by Goguen, whose approach utilises a fundamental organising principle in computer science that of abstract data types. We consider aspects of this work by examining the details of a particular fragment presented in Chapter 4. We reflect on the reasons for

adopting this approach and its appropriateness. We then consider a modelling language that provides constructs for considering parallel and sequential activities - CSP. We re-examine aspects of the model and reflect on its capabilities to convey features of the analysis. We conclude by suggesting some general requirements for modelling with respect to conveying the findings of naturalistic analysis for design.

In Chapter 7 we briefly consider some of the ways in which the findings from naturalistic studies can inform requirements analysis. This is done in terms of critical sensitivities that are considered with respect to two case studies of technologies. The first, a voice recognition system, was intended to radically transform the dealers' work practices. The second, a trade input system for dealers, would only affect some of their activities. The sensitivities are drawn upon to reflect on these technological proposals and also (briefly) with regard to other recent studies undertaken. We discuss how these sensitivities may be used by requirements analysts as resources in the consideration of various types of technologies. In general, requirements engineers' exposure to the setting in which proposed systems are to be placed is very limited. The video fragments, and analysis of work practices that reveal these sensitivities, provide a way for requirements analysts to see how actions are produced and made relevant for others. These sensitivities may be communicated through a case by case approach. But they also offer the potential for informing system design in a much more pertinent way, as described in Chapter 8.

Chapter 8 discusses future research issues, most particularly the consequences of modelling the socio-interactional resources through which people accomplish their work. If a modelling notation such as CSP could allow analysts to reason about the possible consequences of the support or transformation of these interactional features, in the context of various technological requirements, then it may be that the modelling exercise could be a way to explore the consequences of an emerging requirements analysis; thus through this, particular aspects could be considered in more detail in the fieldwork.

We will discuss the original motivations within requirements engineering of addressing social and collaborative features, drawing on a particular orientation within the social sciences, ethnomethodology, and the cognate approaches of conversation and interaction analysis. This orientation offers the potential for developing a systematic analysis of conduct, one that is visible and accessible to others, both when undertaking the analysis but also at later stages of design. We argue that the orientation that this approach gives to the analysis of human conduct is critical to informing system design appropriately. Drawing upon this, requirements analysts will be able to reason more effectively about the consequences of particular aspects of technological systems if some attendance is given to interactional achievements in workplace settings. This will improve both understanding of the workplace and requirements practices in general. The thesis considers what the

appropriate resources are for the analysis of workplace and organisational activities, and provides suggestions for ways these analyses may be integrated into the system development process.

# Chapter 2

## Social Orientations for Technology Design

### 2.1 Introduction

In recent years there appears to have been a convergence in three areas of system design towards incorporating social and organisational issues. In requirements engineering, where typically analysts must understand a problem domain and produce requirements for computer systems based on that understanding, there has been a growing recognition that analyses may be improved through a more detailed awareness of work practices. This has led to a consideration of how to incorporate naturalistic studies in requirements practice. Within the area of human computer interaction (HCI), much of the research remains focused on individual user requirements, but recently there have been suggestions to broaden analyses to incorporate social and organisational concerns. Such a shift has also occurred in the area of computer supported cooperative work (CSCW), where research into the ways in which people work collaboratively is not simply drawing upon naturalistic studies, but using a particular analytic orientation that focuses on participants' own understandings and categories of work, rather than relying on the analysts' *a priori* definition of categories of importance.

These three areas have common themes and concerns. Each is interested in looking at requirements for systems; HCI has a longstanding interest in determining user requirements for the interaction between a user and a computer and interface design. CSCW is particularly interested in user requirements for systems to support collaborative work, either co-present or distributed. Requirements engineering may be concerned with these issues also, but perhaps a distinguishing feature of this area is its interest in 'fitting into' the software development process as a whole.

This chapter discusses each of these areas in turn. Section 2.2 considers the move towards the social in requirements engineering, and its consequences for requirements practice. In Section 2.3 we examine the move towards the social within HCI that nevertheless seems to maintain a cognitive orientation. Section 2.4 discusses recent developments in computer supported cooperative work, where requirements for systems to support individuals and groups collaborating are of critical concern. A key consideration within CSCW has been how workplace studies can inform requirements practice and the development of systems that better fit the ways in which individuals and groups collaborate. We also discuss some of the results of such studies and their impact on system design. The final section of this chapter (Section 2.5) considers the impact of naturalistic studies on requirements practice. It provides recommendations for an analytic orientation that might prove useful for understanding the nature of work in organisations, to allow analysts access to the details of work practices as participants themselves produce and recognise these practices. It is a principal argument of this thesis that attendance to the details of the ways in which participants produce activities for others in the domain is critical for informing system design appropriately, and can lead to more sensitive designs for supporting work. We illustrate how these details impact on design in Chapter 7.

## 2.2 Towards the Social in Requirements Engineering

Requirements engineering became established as a distinct area of investigation and practice in the mid 1970's, at a time when software engineers began to recognise that errors produced at the early stages of development resulted in, at best, more costly maintenance of software systems and, at the very worst, complete rejection of them (Bell, 1976; Boehm, 1981). Thus, a sub-field of software engineering was conceived, namely requirements engineering, that was primarily concerned with developing models, techniques and tools to deal with these issues. Historically, within software development, the term software engineering was introduced to reflect the perceived need for an engineering approach to enable control of the process. This approach was also viewed as desirable for the individual stages or processes within the development of software; hence an engineering approach to requirements was also adopted. This perception of software development as a sequence of processes is reflected in other engineering fields, for example manufacturing, where the product is also developed in a systematic and structured manner (Loucopoulos and Karakostas, 1995). As the field of requirements has matured and research provides more understanding of software practices, various models of the software development lifecycle have been produced that focus on different aspects of the process; however, most models differentiate between certain practices. These include:

- determining requirements for the system resulting in a specification that documents the needs of customers and users of the proposed system;
- defining the system boundaries and information utilised in the interaction between the system and its environment;
- determining an architectural, high-level view of the system's internal design;
- designing the individual components of the system;
- implementing the components that actualise the original requirements.

Though certain process models may suggest that these are distinct phases, in practice this is often not the case. Thus, for example, the process of determining requirements is often considered to be confined to one particular early stage of the software lifecycle, preceding design construction and use. However, in practice, requirements have been found to evolve throughout the lifetime of a system's development and even on into use and maintenance. This has led to a recognition that the process of software development may become too inflexible if distinct phases are rigidly enforced.

Not all system development methods, however, emphasise requirements capture and analysis (cf. Participatory Design). Nonetheless, the majority of the system development industry recognises the requirements phase as a critical part of the process, where a specification is produced that may form the only contract between customers and clients regarding what a proposed system is to do. As this practice is likely to continue for some time in the future, this study is focused on the area of requirements engineering.

In attempts to define the research field of requirements, various descriptions have been proposed. Sommerville (1989) states that requirements capture and analysis is 'the process of establishing the services the system should provide and the constraints under which it must operate'. Goguen (1992) states that requirements are properties that a system should have in order to succeed in the environment in which it will be used. Davis (1993) suggests that requirements is the analysis, documentation and ongoing evolution of both user needs and the external behaviour of the system to be built. Pohl (1993) suggests that requirements engineering can be defined as the systematic process of developing requirements through an iterative co-operative process of analysing the problem, documenting the resulting observations in a variety of representation formats, and checking the accuracy of the understanding gained. These various definitions reflect the lively debates that continue in the field about the nature of requirements practice and the various foci of concern for research.

Over the last few decades within the field of requirements, research has been conducted into developing methods, tools and models, both to enable analysts to engineer a set of requirements to be met by a system, and to understand and control

the process through which this is achieved. The emergence of techniques for software development in the late 1970's, such as structured analysis methods, tended to focus analyses on the functional or behavioural aspects of the software system to be developed. Broadly speaking, this refers to the type of services the intended system would perform or, in other words, the process aspects of a system. These aspects included analyses of the functional transformation of data and models of dynamic behaviour.

As we discuss in Chapter 6, the most commonly used structured methods have been characterised as either classical or object-oriented (Sommerville and Sawyer, 1997). Fundamental to all classical structured methods is top-down functional decomposition and data-flow diagrams. In this model, data is seen to flow between functional processing elements. In contrast, object-oriented approaches support modelling entities in a domain as objects that have associated operations or methods. Structural models, illustrated by the Entity Relationship approach, are also supported by structured methods and describe the structure of entities in a system. Typically structured methods decompose the system into functional transforms and data flows and then develop the structural models, which are usually confined to modelling the structure of the data that is manipulated by the functional transforms. With object-oriented methods, the core activity is the development of the structural model which is the object model.

Within structured methods, techniques have been developed which differ in their approaches to aspects such as process design or structuring of stages. These include: Structured Analysis and System Specification (SASS) (DeMarco, 1979); Structured Analysis and Design Technique™ (SADT) (Ross, 1977; Ross, 1985); and Structured Systems Analysis and Design Methodology (SSADM) (Downes, 1988). These techniques were extended to address more dynamic aspects of embedded systems by Ward and Mellor (1985), and later these modifications were expanded into what is now known as Modern Structured Analysis (Yourdon, 1989).

Other types of techniques have been developed to deal specifically with what has been termed non-functional requirements, which include aspects such as ease of use, portability and reliability; in practice, however, the distinction between functional and non-functional requirements is often unclear. Methods became divided between those that dealt with 'hard' technical issues focusing on system functionality, and 'soft' issues where the determination of non-functional requirements was viewed as a more subjective enterprise. In addition, various methods have been proposed from other disciplines that can be applied to the design of computer-based systems. Soft Systems Methodology developed by Checkland (1981) from a Systems Science background, adopts the view that reality is inherently too complex to be adequately understood by decomposing it into constituent parts such as functions or objects. Thus, this method attempts to take a more holistic approach, and, by using the language of Systems

Theory, and drawing on different participants' viewpoints of proposed computer systems, attempts to present a framework of ideas that allows a number of conceptual systems to be identified and assessed. In this respect, Soft Systems Methodology has been proposed as a basis from which to proceed with data analysis for requirements engineering (Lewis, 1994). Probert (1999) argues that 'One clear aim of using SSM in this respect is to empower the workforce to make a greater contribution to the engineering of the requirements than (it is assumed) can be achieved using structured methods such as SSADM' (p.85). Whether or not this is possible (and Probert argues against such an assertion), there is an increasing awareness that in some domains, neither classical nor object approaches have been successful (Sommerville and Sawyer, 1997). As it became recognised that computerised systems interact not only with other engineered artefacts, but also with people and organisations, it was found that methods that focused mainly on functional requirements often resulted in computer systems that could not support the ways in which the human parts of the work system were organised (Dobson et al., 1994). In attempts to compensate for the perceived deficiencies of techniques focusing solely on system functionality, techniques and methods from disciplines and orientations that focus on more social and/or organisational aspects have been adopted and developed.

One of the most significant influences has come from research in the early 1940's and 1950's looking at both social and organisational issues in relation to technological development, focusing on the link between the technical system of production and the social system of work. The socio-technical systems theory as it became known (Trist, 1971; Trist and Bamforth, 1951) held the view that technological production methods that undermined social activity were necessarily problematic. Although the original emphasis of socio-technical analysis was on organisational choice at the time that technology was introduced, it has since been widened to allow worker participation in making choices among existing technical solutions. Mumford (1983; 1986) has extended the socio-technical approach into the now well-known method for system design, ETHICS (Effective Technical and Human Implementation of Computer Based Systems). This approach attempts to unify concepts such as user needs, participation, organisational structure, and job design. In classical and object approaches, users, managers and other customers are involved in the process to the extent that they are viewed as sources of information for the requirements engineer to understand the problem domain. Their views are elicited through the use of questionnaires, interviews and, sometimes, observation of the work system. In contrast, socio-technical approaches encourage users to actively participate in the decision-making process, and their ability to participate effectively may be determined by both the structure of the design team as well as the techniques used to allow their views to be incorporated. The structuring of such teams forms a key part in many of these approaches (See, for example, Eason, 1988; Macaulay, 1993; Mumford, 1983;

Mumford, 1986). This issue of how best to support user participation in design activities has a long history of research in Scandinavia, from the development of organisational democracy based on workgroups initially commencing in experiments in Norway (Emery and Trist, 1969) and later extending into Sweden and Denmark (e.g. Ehn, 1988). The research area of Participatory Design (PD) (e.g. Greenbaum and Kyng, 1991; Kuhn et al., 1992; Muller and Kuhn, 1993) is concerned, in part, with developing tools, techniques and theories to support the key aspects of the different activities of users and their contributions to design. For example, in Germany researchers have endeavoured to develop an orientation to software development that incorporates a partnership view of users (cf. Floyd, 1987; Floyd, 1992).

Specifically in the area of requirements, various researchers following in the socio-technical tradition have attempted to adopt a wider view beyond that of modelling functional requirements. As Loucolpoulos and Karakostas (1995 p.79) state,

The current thinking in the area of requirements engineering is that requirements need to be articulated in the framework of 'real world' knowledge which provides the purpose of the intended system as well as the knowledge about the phenomena common to the enterprise and system domains.

Thus, enterprise modelling attempts to describe, in a relatively formal way, the context within which the planned system will need to operate (Bubenko et al., 1994; Nellborn and Holm, 1994). Typically, such models will include: organisational structures; objectives and goals; activities, processes and products; and work roles and responsibilities. Methods such as ORDIT (Dobson et al., 1994) consider that organisational requirements come from the system's place in a social context rather than from functions to be performed or tasks to be assisted. The sources of such requirements may be power structures, values, and ethics, and are critical to the approach. However, as such information may not easily be articulated, there is a need for them to be debated explicitly. The main purpose of such modelling is to enable designers to reason about organisational goals, policies, roles and responsibilities and make links to requirements. Other researchers take a multiple view to enterprise modelling and see the activity as one that allows better convergence on functional and non-functional requirements (Bubenko et al., 1994; Nellborn and Holm, 1994; Yu, 1993; Yu and Mylopoulos, 1994).

Similar approaches, drawing on a semiotic viewpoint (Stamper, 1994), suggest ways to determine significant semantic features of an organisation that rely on consensus amongst relevant participants or agents. The MEASUR approach focuses on the notion of an organisation as a norm system, where norms are identified as the defining elements of organisations from which information requirements flow as a logical consequence. Norms represent behavioural options that are socially determined and dictate what should be done when various situations arise. This

method is considered to empower users by providing tools for solving problems that generate requirements specifications as a by-product of solving business problems.

### **2.2.1. Organisational approaches**

The previous orientations attempt to address an apparent limitation of structured and object approaches by incorporating analyses of the social with technical concerns. In various different ways, each attempts to take into account the context within which the proposed system is to be embedded. Though such an endeavour is quite a radical shift in analytic focus for software engineering, the methods nevertheless draw upon quite conservative approaches within the social sciences and organisation theory. To illustrate, we might consider perhaps one of the most pervasive views of organisations that sees them as structures divided into parts that are ordered hierarchically, reflecting lines of command and control. Individuals in an organisation perform tasks assigned according to a strict division of labour. This perspective emerged towards the end of the nineteenth century as expanding markets, larger and more complex factories and the growth of a new engineering profession led to a need to rationalise the workplace and its management through systematising the administration, control, production and planning of factory work. In response, several theories influenced by the prevailing ideology of scientific rationalism, conceptualised organisations as systems which could be designed to maximise their efficiency. Classical Management Theory and Scientific Management were typical of these theories and still influence modern management techniques. To take one as an example, Classical Management Theory (Fayol, 1949; Mooney and Reiley, 1931) focuses on the design of the total organisation, viewing it as one structure divided into interdependent parts or functional departments, each of which is characterised by a pattern of precisely defined jobs. These jobs are organised in a strict hierarchical fashion, with designated lines of authority from superior to subordinate. Because the authority relationships are so clear cut, they can be represented in an organisational chart which captures the structure of the whole organisation.

These structural theories of organisations have attractions for system designers and, in particular, for requirements engineers who will be attempting to discover the structure of a domain and to determine the functions a system is to perform. Analysts may draw on such structural views of work when informing the design of new systems to support workplace activities, and may view work practices as a division of labour between users, assigning each individual a role and allocating tasks to that role. However, the eventual design of systems utilising the specification of roles and the allocation of tasks to roles may prove too inflexible for use. For example, Cosmos (Cosmos, 1988; Wilbur and Young, 1988; Young, 1988), a multi-authoring system that associated pre-defined roles with pre-specified tasks, was viewed by users as too rigid to use (Bowers and Churcher, 1989). Once roles in the system and their

associated tasks had been defined, they were impossible to change and new responsibilities that emerged as the system was being used could not be created. The apparent inflexibility of the Cosmos system may be partly due to the use of a particularly rigid conception of role.<sup>1</sup> Indeed, such a construct does not take into account the flexibility of a working division of labour where participants often perform aspects of each other's designated work depending on the demands of the moment. These in fact may occur more routinely yet are never acknowledged or operationalised explicitly.

The underlying assumption of these structural theories of organisations is that the actions of people can be rationalised and closely defined and, indeed, reactions to the rigid and dehumanising effect of such theories led organisational theorists to 'discover' the informal organisation. With the recognition of the importance of informal relationships in the workplace came the development of prescriptions for the organisation of work. It was suggested that workers should be allowed to participate in some decision taking, thereby giving them a degree of control over their working environment. It was also realised that efficiency can be gained by ensuring that technology and the informal organisation fit together harmoniously: hence the Sociotechnical Systems associated with the Tavistock Institute of Human Relations in the 1950s mentioned previously (Trist, 1971; Trist and Bamforth, 1951).

### **2.2.2. Naturalistic studies**

It seems critical for requirements engineers to consider how different approaches to the study of social and organisational life take account of the real world environment or the context in which the system will operate; what various orientations offer in terms of how to see into a domain, what to look for, and how to justify statements about that domain. There has been a tendency for analyses to rely on descriptions of work practices, for example through interviews, rather than looking at work as it occurs *in situ*. As has been frequently noted in social science texts, the characterisation of what people say they do, even with respect to informal work, may differ from what is observed. This has implications for requirements practice, where consequences for technological design are often drawn from such materials. As a major part of the requirements exercise is to understand the setting – the environment into which the system will be placed - it is necessary for practitioners to be aware of particular methodological problems associated with techniques that rely on descriptions of work practice (Hughes, 1990). Requirements engineers are often encouraged to rely on (un)structured interviews, questionnaires, verbal protocol and personal experience to elicit information about a problem domain. Such techniques are currently employed in situations where requirements specifications are produced

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<sup>1</sup> Carasik and Grantham (1988) report that the COORDINATOR system of Winograd and Flores (1987) was unpopular due to a similar rigidity in the way actions were defined.

with little or no access to the domain in which the system will eventually be placed. Recently, there have been a number of critiques of these elicitation techniques within computer science (Goguen and Linde, 1993; Luff and Frohlich, 1988; Luff et al., 1993), and within the social sciences where they have a long history of use. As stated previously, research has shown that the relationship between what people say they do and what they actually do is problematic. People may find themselves in situations that often change in unanticipated ways, and what may be said in an interview where people are divorced from the processes that can affect various courses of action may indeed change when they are in a particular situation that demands action (Hughes, 1990). In addition, the difference in accounts may occur not only because people have selective or defective memories, but because many activities are performed repeatedly and become tacit in nature; they are seen but not noticed.

Requirements practice has begun to take account of these difficulties. Rather than relying predominantly on approaches that encourage participants to articulate their understandings of the work they and colleagues are engaged in, practitioners may also focus on what activities are as they emerge and come to be *in situ*. Focusing on how work is achieved by participants may bring the two views, the communicative and the functional, talk and work, together in an analytic orientation to reveal aspects of work in interaction that may be unrecoverable from interviews, questionnaires and focus groups in general. Thus, analyses that reveal the tacit nature of activities may complement other approaches such as Participatory Design that encourage full user participation in co-operative prototyping exercises (Bødker and Grønbaek, 1991) or future workshops (Jungk and Mullert, 1987). Supplementing such exercises with analyses of work in interaction may help to provide a more systematic approach and warrant various requirements and design choices. Indeed, current research expresses a desire to understand the details of work practices in analyses (See, for example Grønbaek et al., 1997).

Generally, however, it seems that in attempts to focus the requirements exercise more on organisational issues, the methods and techniques have moved the analytic interest away from actual work activities towards a concern for involving various stakeholders and participants in the process itself. But the growing awareness that methods in requirements engineering take insufficient account of the real-world environment or context in which the system operates has resulted in researchers investigating other approaches from the social sciences that provide a more detailed analysis of work practices in organisations. Recently, there has been a turn towards naturalistic studies, such as ethnography, to inform the process of requirements capture and analysis, with a view to designing more effective systems to be used in the workplace. Naturalistic studies focus the investigation onto real-world settings, as opposed to experimental laboratory set ups or worked up examples; thus work is examined in its local context, rather than either elements being investigated in

isolation from the context of their production or scenarios based on experience or stereotypes. Naturalistic inquiry has shifted the main area of concern from people talking about their work removed from the event, to attempting to understand how people achieve their work in organisational settings. A basic premise of such research is that an orientation to particular aspects of work practice is critical for improving requirements practice and enhancing the results of the system design process, thus leading to more effective systems to support work. The potential of considering social practices has gained influence within software development, to the extent that proposals have been put forward to 'industrialise' ethnography and to suggest ways in which naturalistic studies can be integrated into the requirements process. For example, some researchers have focused on improving the communication between ethnographers and software designers, and suggested ways of making the process more systematic for example in terms of 'a questions and answers' approach, where a set of issues are developed for the ethnographers to pursue and explore with respect to explicit design concerns (Randall et al., 1994). 'Quick and dirty' approaches have also been suggested, that attempt to 'fit' the ethnographic orientation into the practical time constraints of software development projects (Hughes et al., 1994). These approaches also provide guidelines for conducting such studies and for structuring observations in such a way that may be relevant for system design. Hughes et al. (2000) describe a Designers' NotePad, a tool that aims to provide a framework for the analysis and presentation of the social organisation of work settings, and to allow a structured ethnographic record to be utilised for developing requirements and facilitating the exploration of different designs. The main perspectives taken on the sociality of work identified so far include: distributed coordination; plans and procedures; and awareness of work. These perspectives are then integrated with the notion of 'viewpoints' that provide a means of structuring the ethnographic material to allow for the eventual development of models for system design. These viewpoints include: representations of the spatial distribution of the workplace; a workflow viewpoint that looks at sequences of work activities and information flows and social and organisational viewpoints on work that may, for example, take into consideration particular views of participants.

Other approaches to investigating how the details of work practice can inform requirements and design focus on sets of case studies, using video and detailed fine-grained analyses to look at activities and objects to inform technologies to support collaborative work (e.g. Heath and Luff, 2000). Related research provides practical guidelines for requirements engineers on how video and fieldwork can be incorporated into the requirements process, and considers tools and technologies that may be made available for requirements analysts to access video-based fieldwork (Jirotko and Wallen, 2000).

There has been a recent shift in requirements analysis from methods that focus solely on structured approaches for determining requirements based on functions, objects or states, to those that suggest including various participants and stakeholders in the requirements process and encourage group discussion and debate. Potts and Newstetter (1997) characterise this shift as a change from a research paradigm that is founded in the philosophical tradition of positivism where a stable and knowable set of phenomena, be they requirements or facts about the world, can be discovered through systematic scientific investigation, to a more interpretative and qualitative understanding of social phenomena. Though such a shift has de-emphasised the analysis of the details of work activities, it has nonetheless brought the issue of process to the fore, focusing on how best to make the ‘fit’ between such techniques and software development practices. A key concern in requirements, as distinct from the social studies, has been to investigate how studies of what people do in the workplace and need from computer systems to do their work, can be transformed into the design of a new technology.

## 2.3 Human Computer Interaction

HCI is also concerned with developing user requirements for the design of interfaces. Thus a key concern within human computer interaction (HCI) is to understand the relationship between individuals and the activities they undertake on computer systems. Various proposals have been put forward for a systematic approach to conceive of this relationship. Early research focused on the notion of a dialogue between ‘man’ and machine (Martin, 1967) or as a ‘man computer symbiosis’ (Licklider, 1960). Much of the work at this time tended to focus on the physical properties of the systems, constraining the notion of the interface to the immediate properties such as its size and shape.

More recently, the relationship has been perceived more in terms of an interaction between a human and computer (e.g. Card et al., 1983; Monk, 1985), possibly downplaying the early focus on the linguistic aspects of computer use whilst emphasising a consideration of both the computer and human parts of the interface. Early research assessed the use of current technologies, by drawing upon various techniques based on human factors and ergonomics, such as experiments and trials. Such techniques could suggest where users could be having difficulties with the functionality of the system, or where aspects of the interface were confusing. Despite these techniques becoming an integral part of the testing process of a system, various concerns were expressed with the ‘human factors’ orientation to the study of human computer interaction. These concerns involved a recognition that the findings of these studies were often too specific to the system being investigated and, though various recommendations could be made from evaluations, it was often difficult to provide

strong warrants for them. In addition, as the process of evaluation occurred after the system had been developed, it was often difficult to have a significant effect on design. Various alternatives were proposed for addressing these issues with a focus on affecting the design process itself. Iterative approaches were suggested that would allow for more opportunities for assessing prototype systems, and thus increase the possibilities to influence design. In addition, more principled and systematic techniques were required, and led to the provision of general prescriptions and guidelines. These often included the investigation of such aspects as the motor skills needed to enter information using various devices (e.g. Card et al., 1978), or the readability of text on displays. However, though it may be possible to provide recommendations to designers from such studies, it is still not clear how applicable such recommendations may be to other tasks and systems. The role of guidelines and principles to be provided for designers is a matter of ongoing debate (Barnard, 1991b; Norman and Draper, 1986). The need to provide warrants for claims made from prescriptions for design, led to a requirement for a general framework by which one could conceive of the relationship between computer systems and individual users. This framework would provide a foundation from which to investigate activities of individuals that would provide information for the requirements and design of computer systems. The applied programme to emerge is known as User Centred System Design (UCSD), (Norman and Draper, 1986) or User Centred Design (Landauer and Nachbar, 1985). Studies were grounded predominantly in the analytic framework of cognitive science that provided analyses of an individual's use of a computer system in terms of mental processes. Drawing upon theories and experimental set ups, analysts were confident that the knowledge of the user that the findings revealed could then be used in system design. It is still a matter of debate as to how to conceive of the exact nature of the interrelationship between the study of computer use and design (Barnard, 1991a; Carroll, 1990) but, nonetheless, Cognitive Science has provided opportunities to ground design both empirically and theoretically. A key example of such a relationship is seen in the development of a model that reflects a mental model of the user ('user model') (Norman and Draper, 1986). Thus the first step is to develop a model of computer use drawing on the research of mental processes in Cognitive Science. Usable systems are then designed through mapping tasks performed at the interface to mental processes.

Models, processes and techniques have been developed, grounded predominantly in Cognitive Science, in an attempt to provide systematic ways of designing and evaluating systems so much so, that this has pervaded not just the interface and input and output devices, but within UCSD the whole system was required to be developed to support the user. From the outset, designers have to consider user requirements for the development of computer systems, and design the system according to the capabilities of the user. However, within the field of HCI, it has been suggested that

even this definition is too narrowly constrained, and various critiques have suggested that these studies have utilised the wrong conceptions of activity that lead to systems that are essentially too rigid in use (Carroll, 1991; Luff et al., 2000a; Suchman, 1987a; Winograd and Flores, 1986). This narrow view of HCI has implications for requirements engineering, in that focusing on individuals may constrain the requirements analysis, and consequently affect the type of requirements that are elicited. This narrow focus misses important issues about the way in which work is produced for and coordinated with others.

We discuss, as an example, Suchman's (1987a) influential critique of an intelligent system to support the use of a complex interface to a photocopier. This expert system was designed with the aim of providing users with appropriate and relevant help when using the system. Assistance was based on trying to map the user's accountable behaviour, made available through sensors and buttons on the machine, onto a plan. So, for example, the system could detect what state a user was in, and what possible difficulties a user might be having. It would then interpret this information by relating these states with plans, assume what users were doing and how they needed help, and give information appropriate to that state. Suchman's analysis revealed critical problems in the design of such systems but, more importantly it revealed uncertainties regarding the conceptions underpinning the design. These conceptions were that users have goals and plans when undertaking certain tasks, or had plans of the kind represented by the system. From the various inputs to the system, the system could detect both what the plans were, and then suggest help which would allow people to follow the next task in the plan. An assumption was that the sensor could provide this information; a further assumption was that there is a notion of a stable plan. Most importantly, the instructions themselves were used as a resource by individuals, and the way these instructions were interpreted transformed what users did. Thus the stable conception of a plan was misconceived. Designers neglected the contingent nature of the activity that users' actions were situated in relation to the ongoing activity. In particular, users interpreted the instructions from the system in relation to the local context. This included the previous states of the machine, and also activities that were inaccessible to the system, such as users' talk with colleagues, that were relevant to the use of the system.

A more recent analysis of technology by Whalen and Vinkhuyzen (2000) has echoed Suchman's concerns with systems that incorporate and misconceive users' activities. Whalen and Vinkhuyzen have also investigated an expert system in use for call-taking personnel. This system gave advice on people's problems regarding photocopiers, and provided the call taker with assistance to answer callers' queries. Their analysis reveals that the technology did not take account of the interactional context of the call. The system ignored the practical problems personnel had from moment-to-moment, for example having to answer a particular question from a caller.

The system was not sensitive to immediate demands from callers, but also did not take account of the moral and social obligations of having to deal with turns of talk. It could not deal with issues callers explicitly raised, matters which any competent conversationalist could deal with appropriately.<sup>2</sup> For example, the system made seemingly obvious suggestions to the user, given what the caller had previously said, and asked questions that did not seem to be addressing the immediate topic of concern.

Suchman's critique has suggested that the original focus of research on the individual user in HCI may be too narrow. But, more critically, it has also questioned the appropriateness of characterising the interaction solely in terms of the user's cognition. This critique has led to a body of research that utilises a range of analytic orientations that adopt a wider conception of computer based activities. These include Activity Theory, Distributed Cognition and Course of Action Analysis, which are discussed in more detail in Chapter 3<sup>3</sup>.

This research is still at an early stage of development. Indeed, much of the research in HCI has been concerned with developing techniques for understanding user requirements, but remains focused on the individual user's needs. The focus of these studies may be too narrow, and has led to suggestions to broaden the analyses to incorporate social and organisational issues. This has raised concerns regarding the reliance on predominantly psychological and cognitive conceptions of users' actions and interactions with the computer. This shift towards conceptions of the social has profound implications for researchers considering user requirements, in terms of the issues they consider, such as how common notions used in design, like task, plan or activity may be conceived, and the methods that are used to explore these issues.

## 2.4 Computer Supported Cooperative Work

Technological developments in networking, telecommunications and novel applications that provide the infrastructure for applications such as email, desktop conferencing and the Internet have laid the foundation for being able to support the ways in which groups and individuals collaborate. With the emphasis on supporting people collaborating, it has become most obvious that designers need to take account

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<sup>2</sup> Similarly, Greatbatch et al. (1993) have shown how even the design of apparently simple personal computers in the medical domain have neglected the features of interaction between the doctor and patient.

<sup>3</sup> Theoretical and conceptual debates surrounding cognition in HCI are reflected in other studies concerning the use of methods in cognitive science for usability engineering. For example, (Bellotti, 1988) examined several cognitive modelling and usability methods utilised by practitioners in industry and found that these methods were not used as intended, if used at all.

of social and organisational issues. Yet, as new forms of technologies emerge, the requirements for them become less clear.

Such requirements are a particular focus in the field of Computer Supported Cooperative Work (CSCW), where researchers have been considering systems to support individuals and groups collaborating. Initially, this area was concerned with developing systems to support such activities as meetings, carrying out real-time tasks over the network such as shared drawing, or enabling asynchronous tasks like collaborative document production. The design of such systems forces attention on issues such as interpersonal communication and coordination, and on how these are mediated by and may be assisted by computer technology. Thus requirements for these systems are concerned with how people co-ordinate action, how various aspects of people's work are made relevant to others, and how to manage interactions such that one type of activity would not interfere with another. Early research focused on aspects of computer-mediated communication (e.g. Bowers and Churcher, 1989; Winograd and Flores, 1986); group behaviour when interaction is through a computer network (e.g. Bikson and Eveland, 1990; Finholt et al., 1990); and methods of managing interaction between participants (e.g. Greenberg, 1991; McCarthy et al., 1990) all of which noted the significance of social context. It was also clear that the development of these tools required a fundamental understanding of how people work and interact. Galegher and Kraut (1990) suggest that the relative failure of the early systems derived from their insensitivity to what we knew and what we know about social interaction in groups and organisations.

The recognition, that the failures of technologies may be related to our lack of understanding of how individuals and groups do their work, has led in part to the development of a set of studies known as Workplace Studies. These studies examine the use of technology in complex work settings, and their aim is "to respecify technology with regard to human practice and social organisation" (Luff et al., 2000b). These studies focus on a range of settings, including airport control rooms (Goodwin and Goodwin, 1996), air traffic control rooms (Harper and Hughes, 1993), lawyers' practices (Suchman, 2000), transport control rooms (Heath and Luff, 1992a), medical general practices (Greatbatch et al., 1993), financial dealing rooms (Heath et al., 1994-5; Jirotko et al., 1993) and software design activities (Button and Sharrock, 1994). Typically, they look at various aspects of work activities that include: the mundane use of artefacts such as flight strips in air traffic control and paper documents in medical practice and legal work; how various public displays and monitors are used and their interrelationship with talk to make sense of the activities of others in the setting; and they examine certain common sense practices such as annotating and marking documents (Suchman, 2000), organising and sequencing

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work (Button and Sharrock, 2000), and the practices by which formal procedures are shaped with respect to local circumstances (Anderson et al., 1989). A common concern of these workplace studies is to reveal how people manage their everyday work given the various organisational demands on them, and what the common sense practices are that make up that work. By examining what appears at first to be routine, these analysts attempt to reveal the ‘tacit’ practices through which work and interactions are accomplished; work that is seen but unnoticed (Suchman, 1995). Thus these studies attempt to reveal what Garfinkel has termed the *haecceity* of the work, the accountable here and now presence of things. As Lynch (1993) states *haecceity* means the ‘just thisness’ of an object that points to an indexical “making of meaning”(p284).

Within CSCW a major concern has been how workplace studies can inform requirements practice, and the development of systems that better fit the ways in which individuals and groups collaborate. In attending to the details of work and how the features of an individual’s everyday activities are produced collaboratively, workplace studies have provided various recommendations for the design of systems to support collaborative work. They have had some relevance to system design through informing a set of prototype systems, for example supporting collaboration either by providing awareness for other’s activities (e.g. Fuchs et al., 1995; Gutwin et al., 1996; Prinz, 1999) or assisting with referencing to items and coordinating actions (e.g. Benford and Fahlén, 1993; Kuzuoka et al., 1994). In addition, workplace studies have informed the design of Media Spaces (Gaver, 1992), electronic settings that allow groups of people to work together even when they are not co-present. They use audio-visual networks that allow views of the head and shoulders of other individuals in other offices. Analyses of people working through these media spaces revealed that the focus on the head and shoulders did not support activities that people were attempting to perform. Drawing on these findings, in conjunction with analyses of workplace settings, Heath et al. (1997) suggested requirements to redesign media spaces to support the actual activities people wanted to perform through these electronic settings.

Collaborative Virtual Environments (CVEs) are virtual worlds that allow representations of various individuals, and have also been informed by workplace studies. Collaboration is with avatars or with embodiments of others one interacts with. Recent experiments attempt to provide resources for collaboration through body orientation and pointing. Thus researchers are providing ways for maintaining the relationship between an avatar and the object it is acting and interacting with, and allowing others in that world to be aware of this relationship (Hindmarsh et al., 1998).

Some workplace studies have provided very particular recommendations for requirements. For example, Greatbatch et al. (1993), from studies of medical consultations, have suggested recommendations for the organisation of screens for

systems for medical practice. Whalen and Vinkhuyzen (2000) have suggested various resources for systems for call takers, and Bentley et al. (1992) have provided suggestions for the organisation of screen displays for air traffic control. Other studies have provided more general requirements for collaborative systems, such as Heath et al. (1997), that include such recommendations as providing support for the seamless transition between individual and collaborative tasks, and supporting the way activities can be accomplished in relation to material objects and artefacts.

The recommendations for system design that emerge from these workplace studies have not necessarily been systematically derived, but are rather driven from the analysis of the setting. It seems that recent developments in technology promote the key research within CSCW. In this respect, it seems similar to research in HCI that was tied closely to developments of new forms of technology, such as Graphical User Interfaces and personal workstations. In contrast, CSCW has drawn largely from a social perspective, whereas HCI has been influenced from a psychological orientation. But in both there is an interest in relating the analytic orientation of the study to design. The relationship between the study of a setting or activity on the one hand, and the design of a system to support it on the other, remains a key concern and one that may need to be resolved for requirements engineering.

## 2.5 Discussion

In recent years, in the three areas of HCI, CSCW and Requirements Engineering, research has had a convergence of interest in understanding social and organisational issues through naturalistic studies. In requirements engineering, there is a recognition that analysts must understand an organisation before developing requirements for systems to support work for organisational members. Within HCI, there is a change of focus from interaction and the individual user, to seeking to understand the user in context. CSCW retains its interest because individuals and groups collaborating seems to lie at the heart of developing requirements for systems to fit into particular domains. However, the relationship between the observations that result from naturalistic studies and the requirements process remains problematic. In CSCW, Plowman (1995) expresses concern, for example, on the nature of the recommendations, as to how such studies may fit with the design process. Jirotko and Wallen (2000) question whether robust features of work practices revealed by workplace studies can be utilised to conclude either that these features *should* be preserved or that they *will* be preserved when new technology is introduced. These issues are fundamental to the requirements exercise. Barnard (1991b) and Carroll (1991) have raised this issue in relation to HCI as the problem of relating basic and applied science. This has been characterised as a need to understand what should be conveyed from fundamental theories within cognitive science to actual practices of

design. Furthermore, consideration must be given to developing appropriate ways of conveying these theories. Communication of these theories to designers may occur on various levels, including: in providing design recommendations, for example, a menu should have a certain amount of items; principles or guidelines; or, in the most fundamental form, at the theoretical or conceptual level. This could be done in terms of models that can reason about cognitive ability (Barnard, 1991b).

This may also be relevant for considering how studies of social practices and organisational work can inform system design. If interest lies in the complex detail of work practices provided by fieldwork studies, a major consideration must then be how to preserve this richness when communicating effectively to designers. It is necessary to explore how to convey collaborative indigenous practices and provide analysts with a sense of this richness, when these practices rely heavily on the use of documents or various configurations of the local environment. Ways can also be devised to make this information available to design. Reflecting Barnard's concerns, we may consider whether such information should be communicated in terms of presenting findings or through structured forms, packaging the results in some pre-specified form, or whether theoretical or conceptual concerns should shape design practice.

This may be reflected in studies where naturalistic analyses might seek to influence the very structures and objects utilised in computer science itself (Dourish and Button, 1998). As Dourish and Button suggest, the foundations for a relationship can be driven by an understanding of the nature of social action drawn from a particular orientation that looks at common sense reasoning. In their research they describe a familiar aspect of graphical desktop environments, the file copying scenario, that provides an account to users of what it is doing for them. These accounts can provide information to users about what may have gone wrong in the copying process, and thus increase the potential for the user's decision making. Such an approach may be suited to providing tools and techniques for users for practical purposes. However, this work is still in the early stages and it is unclear what the implications of such an approach are. Chapter 8 discusses this research in more detail.

It may be the case that there are more straightforward ways to proceed in conveying the information from naturalistic studies to software designers. Current research attempts to identify what aspects of these studies are most relevant to assist engineers in getting their work done. One approach has been through the development of structured tool support, as in the Designers' NotePad mentioned earlier. Others have focused on the use of semi-formal and formal modelling to convey naturalistic analyses (Goguen, 1994; Viller and Sommerville, 1999). This critical issue of how to model the details of complex activities is discussed at length in Chapter 6.

Essentially, this involves a consideration of what it is that is necessary to communicate to designers. The study of a domain is often taken as unproblematic in

many requirements methods and techniques, with little guidance on how to identify relevant features for analysis. However, the issues of how to see into a domain, what to look for and how to justify or warrant statements made about that setting, are not at all unproblematic. Given a set of observations from a naturalistic study, a critical issue for the analyst is to know how to assess the relevance of statements made about the domain. One way is to interpret observations through a framework of categories such as 'norms', 'meanings' and 'rules' that have been selected prior to the study. However, given the multifarious categories that may be utilised for understanding conduct, the question remains as to how a particular framework to be applied to the data may be warranted. It is unclear how such preselected categories relate to the categories used by the participants themselves, or even whether they are relevant to the ways in which the participants understand and organise their conduct.

In recent years, several orientations have attempted to reflect the relevance of analysis of the meanings and interpretations that participants give to their own actions and the actions of others. This analytic orientation suggests that individuals rely upon a common set of resources for producing social actions and rendering their actions intelligible for practical purposes. As Heath and Luff (1992b p. 311) suggest,

these resources, this common sense knowledge and practical reasoning, which forms the foundation to social life is systematically masked, taken for granted, 'seen but unnoticed'. These resources are unavailable to unguided intuition, introspection or theoretical imagination, but as Garfinkel (1967) and Sacks (1992a; 1992b) demonstrated, they can be made accessible through the detailed, case by case analysis of *in situ* conduct.

This orientation is potentially relevant for requirements engineering where, to the extent to which the putative system will interact with or affect work practices, the requirements engineer requires an understanding of the social organisation of the domain. Currently, in requirements practice, there is little provision for analysts to give warrants for particular analyses of domains. Standards may require that certain requirements can, for example, be traced to their sources of origin (such as government white papers or system level requirements). However, requirements engineers, at present, have few resources through which to ground and warrant their analyses of work. Such information may be crucial for understanding at a later date as to why certain design features were or should be incorporated. Thus, techniques for warranting analysis can provide a justification for the role technology of all sorts plays in the creative achievements of people at work, as well as the investigative biases set up when seeking such information in the first place.

An orientation that reveals participants' common sense practices through analyses of their conduct and views work as an achievement suggests that events, actions and objects in the real world should be treated as practical accomplishments, organised by the members who are party to these events. Work is accomplished through interactions with others, as they coordinate a range of activities and make use of

different tools and resources. These events, actions and objects are then seen as depending upon a social organisation which provides for a publicly available set of practices and reasoning. Often routine performance of activities in organisational environments 'rests upon a complex configuration of tacit knowledge and reasoning, skills and procedures' (Heath and Luff, 1993, p.5). In this sense, these practices are available for scrutiny, not only to colleagues and other individuals in the setting, but also to the analyst, who can then 'reveal' these details in the investigation. Such a naturalistic approach to looking into a domain can be contrasted with techniques suggested by requirements methods described in previous sections, where analysts' preconceptions of a domain and their understanding of the ways in which work is accomplished often determine how the analysis proceeds.

Similarly, traditional techniques used in requirements analysis do not provide access to the interactional organisation of activities. Many seemingly individual tasks are accomplished in collaboration with others, and more 'traditional' methods do not give the analyst access to information about the ways in which work activities are coordinated to this level of detail. Naturalistic inquiry can allow examination of the location of a particular activity within a developing situation; that is, the analyst can consider the sequential development of that activity with respect to the previous actions. As outlined in Chapters 4 and 5, such an analysis can reveal how each action displays a participant's understanding of the prior action, and how the next action displays an understanding of the current action. This kind of orientation can provide a basis for requirements engineers to analyse how it is that people do certain activities, and offers the opportunity to warrant their observations in a systematic way.

There has been a growing awareness in requirements that there is a need to increase our understanding of the social nature of work in organisations, in order to provide designers with an orientation to the details of work practice that are critical to informing system design appropriately. This echoes research in CSCW and HCI, where a body of naturalistic studies have been undertaken, and is beginning to inform the requirements for individual and collaborative systems. Attendance to the social and collaborative nature of work sets up a series of problems in considering an appropriate framework for analysis. This includes considering quite carefully how to transform naturalistic material to make it relevant for requirements practice and system design. Though there may be several ways of accessing this information for design, a particularly promising approach lies in detailing work practice in terms of the participant's own conduct, rather than on *a priori* categories of the analyst. These details of the ways in which participants produce and render their actions intelligible for others in the work setting may then be used as resources for requirements practice to develop systems that resonate these practices. This is not to say that systems should reproduce current working practices, but rather that there are consequences of failing to take the context in which various activities are accomplished into account, and

problems may later emerge in the development and deployment of systems that might have been avoided.

## 2.6 Summary

In this chapter we have looked at three different areas of system design that have recently recognised the need to consider and incorporate social and organisational issues in analyses. Requirements engineering, with its need to understand the problem domain and develop systems based on that understanding, has traditionally focused on eliciting requirements from descriptions of work practices through techniques such as interviews, questionnaires or focus groups. A growing recognition of the difficulties of relying on these techniques has turned attention to naturalistic analyses, to understand how work is produced *in situ* and from the participant's own understandings, rather than from a set of categories determined *a priori* by the analyst. Analyses may reveal the tacit nature of activities that may be unrecoverable from interviews or questionnaires. A major concern has also been to determine appropriate ways to convey this information to requirements analysts, so that it may inform the design of systems to support work practices; we have described some of the main approaches proposed by research in this area.

Human Computer Interaction has a longstanding concern to undertake systematic analyses of an individual's activities as s/he uses a computer system and, from these analyses, to determine user requirements. Various models and techniques, such as User Centred System Design, have been grounded predominantly in Cognitive Science. Recently it has been suggested that such an approach to understanding human computer interaction, where the focus of research is on an individual user, is too narrow and consequently constrains the user requirements arrived at from the analysis. Researchers are now attempting to incorporate social and organisational issues, but this has raised concerns regarding the psychological and cognitive conceptions of the user's activities in the methods and techniques predominantly used.

The requirement to support groups of individuals collaborating through computer systems has led research in Computer Supported Cooperative Work to focus on increasing our understanding of how individuals and groups achieve their work. Workplace studies have examined various settings, with a common concern to reveal the details of everyday work practices and how they are produced collaboratively. The findings of these studies have provided recommendations for the design of various systems such as media spaces, collaborative virtual environments or call-taker systems. However, these recommendations have not been systematically derived, but have been driven from the analysis of the setting.

The issue of how to identify relevant features in a workplace setting for requirements analysis is discussed, pointing to the need for an analytic orientation that reflects the meanings and interpretations that participants in a setting give to their own actions and the actions of others. Revealing the ways in which individuals produce social actions, and rendering those actions intelligible to others for practical purposes, provides a means for requirements to ground and warrant their analyses of work. This may be critical in providing justifications for particular design decisions later on in the development process.

The converging interest in naturalistic studies from Requirements, HCI and CSCW points to a need to consider the organisation of the social, and to develop suitable techniques to facilitate the communication and understanding of the details of particular domains. Whether this is a matter of transforming the existing analytic orientation, creating a hybrid approach, or developing a novel method is still a matter of debate. The following chapter will consider the question of method more closely, and discuss in detail a particular analytic orientation that we argue can provide a useful starting point for requirements analysts to investigate a work setting.

# Chapter 3

## Naturalistic Analyses and the Context of Technology

### 3.1 Introduction

Observation of work activities in organisational settings is an intrinsic part of a number of requirements methods that attempt to provide analysts with a way of understanding a problem domain. In recent years, naturalistic studies of work practices that originated in the social sciences have become attractive to designers of technology. This is, in part, due to a recognition that failures of computer systems may be attributable to a lack of understanding of the complex detailed ways in which people work and coordinate their activities. Naturalistic studies of work practices produce descriptions of the rich interrelationships between work activities and technological artefacts. These descriptions and the techniques utilised in their production are potentially usable by system designers to understand existing domains through their technological and organisational elements. Some researchers have claimed that the design of various systems risk ‘inadvertently destroying many of the most valuable aspects of current ways of doing things because we do not understand how they work’ (Hollan et al., 2000). Providing designers with a deeper awareness of work practices may improve the process and product of requirements analysis, and thus lead to better and more efficient systems to support work in organisations.

This chapter summarises the approaches to naturalistic studies of work settings and their relevance for determining requirements and design for technological systems. Section 3.2 discusses naturalistic analyses in general, and emphasises the importance of an analytic orientation for shaping research and fieldwork. Particular analytic orientations are then further elaborated. Section 3.3 summarises the predominant psychological approaches to such studies and discusses Distributed Cognition and Activity Theory in particular. Section 3.4 describes the sociological research traditions of ethnographic studies emerging from the work of

Everett Hughes and the Chicago School, Symbolic Interactionism and the Social Construction of Technology. Though many of these approaches have made very valuable contributions to system design in terms of deepening our understanding of the complex and subtle nature of workplace activities, we argue it is perhaps the ethnomethodological orientation in particular that seems to offer unique resources to system designers. Section 3.5 discusses in detail the ethnomethodological orientation and the cognate approaches of conversation and interaction analysis. We argue that this orientation provides a starting point for requirements engineers to investigate the details of work activities in their local context, whilst providing a warrant for analyses through the sequential organisation of talk and visual and bodily conduct. We draw on these resources when analysing work practices in the financial dealing-room settings. Section 3.6 summarises the approach used in collecting materials, the types of artefacts collected, and what methods were used for this thesis. We then provide a brief outline of how these may be transformed to be relevant for design. Such issues are then discussed at length in Chapters 6, 7 and 8.

## 3.2 Background

In recent years a series of failures and disasters have emphasised the difficulties of developing computer systems to support complex organisational activities. Two significant examples of such disasters in the UK, the collapse of the Taurus system for the London Stock Exchange and the widely publicised case of the deployment of the Computer Aided Dispatch (CAD) system into the London Ambulance Service, have not only caused grave concern regarding the viability of such systems, but have also brought to public attention the ways in which advanced technologies may be failing to support routine working practices. As mentioned in the previous chapter, recent debates have focused on the ways in which computer systems are not designed appropriately to ‘fit’ the way people work (Landauer, 1995; Norman, 1988; Norman, 1993; 1998). In attempts to design systems that provide such a ‘fit’, and hence increase the probability that they will be used more effectively, system designers and researchers have begun to seek more appropriate and innovative approaches to understand the problem domain. As a result, system designers have become increasingly concerned with developing an understanding of the working practices of users and the organisational context in which the technology is deployed. Thus, we find a move towards the use of naturalistic or qualitative methods and techniques in the early stages of design, where analysts gain access to various work settings and observe the work practices of people in organisations.

However, observing what it is that people are doing in the work setting is not a new practice for system design. There is a longstanding tradition within system development of conducting observational studies, for example, in task analysis, where the overall work is broken down into its component tasks (e.g. Kirwan and Ainsworth, 1992), and in HCI where researchers have analysed sequences of tasks in order to establish a semantics or grammar of activities (e.g. Payne and Green, 1986). Similarly, methods within requirements engineering also suggest that analysts should observe the working environment in order to get a sense of the work practices and objects in the setting. After all, various object-oriented approaches (e.g. Booch, 1991b; Coad and Yourdan, 1989; Yourdon, 1989) recommend observation of activities in the workplace, even the taking part in work activities; from this field work, they suggest that the objects that are relevant to the requirements analysis can be determined. This has led some researchers to question whether in fact requirements practitioners may actually only need better fieldwork or observational techniques (Anderson, 1994). However, Potts and Newstetter (1997) claim that a more significant shift may be needed within requirements engineering. They suggest that in fact conducting naturalistic analyses is fundamentally anti-positivist, and thus does 'not align with conventional RE practice' (p.119). They argue that most RE practice proceeds from a research paradigm founded on the philosophical tradition of positivism 'which construes knowledge as accruing through the systematic observation of stable and knowable phenomena' (p.118), whereas naturalistic inquiry looking at people's actions and work practices proceeds in a more interpretative manner. The problem of interpreting human conduct is complex and the subject of deep seated debates within the social sciences. Indeed, as Heath and Luff (1994, p.2) argue,

unlike other 'phenomena' which may be subject to analysis using various forms of methods drawn from the natural sciences, human beings act on the basis of meanings they attribute to their own actions and the interpretations they make of the actions of others.

Various methodological frameworks have emerged within the social sciences that 'attempt to conceptualise the collective bodies of interpretation and understanding that particular categories of individuals develop in engaging in certain forms of conduct' (p.2). Because these various approaches all utilise observation in the field, it has been argued that where analysts are attempting to understand the nature of work practice for system design, it is not solely a question of providing better or more sophisticated observational techniques. Rather, there is a need to recognise that observational techniques are utilised within an analytic orientation that may guide what is attended to in the domain and how it is interpreted for analysis (Button and King, 1992).

Naturalistic studies are qualitative in nature where ‘findings are not arrived at by means of statistical procedures or other means of quantification’ (Strauss and Corbin, 1990 p.17). The various approaches to qualitative research all share a commitment to systematic inquiry in a natural setting, as opposed to one that is artificially constrained such as an experiment (Marshall and Rosman, 1989). An important justification for researching people and their activities in their natural environment lies in a recognition that the researcher cannot know in advance what the relevant features of a setting might be. This may be contrasted with common techniques in system design, where often in experimental situations or from semi-structured interviews or focus groups researchers formulate categories and hypotheses of individuals’ conduct *a priori* to the investigation. These categories are then used to account for various activities and actions. As Heath and Luff (1994 pp. 4-5) argue,

the relationship between the user's conduct and certain variables is often asserted statistically, and in itself provides no firm foundation for believing the ways in which the researcher categorised the actions and explanations which are proposed correspond to the participants' orientations.

As mentioned in Chapter 2, a particular qualitative research tradition within the social sciences, ethnography, has been the focus of some attention in system design in recent years. This form of research originated within Anthropology and Sociology and focuses on an observer going into a setting and ‘immersing’ him/herself in the organisation or culture and its activities. Typically, the ethnographic inquiry looks at the everyday routine activities of the participants themselves. Those studies that have been concerned with technological design issues tend to be concerned with looking at the *in situ* production of activities, and the ways in which individuals accomplish their work through their interactions with each other and technologies and other artefacts in the setting. By focusing on what at first appears to be routine or mundane, ethnographers try to reveal the tacit ‘seen but unnoticed’ practices through which users produce and recognise (technologically supported) actions and activities. Often, traditional requirements techniques for eliciting work practices, such as interviews and questionnaires, provide formalised or operationalised accounts of work. Yet, it is critical for designers to also be sensitive to the tacit practices, such as those described in Chapters 4 and 5, that may be problematic for participants to articulate. It is suggested that attending to such features can improve the requirements process, and thus ultimately leads to more sensitive system design. We provide examples illustrating such an approach in Chapter 7.

As discussed above, ethnographic fieldwork is conducted within an analytic framework; the observations made may be related to specific theoretical approaches which can themselves sometimes be contradictory (Button and King,

1992; Shapiro, 1994). Thus, we might encounter functionalist, structuralist and Marxist ethnographies or cognitive or symbolic interactionist approaches. In Sections 3.3 and 3.4, we discuss a range of orientations broadly categorised under psychological and sociological approaches that have received attention from HCI, CSCW and requirements engineering, and we describe the ways in which they have informed system design. In Section 3.5, an orientation that seems particularly relevant in the design of technologies is described; one that reveals the indigenous practices of participants in a setting, looking at the moment-to-moment production of activities. Ethnomethodology and cognate approaches such as conversation analysis and interaction analysis have been the focus of some interest to designers in a variety of ways, from informing the process of requirements capture to providing opportunities for more sensitive deployment of systems in the workplace.

### 3.3 Psychological Approaches

Cognitive Science as a research programme draws from various disciplines such as linguistics and computer science, but mainly from Cognitive Psychology and Artificial Intelligence. It became particularly influential during the 1970's when a great deal of research interest was focused on developing machines that display intelligence and, in the process, considering how computers and computation might inform our understanding of cognitive activities. The predominant orientation that features in this research programme is an information-processing model of human conduct in which mental processes are modelled in computational ways (Marr, 1982). Cognitive Science therefore, focuses research on areas of human behaviour such as mental processing. This processing may further be distinguished into tasks or theories that may be categorised according to central processes such as memory, decision making, learning, problem solving. Much of the work in Cognitive Science emphasises relationships between inputs, outputs and symbolic representations required in the processing, along with a concern to develop a deeper model of computation that uses concepts originating from computer science such as symbol processing (e.g. Johnson-Laird, 1988 [1993]; Marr, 1982).

The information-processing model has been strongly influential within psychology, particularly when modelling mental processing and, as mentioned in the previous chapter, it is also the dominant paradigm for considering human computer interaction. Such a model resonates strongly with the conception of an individual user of a computer system. To provide an example of a relationship between an individual's actions and a computer system, Norman (1986) sees the

use of a system in terms of a cycle of evaluating and executing mental processes (See Figure 3.1).

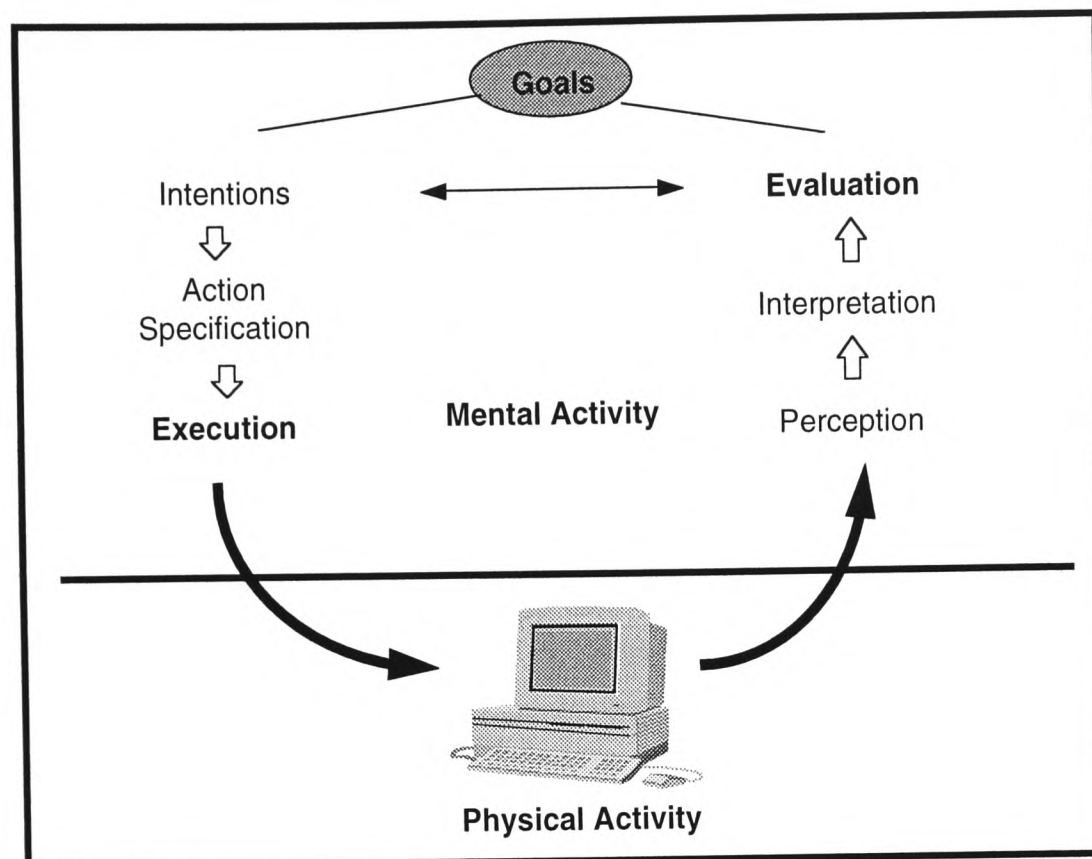


**Figure 3.1** A Cognitive conception of Human-computer interaction (after Norman, 1986, p.539)

In this cycle of actions, users interpret what is on the display in terms of their goals and expectations, and then generate actions to perform commands on the interface, thus changing what is on the display. As the physical and mental activities are repeated, they are considered as an interaction with the system. Norman suggests that achieving a better understanding of these activities should allow research to influence the design of input mechanisms or the order and organisation of commands.

As discussed in Chapter 2, such a view of human computer interaction seems particularly constrained, even for examining an individual's activities (Carroll, 1991), but more so when we consider how technologies are placed within collaborative and organisational work. The growing recognition of the situated and collaborative nature of activities is reflected in the emergence of Distributed Cognition (Hutchins, 1995; Salomon, 1993). This approach seeks to preserve many of the concepts deriving from cognitive psychology and apply them in different ways to account for complex, socially distributed cognitive activities. As its name suggests, the approach stresses the distributed nature of cognitive activity across individuals, artefacts and internal and external representations, using a common language of representational states. Rather than focusing analyses of activities on processes acting upon representations inside an individual's 'head', distributed cognition draws on the existing cognitive concepts and applies them to the interactions that occur between any number of individuals, artefacts and digital

artefacts for any given activity. Thus, broader classes of cognitive events are proposed that may not all be in the 'head' of an individual. Hutchins cites an example from an airline cockpit where an investigation into memory processes reveals that 'memory involves a rich interaction between internal processes, the manipulation of objects, and the traffic in representations between the pilots.' (Hollan et al., 2000 p.176).

As the unit of analysis is not now focused on the individual's mental processing, cognition can no longer be understood in isolation from its context as 'culture shapes the cognitive processes of subsystems that transcend the boundaries of individuals' (p. 178). In order to investigate this phenomena, distributed cognition draws on various techniques including a cognitive ethnographic approach. The analytic orientation that is applied is seen to retain 'an interest in individual minds, but adds to that a focus on the material and social means of the construction of action and meaning. It situates meaning in negotiated social practices.' (p. 179).

A series of ethnographic studies have been undertaken using this approach most notably, Hutchins' study of navigation on a ship in *Cognition in the Wild* (1995). His study analyses the cultural-cognitive processes that take place when steering a ship into harbour, and the detailed coordination of representational states across media that take place for the plotting a fix. This is a highly routinised activity, involving several members of the navigation team, and requires the complex co-ordination of participants and artefacts in order to keep the ship on course. Hutchins also describes how such activities in turn provide a structured experience within which individuals can learn the procedures and practices of the navy.

The ethnographic work under the rubric of distributed cognition has described a range of cognitive systems from air traffic control (Halverson, 1995) to software engineering practices (Rogers, 1994). Much of the ethnographic work looks at the use of technologies in organisational settings including an extensive study of airline pilots (Hutchins and Klausen, 1996). Based on this ethnographic work, Hutchins designed a graphical interface to the autoflight functions of the Boeing 747-400.

From such studies in interface design, Hollan, Hutchins and Kirsch (2000) go on to propose distributed cognition as a new foundation for studying human-computer interaction; in their paper they describe an integrated framework for research for the design and assessment of people's interactions with digital artefacts. Through this framework, these researchers aim to be more sensitive to the possibility that the 'design of new digital displays and interfaces risk inadvertently destroying many of the most valuable aspects of current ways of

doing things because we do not understand how they work' (p. 180). Cognitive ethnography can provide access into current work practices that may be incorporated into new designs or new uses found for these strategies or, indeed, some ways of working may be transferred into different settings.

Distributed cognition is not the only attempt to consider aspects of the social within a psychological paradigm. An earlier approach, Course of Action Analysis (Pinsky, 1979; Pinsky and Theureau, 1982; Theureau, 1992; Theureau et al., 1994), is part of the French ergonomics tradition that considers analysis of activities of individual participants in naturalistic settings to be critical to ergonomics development and design. The approach is concerned with explicating the use of tools and technologies from within the courses of action in which they are embedded. Here, researchers examine the notion of communication and dialogue between individuals particularly analysing longterm interactions. Similar to distributed cognition, analyses examine trajectories of activities over periods of time, whilst also preserving an orientation to the cognitive in their account of social and communicative conduct of participants<sup>4</sup>.

Distributed cognition offers a significant shift from previous conceptions of the cognitive, whilst also attempting to account for the nature of social action. Theories and concepts from cognitive science have informed the theoretical framework that is then applied to a broader understanding of a cognitive system, rather than just to the inside of an individual's 'head'. In this respect it provides a radical reconceptualisation of the ways in which individuals interact with each other and with various digital and other artefacts, and has been proposed as a possible alternative foundation for the study of human computer interaction.

However, various critiques of the approach have pointed to the difficulties in maintaining a cognitive orientation in the study of social and collaborative interactions, suggesting that it is not often clear if the analyses provide a coherent framework for understanding both psychological and social conceptions of meaning (Button, 1997; Luff, 1997). Distributed Cognition seeks to extend analyses towards the social, drawing heavily on an ethnographic orientation to accomplish this. A key feature of the analysis is an attempt to incorporate cognitive representational states that suggest a stable notion of meaning. It has been questioned to what extent the notion of cognition assists in our understanding of social and collaborative practices. For example, tying the notion of a mental process to a pen lying on a book, where an internal process becomes part of an object acting as an external memory. It is unclear in this case if a pen lying on a

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<sup>4</sup> A similar move to the social and collaborative in psycholinguistics drawing heavily on conversation analysis is reflected in the work of Herb Clark (Clark, 1996) in grounded communication theory.

book may be seen as a resource for prospective action or as an external memory. As meaning is situated in negotiated social practices, the analyses seem to resonate with early traditions in the social sciences; for example, Symbolic Interactionism (Heath and Luff, 2000) discussed in more detail in the following section. Concerns have been expressed regarding the stabilised notion of meaning into the object, that in relating the individual and the artefact, participants are considered to hold onto, even if for some time, a stable set of meanings for the association to endure. Such a view loses the ways in which meaning is produced and recognised moment-to-moment for the local context.

An even broader conceptual and methodological framework for the analysis of workplace activities is proposed by Activity Theory, that takes cultural-historical notions into account. This rich and complex approach originated in Soviet psychology based on the work of Vygotsky, Leont'ev and Luria and, over the years, there have been many interpretations and developments drawing upon the framework. Much of this work shares a basic concern to view activities as having a history and, in order to understand a current situation, a historical analysis of the development of activities is often required. In addition, activities always contain particular artefacts that have a mediating role and are in turn created and transformed during the development of an activity, thereby supporting a history of that development (Kuutti, 1996). The approach provides a conceptual framework based on the concepts of activity, actions and operations and stresses the evolution and development of artefacts as mediator in human activities (Bannon and Bødker, 1991; Nardi, 1996). Various researchers have discussed the potential relevance of Activity Theory to HCI (e.g. Bannon and Bødker, 1991; Kaptelinin and Nardi, 1997; Kuutti, 1996) and a range of studies have drawn upon the framework to analyse the use of artefacts in different work settings. These studies include analyses of user interfaces for systems to support the production of newspapers (Bødker, 1989) and hospital medical care (Engeström, 1993). Indeed, Rogers (2000) argues that a main rationale for utilising the framework of Activity Theory in HCI is that it provides a useful approach to considering the design of user interfaces and technological systems as it is grounded in an understanding of the work settings in which these systems will be used (Bødker, 1989). In addition, Rogers argues that the theory is also seen to provide a context from which analysts can better design technology to fit the needs of participants in their work settings, a feature that was unavailable to traditional cognitive theories.

Recently, researchers have been investigating the relationship between activity theory and other analytic orientations. Suchman (2000), in her analysis of civil engineering, work sees a common orientation to material artefacts as mediators to human activity as the strongest feature that aligns activity theory with ethnomethodology. However, there are possible fundamental differences to do

with the nature of theorising. Suchman takes Kuutti's view that both the term activity and theory are problematic in that 'the tradition is neither interested in activities in general, nor is it a theory, that is, a fixed body of accurately defined statements' (p. 25 – cited by Suchman). But, following Nardi's (1996) view, Activity Theory may provide a potential theory building practice for human computer interaction studies. This, as Suchman (2000) states, stands 'in profound tension with ethnomethodology' that 'resists taking up the rules of sociological method, in particular the various procedures that turn lived experience and embodied practice into general lexicons and associated models' (p.16). Rather, analyses must take practical activity as the 'fundamental phenomenon' to be recovered.

The developments described in this section adopt a fundamentally psychological orientation, and attempt to extend their interest in cognitive phenomena in a variety of directions to the study of social and collaborative work practices. Various psychological notions are broadened in these analyses but, in so doing, it may be difficult to maintain the integrity of the original concepts. It has also been suggested that the use of ethnographic fieldwork, combined with an interest in analysing how meanings are socially constructed, resonates strongly of particular social constructionist approaches within the social sciences. These are discussed in the following section.

### 3.4 Sociological Approaches

A particularly influential body of ethnographic work within the social sciences emerged from the Chicago school under the leadership of Everett Hughes in the early 1950's. A major part of this research revealed how organisational work is dependent upon a tacit and emergent culture that is produced and reproduced in the course of the everyday problems that people have to deal with (see, for example, Becker et al., 1961; Davis, 1963; Goffman, 1961; Hughes, 1958; Hughes, 1971; Roth, 1963; Strauss et al., 1964). For Hughes, social interaction is the foundation of organisational life.

It is through social interaction that organisations emerge and are sustained; it is a consequence of social interaction that people develop routines, strategies, practices and procedures, and it is by virtue of social interaction that clients receive, and perceive, goods and services in ways defined by the organisations and its occupation(s).

(Heath and Luff, 2000, p. 6).

The Chicago work, later typically characterised as 'symbolic interactionism' (cf. Corbin and Strauss, 1993; Strauss et al., 1964; Strauss, 1987; Strauss et al., 1985) has been influential in the social sciences, not only in the sociology of work and

organisations but also in research into health, criminal justice and new technology. Thus, more recently, ethnographic studies of technologically mediated collaborative activities have informed debates on the social and technical within CSCW (see Bowker and Star 1994; Star 1989). Star's (1989) concept of *boundary objects* describes artefacts used in organisations such as maps that are at once 'plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites' (p.46). According to some researchers, this concept of boundary objects is useful in technological design by providing them with a way of 'articulating previously nebulous and ill-formed ideas' (Rogers, 2000, p20). Similarly, Bowker and Star's (2000) work on categorisation examines how professionals working in health and illness formulate work in terms of diseases and problems. Various medical professionals may categorise aspects of their professional work differently, and the negotiations that take place about these categories are then analysed. This research may be particularly relevant for information systems, where different categories apply, to inform the design of databases for example.

Symbolic interactionism has informed social analysis of quite a different kind concerned with the study of technology. The Sociology of Scientific Knowledge (SSK) (e.g. Collins, 1985; Latour and Woolgar, 1979 [1986]; Woolgar, 1988) considers how scientific knowledge is constructed and negotiated by individuals and practitioners working within institutions. Drawing on this research, the social construction of technology (SCOT) (e.g. Bijker, et al., 1990), and various approaches known as actor-network theory (e.g. Bijker and Law, 1992; Callon, 1986; Latour, 1987; Latour, 1988; Law, 1988; Law, 1991), examine how technologies are constructed in their course by designers and users. These qualitative, ethnographic studies focus on the ways in which technology is designed, and how 'meanings' surrounding technology are constructed in terms of various sociological characteristics. As this work remains primarily sociological, these analyses may be described in terms of general characteristics such as power or gender of the participants in the studies; or they may have more specific concerns, for example, how different participants in institutions mobilise resources to construct the meaning of a technology (e.g. The Aramis Project Latour, 1993 (1996)). This type of research reveals that a particular meaning of a technology is often the result of how well a group of individuals mobilised their resources and, as such, reflects on social processes fundamentally for sociological audiences.

As characterised by Button (1993), this orientation looks at how participants *construct* technology through actions rather than how technologies are utilised in the *production* of social action. The approach is concerned with examining the informal socially constructed nature of meaning; most specifically, how meanings

are negotiated by participants and dependent on particular contexts. Underlying this approach is a conception of meaning that recognises that, although ‘meanings’ held by participants may be in flux for a period of negotiation, they may then remain stable and can be utilised as a resource for social action.

Often these approaches produce quite subtle analyses of the ways in which artefacts are configured in the work practices of individuals, but their relevance is addressed to more sociological concerns such as analyses of how technologies come to be viewed as successful by various parties. As such, various concepts developed from such analyses may be useful for questioning underlying assumptions on which technological development and scientific knowledge is based. They may also provide rhetorical devices to allow access to previously difficult and intangible problems (Rogers, 2000). Research informed by this approach (e.g. Bowker and Leigh Star, 2000) seems to be moving towards issues that are similar to concerns within ethnomethodology, for example, the uses of categorisation for doing professional work, or the use of objects as a resource in accomplishing work in organisations. However, the conceptual framework that informs this research is different; focusing on the socially constructed nature of activity assumes a stabilised notion of meaning that seems to lose the constant concern of ethnomethodological research which lies in revealing the active ways in which meaning is produced and recognised for the local context. In practice, ethnomethodological concern focuses on categories in use; how they are used moment-to-moment in the production of professional work, rather than how their meanings are negotiated.

### 3.5 The Ethnomethodological Turn

Button’s critique of the Social Construction of Technology reflects an interest in an ethnomethodological orientation to the study of technology that is concerned with the indigenous practices through which various activities are accomplished, and how technology is utilised by individuals to achieve their everyday work. This orientation has been drawn upon by a range of studies within the social sciences pioneered by the early work of Garfinkel in *Studies in Ethnomethodology* in 1967. This work collects together empirical studies of different kinds, looking at the everyday sense-making practices of individuals, including: the work necessary for coders to interpret and fill in forms correctly; the resources which juries utilise to make decisions; and, perhaps most intriguingly, the breaching experiments where various sets of activities were undertaken to unravel some of the resources through which everyday social organisation is accomplished. These sense-making practices, activities that people accomplish in everyday settings, reveal what is

taken for granted and what resources individuals rely on to make sense of each other's actions.

This work has had a powerful influence on a large body of empirical studies. For example, Wieder (1974) discusses a case revealing the social practices through which people make formal rules work and how in their activities they produce these rules. Lynch examines how scientific artefacts are organised to accomplish the activities at hand in a laboratory (Lynch, 1985). And Livingston looks at 'the lived work' of producing mathematical proofs on the blackboard (Livingston, 1986). Other more recent work that has been influenced by this approach is illustrated by Suchman's study (1987a), mentioned in the previous chapter, that reveals the practices individuals utilise in order to make sense of instructions provided by an intelligent system for a photocopier.

Garfinkel has shown how social actions are thoroughly embedded in a body of sense-making practices and practical reasoning that renders human conduct 'account-able' (Heritage, 1984). The ethnomethodological orientation concentrates analyses on the *in situ* accomplishment of social actions and the resources that individuals utilise in producing, recognising and coordinating their conduct with others. It further stresses that the sense of descriptions is indexical or 'powerfully influenced by the context in which they are uttered' (Heritage, 1984). As Heath and Luff state,

(t)he contextual organisation of social action and the uniqueness of meanings and interpretations therefore, may direct our analytic attention towards the resources, the practices and reasoning, the knowledge-in-use, through which individuals produce actions and recognise the activities of others; resources which are taken for granted by 'members' and remain unexplicated

(Heath and Luff, 1994, p. 4)

### **3.5.1. Conversation analysis (CA)**

Harvey Sacks, strongly influenced by Garfinkel and contributing to the early work in ethnomethodology, looked at one particular aspect of social interaction, that of the social organisation of conversation (Sacks, 1992c). This research investigated the ways in which individuals make sense of each other's conversation, attending particularly to its local organisation, that is, the moment-to-moment production and recognition of actions through turns of talk. Such an approach was made possible by audio recordings of naturally occurring conversations in the early work, principally recordings of telephone conversations and group-therapy sessions. Sacks recognised that these materials made possible the study of naturally occurring conversations and attempted to reflect Garfinkel's concerns to reveal the resources through which participants produce their everyday conduct. In addition, Sacks and his colleagues Schegloff and Jefferson focused on 'the primacy of mundane conversation' (Heritage, 1984, p.238), that through talk

sociality is produced. The fundamental assumptions of conversation analysis have been summarised by Heritage as:

interaction is structurally organised; contributions to interaction are contextually oriented; these two properties inhere in the details of interaction so that no order of details can be dismissed, *a priori*, as disorderly, accidental or irrelevant

(Heritage, 1984, p.241).

The significance of a speaker's utterance is *context-shaped* and *context-renewing*. It is context-shaped in that a contribution to an ongoing sequence of actions can only be understood sufficiently with reference to the context, particularly the immediately preceding actions. An utterance is context-renewing since, because every immediate turn of talk forms the context for a next turn of talk, it

will inevitably contribute to the framework in terms of which the next action will be understood. In this sense the context of a next action is repeatedly renewed with every current action

(Heritage, 1984, p.242).

Consequently, conversation analysis is concerned with revealing how people themselves orient to these 'seen but unnoticed' practices in their local context, attempting to unravel the practices through which their social actions are produced.

Early work by Sacks, Schegloff and Jefferson (1974) examined some of the procedures and organisation of everyday talk, for example the ways that turns of talk are ordered within a conversation. They reveal how certain types of turn set up the interactional context for other types of turn, for example, adjacency pairs such as question and answers; and how openings are initiated and closed. This led to a large body of work looking at different aspects of conversation (Atkinson and Heritage, 1984; Boden and Zimmerman, 1991; Button and Lee, 1987). This research also investigated not only ordinary conversation but also institutional talk (e.g. Drew and Heritage, 1992) where talk in domains other than ordinary conversations are analysed. These studies are concerned with how the basic sequential organisation of talk is transformed in these new settings such as legal scenarios (e.g. Atkinson and Drew, 1980), medical consultations (e.g. Heritage and Sefi, 1992; Peräkylä and Silverman, 1991) and news interviews (e.g. Greatbatch, 1992; Heritage, 1989). As the analyses are focused on talk in organisations and attempt to reveal how particular institutions under investigation are embedded in the 'talk at work' they become more relevant for workplace studies in general.

### **3.5.2. Interaction analysis**

Broadening the focus on naturally occurring conversations, researchers recognised that the visual conduct of participants was critical to understanding the production

of conversation. Following early work by Sudnow (1972), researchers have been able to draw upon video data to provide material resources for understanding naturally occurring bodily conduct, such as visual conduct, the movement of gaze, head and body orientations and the use of artefacts. Once again the concern is to reveal the sequential organisation of these features; how they are organised locally, and how they are produced and rendered intelligible moment-to-moment within the ongoing talk. Research has revealed how the elicitation of gaze can be related to perturbations in speech (Goodwin, 1981), and how various bodily orientations can be configured to initiate interaction (Goodwin, 1981; Heath, 1986). Studies drawing upon an interaction analytic orientation have looked at the accomplishment of work and other activities in a number of settings, for example, control rooms, service enquiries and medical practices, and have formed an intrinsic part of the workplace studies referred to previously in Chapter 2. These studies have investigated aspects of work settings such as the use of schedule boards in airport control rooms and how, in relation to participants' talk about planes coming in, the schedule boards help others in the setting to make sense of the talk about particular planes (Goodwin and Goodwin, 1996). In a study of the London Underground, Heath and Luff (1992a), reveal how participants produce talk for others to overhear; how certain types of conduct display engagement in activities to colleagues; and how particular artefacts can be used to make sense of and display understanding about certain activities. These and related workplace studies have had a great impact in the field of Computer Supported Cooperative Work (CSCW) perhaps, in part, because the use of video provides access to the actual details of naturally occurring data as part of the analysis, revealing aspects that are of interest to CSCW designers such as peripheral participation, awareness, and the use of public displays.

Indeed, some researchers have also laid out certain very general requirements for potential CSCW systems, drawing from studies utilising this orientation (Heath and Luff, 1992a). For example, they have suggested a requirement to support both collaborative and individual work and the seamless transition between the two. What appears to be needed are systems that allow for many different forms of participation in collaborative activity and the flexible transition between these different forms. One aspect of this is that systems should support peripheral awareness and monitoring by allowing others access to an individual's activities. In addition, in many settings collaborative work is accomplished predominantly in relation to objects and artefacts, documents in particular. Therefore, CSCW systems should support activities in relation to these objects and artefacts. Furthermore, collaborative work is not accomplished necessarily face-to-face. Rather, people adopt a variety of orientations towards objects and others in the local environment and vary these in the course of an activity. Thus,

systems should also support multiple orientations to activities. Finally, observed in many different types of settings, there is a requirement to have different forms of access to the task at hand; for example, people might be joining an activity, moving into collaboration or jointly engaged in an activity. Providing such general requirements may offer one way for sociological studies to inform requirements gathering.

Interaction analysis is concerned with the locally ordered, indexical nature of conduct in a range of domains. The power of video materials lies in their ability to provide access to the details of naturally occurring bodily and visual conduct. Analysts look at the production of understanding through talk, and a warrant for an analysis is given in terms of the sequential organisation of talk. However, when considering such conduct as gestures, such a strong warrant may of necessity need to be relaxed.

As mentioned previously, Anderson's (1994) concerns lie with the role of ethnographic studies in system design, both for CSCW and Requirements Engineering, questioning whether analysts simply need better access to the domain or whether other aspects may be relevant for analysis. Certainly, Heath and Luff (2000) and Button (1992) attempt to outline how drawing on naturally occurring data, detailing participants own practices in analyses, is relevant to system designers. This reflects Potts and Newstetter's (1997) concerns, where ethnomethodology seems to provide analyses that are grounded in people's own conduct not generated in relation to a pre-specified hypothesis about their behaviour. Thus, as Button and King (1992) argue, it is not sufficient just to do observational studies; what is needed is an analytic orientation to frame the fieldwork. Ethnomethodology with its concern for revealing participants' understandings of their own practices, at the very least provides a starting point for attending to the ways in which activities are produced and rendered intelligible for others in the workplace. Interaction analysis examines the moment-to-moment details of talk and bodily conduct. These techniques may provide a foundation for investigating the details of activities in their local context. Such an effort is not done simply to require systems analysts to consider 'the social' in their technical endeavours. Rather, analyses of the ways in which participants themselves organise and coordinate their day-to-day activities have allowed researchers to reconceptualise quite powerful notions that have informed system design in the past; notions such as the division of labour, task, and individual. In addition, the analyses can provide strong justifications for design grounded in empirical analyses of individuals' indigenous work practices that are available to repeated scrutiny throughout the lifecycle of a system design and beyond.

## 3.6 Data and Methods

This thesis is concerned with how ethnomethodological and conversation-analytic orientations may be made relevant for system design, particularly for contributing to a developing requirements analysis. The analytic orientation by itself cannot be seen as a resource for addressing various problems in requirements such as, how to arrive at a system or users' requirements from a detailed ethnomethodological analysis. This issue is explored in some detail in Chapters 6 and 7. However, ethnomethodological analyses of workplace and organisational activities do suggest the resources by which a practitioner could warrant a requirements analysis. Various user or system requirements may be justified by referring to detailed analyses of particular activities in relation to systems designed to support or transform these activities.

There is currently some concern regarding how ethnomethodological observations may best be conveyed and transformed for informing requirements analysis and system design. In the course of their transformation, various issues particular to system design may need to be considered. For example, when considering requirements for a computer system, designers may need to reason about what aspects of current practices should remain stable; in other words, what aspects of participants' practices should be preserved when new technologies are to be designed. In addition, features of initial analyses of workplace activities may need further explication and deeper analysis to make them relevant and accessible to communication to designers. Of particular concern here is whether designers' practices of modelling hard problems is appropriate in relationship to these materials; that is, to attempt to get a better understanding of the activity by modelling it in some formal or semi-formal way. Given the complexity of social conduct, we might consider whether such a task is appropriate and what the difficulties are in doing so. In Chapter 6 we look at recent attempts to model social and organisational behaviour using sophisticated modelling techniques, in order to investigate the extent to which such an approach might be appropriate for developing, understanding and breaking apart the nature of the problem.

In essence, we are concerned with accounting in the analysis for the details of participants' own practices and interactions as they are produced moment-to-moment and rendered intelligible for others in the local domain. These practices are often collaborative, performed by two or more participants. They may also occur in parallel with other activities, or participants may interleave various activities in particular ways. Individuals may often shape their actions according to the ongoing interactions to display to colleagues various aspects, such as engagement in an activity, initiating or completing an activity. Artefacts such as computer screens may also be used to make sense of the activities at hand.

In this regard, we draw on an extended case study of one specific domain that provides access to complex sets of parallel activities and involves the use of different types of artefacts, including various computer systems. It also allows access both to real time and asynchronous aspects of collaboration and the coordination of activities. Moreover, the setting has been under transformation in terms of the deployment of new technologies that have been aimed at changing the ways in which participants carry out their work. The study looks at three financial dealing rooms; one characterised as a fast-moving, highly volatile setting with complex technological support; another providing services for smaller trades and shareholders to buy and sell shares; and a third characterised by a mixture of open-cry and telephone-based trading in a fast-moving market, but with little technological support. We have examined the work of traders at their desk, how they coordinate their activities in dealing through their interactions with other traders and personnel, and how they use paper documents and different forms of technological support and artefacts to accomplish their trades.

### **3.6.1. Data collection**

The materials collected for this thesis, fieldwork notes and video data collection, were gathered over a period of several years. The initial fieldwork was undertaken in 1992 in a regional trading centre of a large well-known high street bank. This trading centre principally provided clients of large companies with short-term loans and transfers between currencies. The period of data collection involved three groups of three days each, where data were analysed after each period and informed the fieldwork for the next. In the initial phase, we used one camera and gathered seventy-two hours of video data. We then looked at much faster moving markets in both equities and derivatives with telephone and electronic-based trading. One is a market-making section that manages the risk-taking activities related to equity-related investment products such as equity warrants, convertible bonds, futures and options. The trading floor has six large desks, around which five or more traders sit (or more usually stand). These market makers deal in Japanese warrants and are responsible for between 50 to 60 Japanese warrant issues. Fieldwork consisted of two groups of three days at a time, and one camera was used to gather video data. Trading in these markets often started at 8 o'clock in the morning; thus we gathered about ninety hours of data in this setting.

The analysis focuses mainly on the equities market, as the technology supporting trading in this market is much more sophisticated than the derivatives floor and the interactions are typically much less complex. Initial fieldwork in the equities market took three groups of three days, updated by visits of two to three days at a time. Visits occurred over a period of several years and, occasionally, we used two cameras to analyse screen-based activity or document writing activity in

relation to talk. In total, we gathered about two hundred hours of video data. This was a period of great transformation in the equities market with various changes occurring in work practices and technology. Following the 'Big Bang' in October 1986, there was a move from open-cry trading where trades were done in a central location and buying and selling stock were done by shouting and signalling to other traders, to electronic dealing where deals were carried out on the telephone and computer systems provided information on the state of the market. As Chapman (1994 p.22) states,

By far the biggest force for change was technology: the combination of hi-speed telecommunications and the microprocessor meant that international deals could be carried out anywhere.

Trades were done by market makers and, typically, individuals other than the market maker recorded the deals on computer systems. We also collected various documents and copies of records as part of the fieldwork. From 1993-1996 the Exchange embarked on the Sequence programme. This was designed to be the final step towards a fully electronic exchange. Thus we were also able to investigate this setting in a period of technological transition.

To collect the video data we used standard non-intrusive Hi8 camcorders, often using two to capture aspects of work in interactions. We tended to do static block recordings, having cameras in fixed places in order to avoid the problems of tracking individuals around the setting, a practice that is likely to be much more intrusive. After initial periods of data collection, we would vary camera angles to focus on particular areas and also vary the frame rates when looking at data to capture screen-based information. In terms of camera angles, we attempted to capture two or three people in relationship to technology, occasionally using a second camera. However, capturing all the screens dealers had in front of them was problematic (in the equities market each dealer had a bank of eleven screens). Sound is a critical part of the recording and an essential feature for capturing talk for the analysis. We used PZMs, omni-directional microphones to capture most of the sound in a specific area, but could mask the particular direction the sound came from.

When negotiating access to these sites we agreed to preserve anonymity, both personal and organisational. The data used in this thesis and the corresponding analyses have been passed back to members in the setting and agreed with them. We also agreed to destroy any data viewed as sensitive and to stop video recording if an upcoming event was viewed as potentially sensitive. In the event, no such issues were raised.

Many field notes were collected and written up immediately after the day in the setting. These comprised such features as sketches, notes about what dealers

wrote, glossaries of terms etc. In this way, the video analysis was supported by ethnography, each informing the progress of the other in an iterative manner.

### **3.6.2. Data analysis**

Initial periods of data collection suggest issues for further investigation, either through fieldwork or more data collection. Fragment tapes were developed where a set of issues were refined, and then key fragments were analysed to greater levels of detail. Transcripts were developed and used to make sense of the data utilising a transcription system that supported the analyst in attending to the details in the video materials. For example, it may be difficult to ascertain the ordering and positioning of particular features of interaction until they are written down. In the initial conversation-analytic studies a transcription system was developed by Jefferson (as outlined in, for example, Atkinson and Heritage, 1984) (See Appendix). This transcription system was designed primarily for talk and lays out certain aspects of the timing and pacing of talk and the delivery of turns in terms of intonation and stress, whilst preserving a standard orthography for the talk. The transcript acts as a resource for analysis and is not intended to be seen as a representation of what is occurring in the data. It is also used to present certain features of the fragments in this thesis and forms the basis for extensions by Goodwin (1981) and Heath (1986) for laying out visual conduct. Such conduct is laid out horizontally and used for such aspects as eye gaze, hand movements, and other activities relevant for the analysis. These transcripts also support the analysis and presentation of issues raised by the data. Where relevant, we also present frame-grabbed images of video data from the original materials. These are used simply to illustrate the analysis, to give some sense of the nature of activities in the materials. As is typical when drawing upon conversation analysis and ethnomethodology, the materials make it possible to subject analyses and tentative analyses to scrutiny by others. In the course of this study, several data sessions were undertaken to clarify issues and to explore themes related to system design (ten Have, 1999).

## **3.7 Summary**

We have discussed the need for an analytic orientation to shape fieldwork and observations that form part of naturalistic studies. Various orientations have been considered, including Distributed Cognition, Activity Theory and Symbolic Interactionism and we have outlined the ways in which they have informed the design of technological systems to support organisational work. It is argued that an ethnomethodological orientation provides a basic starting point for requirements analysts to consider the details of work practices that may be

supported or transformed by proposed technologies. The ethnomethodological orientation reveals the details of how work practices are achieved in collaboration with others moment-to-moment for the local context. Such an orientation provides requirements engineers with a way to look into a domain and analyse work practices from the participants' own understandings, rather than from pre-selected categories a requirements engineer determines as important. Instead, analysts look at the production of activities through talk and a warrant for an analysis is provided in terms of the sequential organisation of talk. Being able to provide a warrant for analyses may also support justifications for requirements for computer systems designed to assist or transform work practices. Analyses are supported by video data that allow analysts access to detailed practices and the subtle coordination of activities in the workplace. These videos and analyses may be subject to repeated scrutiny.

Ultimately, we are concerned with such an orientation in order to investigate a refinement of concerns in relation to certain practices in requirements analysis and system design such as modelling. This issue is explored at length in Chapter 6. In the following two chapters we introduce the dealing-room setting, the range and types of materials we gathered, and discuss the very detailed work that goes into making a deal. We consider how dealing is interactionally produced, how artefacts are used in making deals and how recording a deal is accomplished. We then discuss the importance of such an analysis for developing requirements for technology to support aspects of trading.

# Chapter 4

## The Collaborative Production of Dealing

Can you get what traders call ‘color’ from a computer screen trading system? Color is what traders glean from being with other traders physically in the same place: information from looking another trader in the eye, watching the intensity of the bidding in a crowd on the exchange floor, or recognising the people in a crowd and making a judgement about how much they might be trading and why. Color comes from a screen, but it is a totally different process of taking in information. You see the markets blinking. You see their price and volume change. You see their ebbs and flows and unusual movements, which tells you something.....People who claim they don’t get color from trading on screens, usually miss hearing things; hearing the noise on the floor build, hearing the voice of the person on the other end of the phone and trying to guess what they are thinking about or are about to do on the market. But screen color can be learned.

Trader cited in (Davis, 1997, p. 240).

### 4.1 Introduction

A major concern of this thesis is to understand the social organisation of work, in order to investigate ways in which the details of work practice can inform the requirements for computer systems to support or transform these practices. This is based on a view that attendance to certain features related to the social organisation of work in system design will improve requirements practice and ultimately lead to better designed systems. In the light of this view, we wish to study the collaborative practices of a complex setting in order to see how an understanding of the details of the work in the setting can inform the design of technology. We have chosen to focus on the work of participants in financial dealing rooms for several reasons. As mentioned in Chapter 3, this setting has been undergoing major technological transformation over the last decade and, as such, is a rich environment for the design of technology in general. As there is an increasing demand for better systems to

increase the volume of trading, it seems that there is a need to understand how to improve the process of developing requirements for such systems. This appears all the more critical in this setting where system developers often experience a certain amount of hostility from the participants who, we were told, would simply ‘throw the system out of the window’ if it did not suit. Generally speaking, work in financial dealing rooms is characterised as fast-moving and highly complex, and relies on both the production and recognition of talk and visual conduct by the participants.

This chapter reveals some of the details of the ways in which deals are produced through vocal and visual conduct. Section 4.2 provides a brief background to related research in this setting before we discuss the observations made in the regional trading centre of a large high-street bank. We provide a preliminary analysis of the work of these dealers in a treasury service to their clients and acting as intermediaries between clients and the bank’s main trading room. Though this trading room is not particularly technologically sophisticated, we begin to see how the use of various information systems is not only interleaved with talk on the phone, but also with the use of more mundane artefacts such as pens, documents and electronic calculators. It also becomes apparent that much of the talk involves numbers and transformations of numbers. Section 4.4 describes the more interactionally complex trading of a derivatives dealing room. Through an analysis of visual and vocal conduct, we reveal the ways in which traders overcome possible interactional difficulties inherent in the setting. We note that the talk between dealers is very concise where items are often abbreviated, and we reveal how the work is a mixture of highly complex and parallel trading for short periods with longer periods of discussions and bureaucratic record keeping.

Due to the problems inherent in this setting for analysis, we focus our study on the third setting, dealing in an equities trading room in Section 4.5. The two principal activities of deal production and the recording of deals is very apparent in this setting and a focus of technological concern. We describe in the analysis how dealers collaborate through the use of various information screens to make sense of particular deals and use them as a resource to move into more focused collaboration. We note how dealers may design talk that can encourage any number of others to respond or to hear the information, without demanding that anyone in particular address the utterance. The analysis also reveals how dealers may be seemingly engaged in one activity and may have to participate simultaneously in the activities of colleagues. We consider in Section 6 the various systems proposed to support trading and, most particularly, the two activities of deal production and deal capture and suggest the importance of considering how talk and interaction relates to the recording of deals.

## 4.2 Background

The chapter investigates the work of traders in a variety of financial trading rooms. These settings range from those that may be characterised as fast-moving with high liquidity of stock and complex technological support, to those that provide services for smaller trades and for shareholders to buy and sell stock and shares. A great variety of characterisations of trading rooms prevail, particularly those that focus on high stress factors and fast ‘burn out’ of traders in such a dynamic and high-risk environment. Indeed, even a quick glance at the interactions of traders reveals a setting where a lot of ‘noise’ is generated from people shouting and broadcasts of events of importance, and a great deal of local movement as traders seem to gesture frantically to others in the local domain. Whilst there is a wealth of literature describing various aspects of the financial world, some looking most particularly at technology, previous related research in this setting has tended to focus on psychological features such as the various stress factors of performing under pressure (Kahn and Cooper, 1993), organisational features such as the values of traders and organisational change (Mumford, 1981), and the social factors influencing why, even with electronic dealing, the City is still a focus for trading (Thrift, 1994).

In general, this is a setting that is not only very complex in terms of the interactions between traders and others in the financial sector, but also has a long history of technological development. Thus, it seems an excellent setting to consider the development of requirements for, and evaluations of, new technology, and provides a rich setting for examining how people use technologies in collaborative work. Previous work by Heath et al. (1994-5) examined the detailed work of traders in terms of individual vs. collaborative work. In this chapter, we will attempt to look further into the details of the use of technologies to support trading, and also provide some sense of what constitutes the work of traders, what makes this setting distinctive in terms of the practices of traders.

There are various different types of dealing that take place on trading-room floors; for example, there are markets in foreign exchange, bonds and derivatives (‘forwards’, ‘futures’ and options), and combinations of these vary from one trading floor to another. Our study looked at three financial trading rooms: a small regional dealing room, a fast-moving derivatives floor, and a technologically sophisticated equities trading room. In each, we examined the work of dealers and how they used paper documents and different forms of technological support, and their interactions with other traders and personnel.

## 4.3 Dealing in Regional Trading Centre

The first trading room is a regional dealing centre of a large well-known high-street bank (see Figure 4.1).<sup>5</sup> This provides a treasury service for large corporate clients in the area. The work of the four dealers in the office is therefore principally providing these clients short-term loans and transfers between currencies

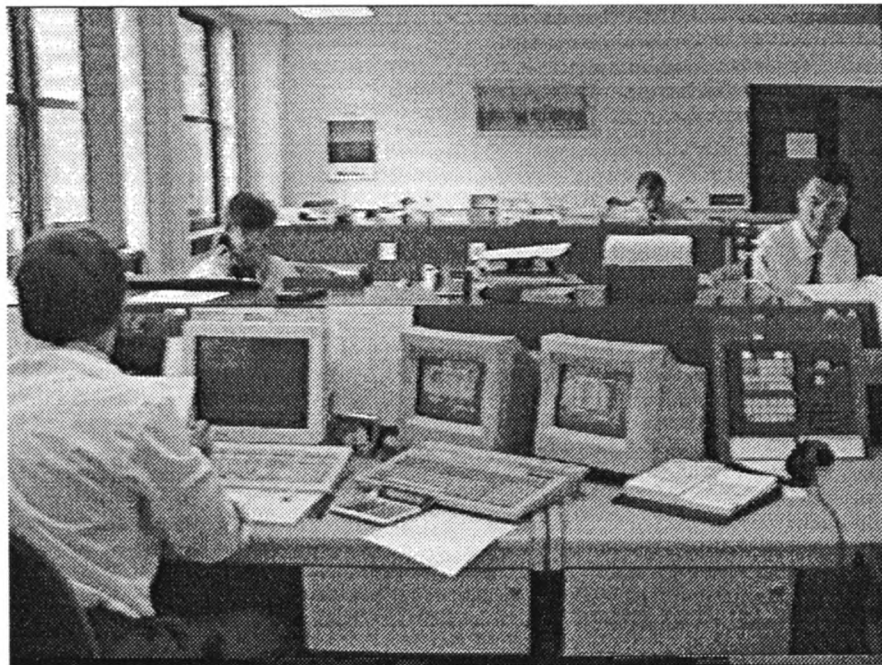


**Figure 4.1:** The Regional Trading Centre. Stuart is second from the left (facing).

These are typically for situations where clients find themselves holding large amounts of cash and wish to reduce their exposure to interest and exchange rate fluctuations, or try to maximise any benefits from holding these monies. The deposits are traded in much the same way as stocks, shares, commodities and foreign exchange. How long they are for, and the interest rate given to the customers, can vary. In the first instance, a call comes from a client and is taken by Stuart, one of the dealers.<sup>6</sup>

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<sup>5</sup> For the purposes of this thesis the individuals and organisations have been made anonymous.

<sup>6</sup> The fragments of talk in this section are transcribed according to the orthography developed by Jefferson (1972), utilised in the contributions to works such as those in *Structures of Social Action* (Atkinson and Heritage, 1984). Lengths of pauses are given in seconds in brackets. A pause of 0.1 seconds is represented as (.). Intonation is shown by up arrows ↑ and down arrows ↓. A full orthography of this transcription notation is given in the Appendix .

### Fragment 1

S: <Windsor> dealers?

(2.2)

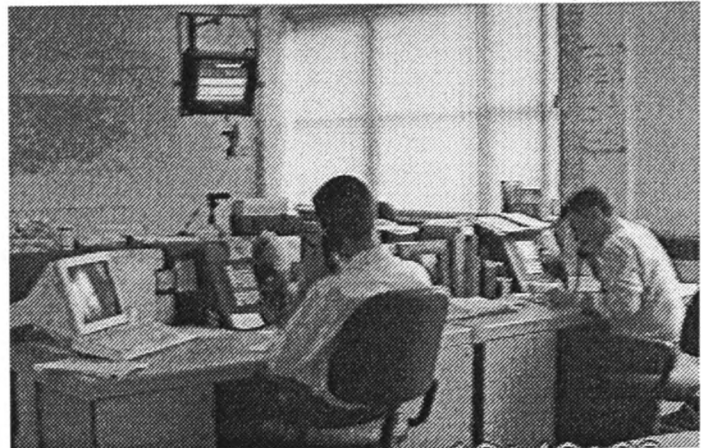
S: Hello there.

(1.0)

S: Errrm. They have been pretty poor↓ (that was today) they have started to make up slightly

(2.5) ((types into computer))

Stuart (S)



S: Overnight (.) I will pay you nine percent↑

(3.0)

S: °Okay

(2.5)

S: fifty one thousand exactly right <let me just check the figure for you

(17.5) ((puts phone on hold, sorts papers and uses electronic calculator to work out the figure))

S: your new figure will be six eight five↓ (0.7)

seven one two↓ ninety three↑

(12.5)

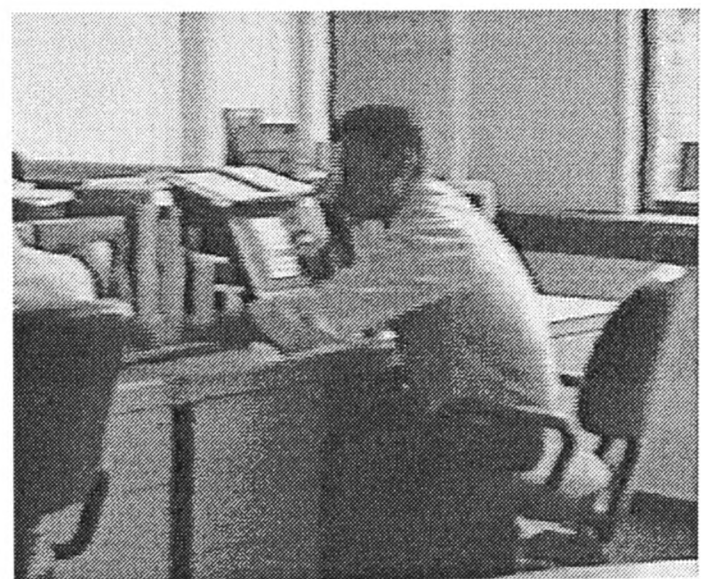
S: (yes) nine percent overnight.

(.)

S: okay?

(0.5)

S: bubbye



This is a fairly simple deal, just for depositing £51,000 in a foreign currency overnight. From the available talk on the phone, Stuart is heard to offer an initial quote; then, on being given the exact amount to be deposited, he calculates the amount that will be deposited in the currency. The deal is then agreed. Stuart gets the interest rate from one of the two screens in front of him - the Reuters system which provides the current rates of interest. The dealers aim to make profits from such a deal by making small increases from the buying price of the currency in the market and/or by the bank being able to make use of the currency in the period it is being deposited. Being part of a large international bank means that the organisation is able to trade at other times of the day elsewhere in the world, even when only deposited overnight. The work of the provincial dealers involves trying to get the best rates and prices so that the clients - who themselves are typically very large organisations - will trade with them, whilst also providing an adequate profit on each deal (the so-called 'skim'). Although this trade was for a relatively small amount, in the following instance a client enquires about a much larger overnight deposit. The fragment begins with Matt replying to a client's enquiry.

## Fragment 2

- M: they started off soft (only) to give you a bit of a warning, but let me get (a), see if I can get an (update) price for you (.) wait a sec  
(9.3) ((puts customer on hold and selects phone of brokers))
- M: Hi can you get me (.) overnight one week  
Sterling bid please in between five and er (0.2)  
twelve (°million)  
(1.9)
- M: best you can its in competition  
(0.2)
- M: (highest) price is what?  
(1.4)
- M: right  
(3.9)
- M: splendid thanks a lot okay (0.3) cheers  
(2.5) ((puts phone down and disconnects brokers))
- M: umm ( )  
(1.7) ((selects customer phone))
- M: hello there (0.7) right better than I expected actually overnight is nine and a quarter for one week is going to be nine and thirteen sixteenths okay  
(4.0)
- M: as quick as you can (.) thanks a lot  
((M puts down phone))

In this instance the client has a vaguer enquiry for Matt, both in terms of the amount and the duration of the loan. Matt puts the customer on hold and then calls up the bank's main dealing room. Given the large amount to be deposited (more than £5 million), it is the policy of the regional dealing room for the traders to call the main dealing room to get the most accurate price the bank is trading at, at that moment and for that amount. Matt asks for both the overnight and the one-week price - the latter being the higher. In this case the client does not immediately deal, as they are considering quotes from other banks.

These two brief instances provide a sense of the nature of the work in the regional dealing room. Dealing that is principally undertaken on the phone usually involves interaction with customers directly. For this dealing room, a small trade is considered to be less than £5 million and, for anything above this amount, the dealing room acts in effect as an intermediary for the main dealing room of the office. Indeed, the trading room can often act as an intermediary between local branches and the main dealing room, when a local client has a large amount to deposit or exchange. Hence, much of the work involves transforming requests from clients for others in the bank and then reporting back the responses to the clients. This may account for why dealers in these fragments initiate the substantive talk on the phone with a rather vague account of the nature of the market price - 'They have been pretty poor↓ (that was today) they have started to make up slightly' and 'they started off soft (only) to give

you a bit of a warning'. This turn shaping the course of the upcoming talk, providing for the possibility that they might have to look up the details of the deal or even call someone else for a quote. Because of the intermediary nature of the activity, the nature of clients and the types of deals they require, trading is neither very frequent nor highly paced. Nevertheless, it should be noted that there is little of what could be considered as negotiation in the trading. Quotes for interest and exchange rates are given and these are either accepted or rejected by clients.

Three other points should be noted about dealing in this trading-room setting. First, it is not what could be considered technology-saturated. Apart from the fax, the phone system and an intercom (or 'brokers box'), which can be used for contacting dealers in the main bank trading room, the dealers have two principal systems: the Reuters system for current rates and the bank's own on-line dealing system for recording deals. However, even with this system, the deals are also recorded on paper, in fact often the bank requires two paper records to be made. Therefore, the use of the technology is not only interleaved with talk on the phone but also with the use of more mundane artefacts such as pens, documents and electronic calculators. Second, the nature of dealing in the regional dealing room usually means that a deal can be handled by one trader. There are many examples of dealers passing on calls to others, commenting on the trades others have made or confirming what they may have overheard, but the intermediary nature of the activity requires much of the activity to be undertaken on the phone. The trading room only involves four individuals, so this is not the kind of dealing room familiar to news broadcasts or elsewhere in television and the media. Third, it is obvious that much of the talk involves numbers and transformations of numbers. These may be prices, amounts or rates. They may be abbreviated or outlined in full and from the talk it may not be clear what they refer to. The production of these numbers will be a critical issue returned to later in the thesis.

## 4.4 Dealing in a Derivatives Trading Room

The howling of the wolf, the grunting of the hog, the braying of the ass, the nocturnal wooing of the cat, all these in unison could not be more hideous than the noise which these beings make in the Stock Exchange.

Anonymous commentator on the scene in Change Alley, London 1695  
(Chapman, 1994)

The second dealing room may seem more characteristic of financial trading. Deepdene Partners is the London-based group of companies with offices in London, New York, Tokyo, Hong Kong and Zurich. The group itself is part of a large international investment company based in Paris. The London office is the principal market-making arm of the group and controls all the risk-taking activities, particularly equity-related investment products such as equity warrants, convertible bonds, futures

and options. These products are known as derivatives, as what is being traded is usually some derivative or option on an equity rather than the stocks or shares themselves. So, for example, a warrant gives the holder the right to subscribe at a fixed price for shares in a company at some future date. The subscription price will usually be more than the price of the shares when the warrant is issued. An example may make this clearer.

Suppose a warrant is issued which gives the right to subscribe for one share at 180p at some point in the future. The current share price is 150p and there is no intrinsic value in the warrant. But if the share price should rise to 250p, there is a clear value in the right to subscribe at 180p for a share that could immediately be sold for 250p, and the price of the warrant itself will reflect this value.

(Brett, 1991, p.77)

Traded options are much the same, but a warrant gives the right to subscribe cash for a new share the company issues. An option gives the right to buy an existing share from its present owner and does not affect the finances of the company itself. Trading in derivatives is usually considered to be much faster than trading in equities.

The trading floor at Deepdene's has six large desks, sitting (or more usually standing) around each are five or more traders.

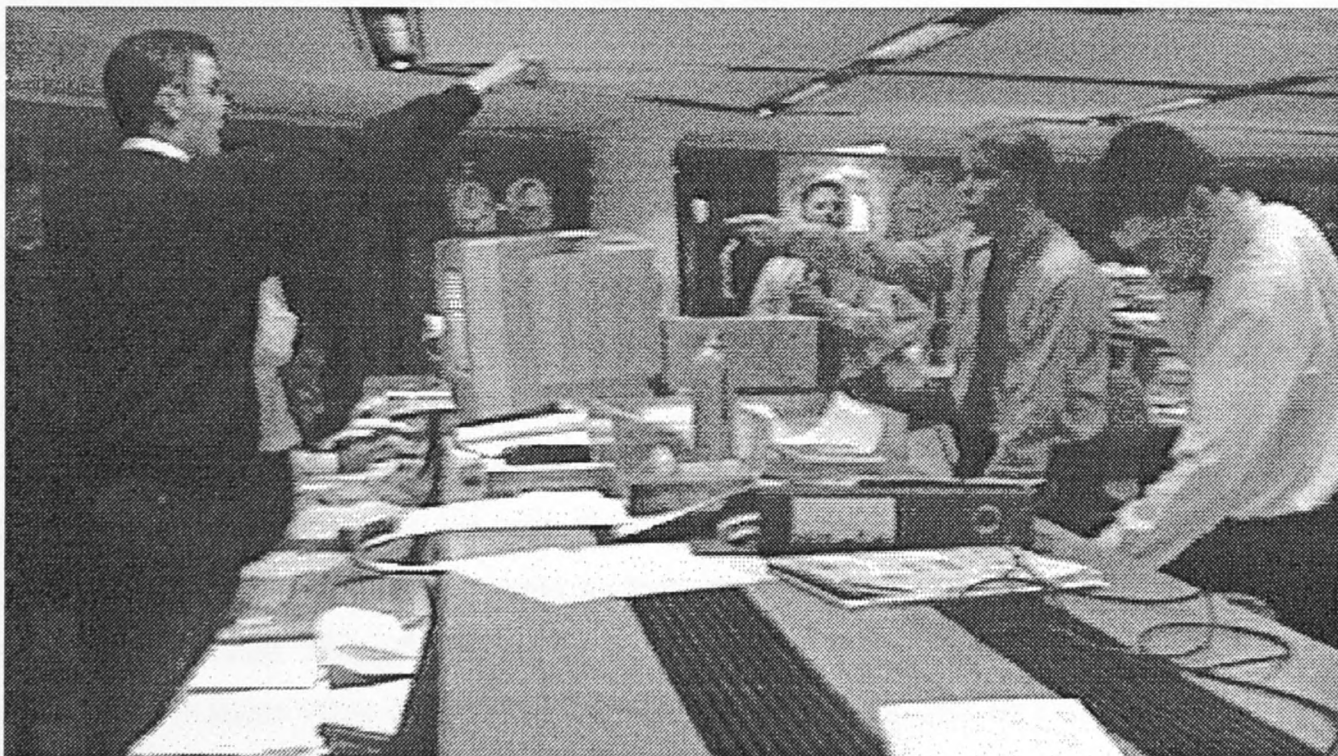
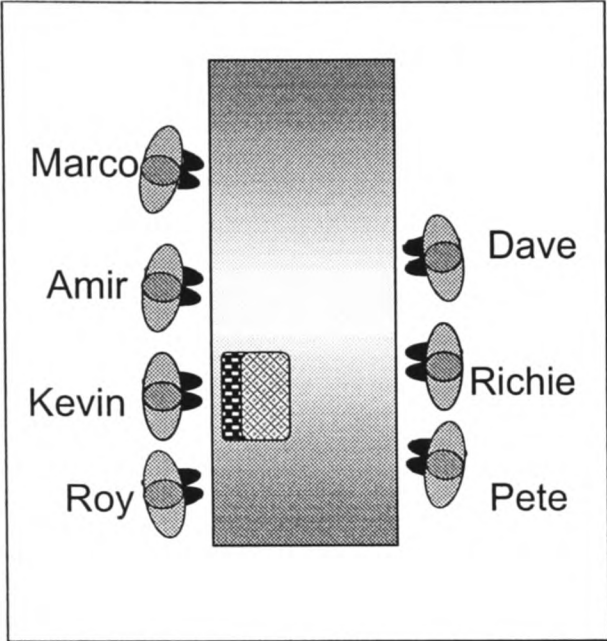


**Figure 4.2:** The Japanese Warrants Desk of Deepdene's Derivatives Trading Room

So, in the following instances there are seven market makers dealing in Japanese warrants (see Figure 4.2) who are responsible for between 50 to 60 Japanese warrant issues, divided in alphabetical order into groups for each of them. All the trading seems to emerge from phone calls, usually from the market makers from the other 12 or so trading rooms in the City of London dealing in Japanese warrants. The fragments are selected from the moment the market opens in these warrants; characterised by the traders themselves as 'zoo time'.

The following instance illustrates deals in three different warrants.

**Fragment 3 Transcript 1 (simplified)**

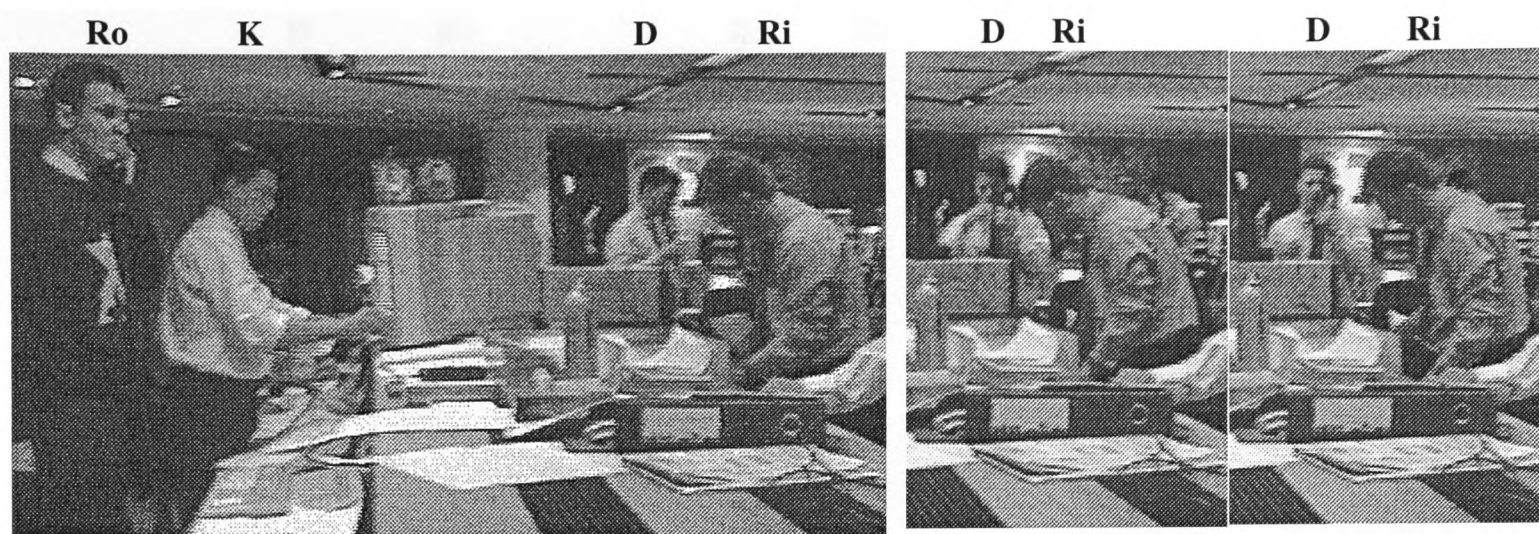


Pete: Kissei five °please Roy  
(0.2)  
Roy: Who was that for?  
(.)  
Pete: (°Nikos)  
(0.2)  
Richie: Yeah right What do you want S M M  
fives's?=  
Dave: =one and a ha-If three's ( )  
Roy: What are SHIMANO  
Richie?  
Richie: Yeah  
(.)  
Richie: SHIMANO are eight (.) nine and a half

In the course of this fragment, which lasts around six seconds in all, four of the dealers participate in different ways in three deals - one in 'Kissei 5's', one in 'SMM 5's' and one in 'Shimano'. These are the names of the different issues of warrants on the Japanese derivatives markets. As they are talking, three of the participants, Pete, Roy and Dave are also on the phone to other market makers in the City. The dealers have a critical practical problem to resolve. As the fifty or more Japanese derivatives they deal with are divided up amongst the traders, each dealer is likely to receive requests on the telephone to buy and sell for derivatives they are not responsible for. The traders then have to get the price from the relevant trader, carry out the deal, and then inform the trader responsible for the derivative that the trade has been done and with whom. So, the activities the traders accomplish are also distinctive, including calling out trades that have been made that need to be recorded, requests for quotes and quotes on prices to buy or sell. For example, Pete's 'Kissei five °please Roy' is said whilst on the phone and records to Roy that a deal has been made which he later informs Roy is with 'Nikos'. As might be expected, fragments of trading between the dealers can become very complex, the dealers utilising not only their talk but their bodily conduct to identify potential interactants and participate in a trade. So, as Richie is saying 'Yeah right What do you want S M M fives's?' he is looking down to his jotter shuffling this notebook on the desk. Dave, who is on the phone, is standing just to his right facing Richie but is turning to his left, away from Richie, as Richie is talking.<sup>7</sup>

<sup>7</sup> Visual conduct is transcribed horizontally along the page. Features of Richie's conduct are given above his talk and Dave's below his. The transcription system draws on that developed by Goodwin (1981) and Heath (1986). A continuous line indicates that the party is looking towards

### Fragment 3 Transcript 2



Richie orients to Dave

Ri: Yeah right What do you want S M M fives's?

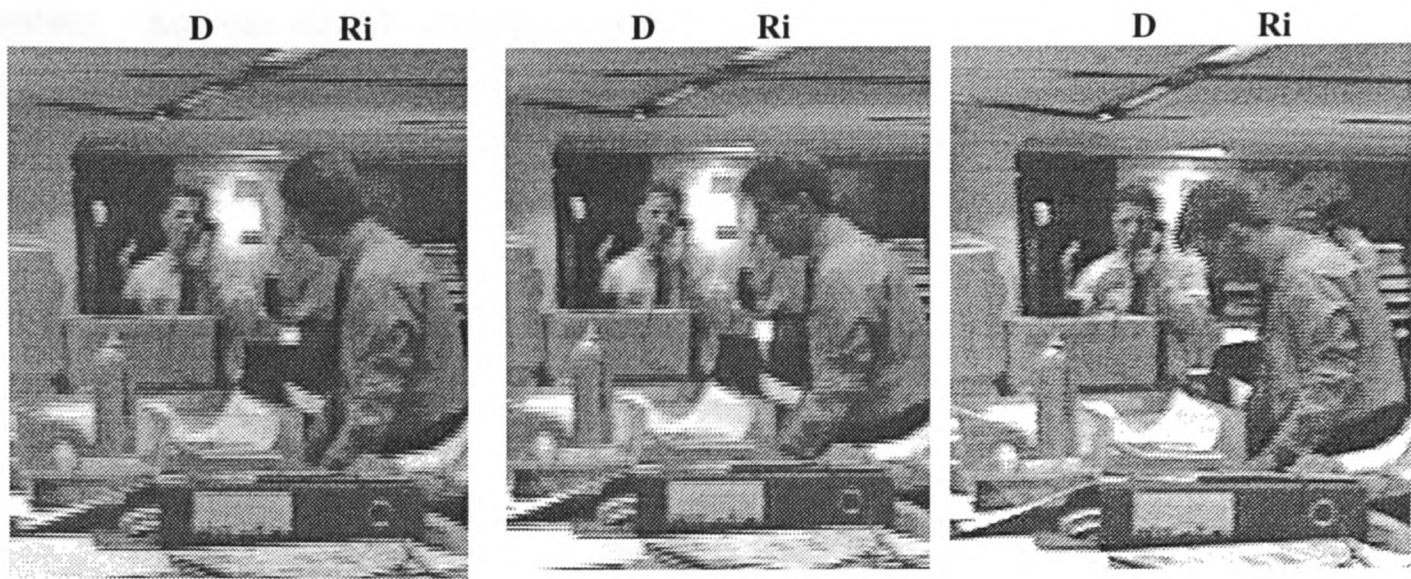
D: one and a half

Ri

Richie's very slight shift in bodily orientation towards Dave and his talk seem to combine to engender Dave's response. Richie is responsible for 'SMM 5s' and the caller on the phone appears to want to buy at the price 'one and a half three's'. Only when Dave has said the price, and seems to be saying who the trade is for, does Richie turn towards Dave.

an individual or an object; dots indicate a turn towards a co-participant and commas away. The full transcription system is reproduced in the Appendix.

Fragment 3 Transcript 4



Ri \_\_\_\_\_, , ,  
D: one and a half three's ( ) -  
Ri: Yeah-SHIMANO are eight-nine and  
    . . \_\_\_\_\_,  
    D

Richie's 'Yeah', coming after the quote and uttered whilst looking at Dave, seems to agree to the deal. Dave turns away and then can be seen to be talking down the phone. As Dave has been giving his price for SMM5's, Roy has turned towards Richie and asked him for a price on Shimano 'What are SHIMANO Richie?'.

Fragment 3 Transcript 5



D: a half three's ( ) -  
Ro: What are SHIMANO Richie?  
Ri: Yeah-SHIMANO are eight-nine and a  
    . . \_\_\_\_\_, .  
    D

[ ]  
Richie looks at sheets  
on desk in front of him

Richie's response to Roy comes immediately after his response to Dave 'SHIMANO are eight-nine and a half'. Roy then does another deal on these derivatives. In the course of one utterance Richie confirms a deal with Dave and provides a quote for a different derivative to Roy. Despite both Dave and Roy's utterances overlapping, Richie can both hear both and respond to them appropriately.

Not only this, but he marks his participation in each deal by making use of his bodily orientation - not necessarily turning towards another but delicately shifting in the direction of another - first towards Dave and then away to his sheets on his desk. Thus, participant's design their bodily conduct for others in the local domain. This is accomplished unproblematically with Dave and Roy both returning to the deals on the phones. Richie's utterance is produced in different ways for each of his two co-participants and he produces his conduct to subtly manage their different participation in the deals.<sup>8</sup>

Such multiple participation in deals is quite common at Deepdene's, with different combinations of traders participating in various deals. In the following instance, three traders (Richie, Amir and Marco) are dealing in related stocks whilst two of them (Amir and Marco) are also on the phone to dealers elsewhere in the City.

### Fragment 4 Transcript 1 simplified

Richie : Who wants a price?  
         (0.3)

Richie:      Who wants>who wants { TOYO KANETSU?

Marco :                  { construction five's he re↑

Richie :                         { Oh bloody hell

Marco           Toyo Kanetsu { to me

Richie:                         { Kanetsues are five (0.3) six and a half↑  
                                          (0.3)

Amir:                (Toyo) Construction five?=  
Richie : =yeah he's coming he's coming he's fucking com ing ( )

Marco:                                 { What  
  
         did you say { Toyo Kanetsu is?

Richie :                         { four five and a half for you are↑  
                                          (0.2)

Amir:                Sorry?  
                                  (0.3)

Richie :               five six and a half=

Richie:               =you're four five and a half<Could someone get me TOBU  
                                 bloody STORE↑

In this instance, Richie in response to a couple of requests for quotes says 'who wants a price?' and then 'Who wants>who wants TOYO KANETSU?'. It appears that there have been two related requests from Amir for a quote in 'Toyo Construction 5's' and one from Marco for 'Toyo Kanetsu's'. Marco's utterance reflects this: pointing to Amir (who is sitting and obscured from view) as he says 'construction five's here↑'

<sup>8</sup> Goodwin (1981) reveals how talk is often coordinated with the onset of gaze; even a turning towards another can be used as a resource for initiating interaction.

and raising his own hand when saying 'Toyokanetsu to me' as he also steps forward towards his work space.

M Ro K



D Ri

M K



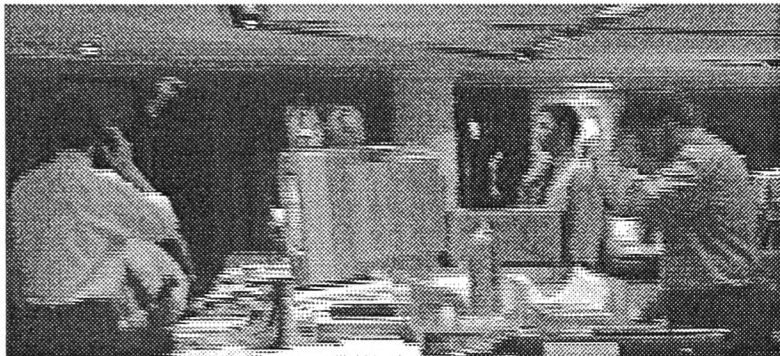
M K



M: construction five's here↑ Toyo Kanetsu to me

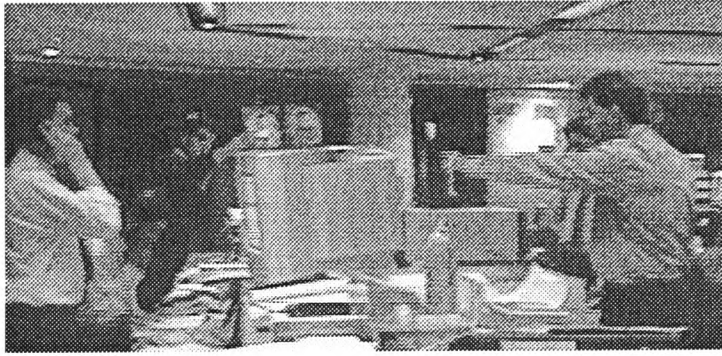
Richie's subsequent turns then give the appropriate prices to Marco and Amir. So, Richie's 'Kanetsues are five (0.3) six and a half' is directed towards Marco, Richie looking up from his price sheets and pointing towards Marco as he says this.

K M



D Ri

K A M



D Ri

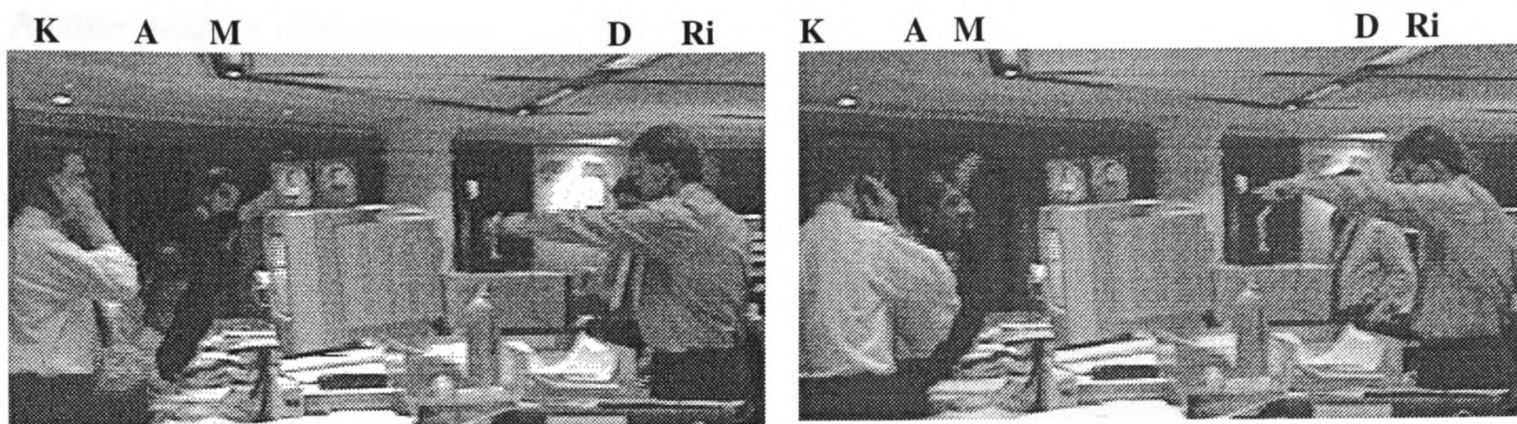
Ri: Kanetsues are five (0.3) six and a half↑

Marco: What did you say

four five and a half for you are↑  
Toyo Kanetsu is?

Unfortunately, after he does this Marco asks 'What did you say Toyokanetsu is?'. Amir asks once more for a price for 'Construction 5's' '(Toyo) Construction five?'. Richie seems to be searching for the price on a sheet in front of him whilst uttering 'yeah he's coming he's coming he's fucking coming' and then orienting to Amir whilst saying 'four five and a half for you are'. However, Amir also seems to have problems hearing this and utters 'Sorry?'.  
Richie is then faced with having given out prices to two different dealers, who are sitting next to each other, on two closely related derivatives, and neither having been heard. These are two of the seven 'Toyo' derivatives. Richie also has to deal with potential interactional difficulties in the talk. Marco's request for clarification of his price overlapping with Richie commencing a price to Amir.

Richie utters the two prices again, explicitly turning and pointing to each - to Marco on 'five six and a half' and to Amir on 'you're four five and a half'. Richie then goes immediately on to trade in with two other dealers (Roy and Dave) concerning derivatives 'Tobu Store'.



Ri: five six and a half=

=you're four five and a half

Throughout this fragment, the display of body movements in relation to the talk provides dealers with the resources to secure engagement in the interaction, to break apart from the talk when necessary and to initiate further interactions.

Handling a continuous stream of phone calls for any derivative sets up a range of practical problems for the traders. It may be that the remote dealer on the telephone is requesting a quote on one of their own derivatives, but more than likely it will be the responsibility of one of their colleagues. In such cases they have to secure, whilst on the phone, the engagement of the appropriate colleague, request the current price of the derivative and later note whether the trade had been done. This is while the colleague may be on the phone himself or being addressed by others and embedded within the other talk in the trading room. Dealers manage these practical problems through a range of fairly conventional interactional devices: they direct particular utterances explicitly at colleagues, by name, for example, or shout out names of derivatives that would encourage the participation of a colleague. However, what is noticeable in these materials is the bodily conduct of the participants. As they are usually standing they are continually turning towards and away from colleagues, waving to each other across the desk, pointing or raising their hands and arms.

What this apparently extravagant conduct may be accomplishing, in part, is overcoming potential interactional difficulties inherent in the setting. What is most noticeable is the prevalence of overlapping talk. In the fragments presented, there is a great amount of talk occurring within the trading room from other dealers unrelated to the deals we are examining. For clarity we have not presented this talk in the transcripts. The dealers seem to be able to recognise talk that is potentially relevant to them and undertake next actions appropriately. However, overlapping talk when produced by multiple participants, where both may be relevant to a single co-respondent, requires the co-respondent to produce the appropriate responses in the appropriate order. In conversations, interactants can rely on the sequential ordering of turns of talk to supply the interactional context with which to both produce and recognise relevant next responses (e.g. Schegloff, 1991). In this setting, such resources are rendered potentially problematic. As in fragment 4, where two requests for quotes and then two requests for clarification require different responses for different participants, and when the requests for prices and for clarification overlap.

At one point a relevant next turn for Richie could be a quote for Amir or a repeated quote to Marco, where both could be prices. The problem may be interactional but so is the solution: Richie pauses, orients to each and, as he gives the price, pointing to each dealer in turn to mark out the intended recipient.

What may also be noted is that the talk is very concise, typically mentioning the name of a derivative, a price and the dealing room who they are buying from or selling to. Often even these are not clear or made explicit. Prices are given in abbreviated forms and so are the names of issues of derivatives. One of the skills of trading is being able to produce and recognise these names and prices and immediately assess their relevance. We will consider these practices in more detail in Chapter 5.

The fragments given here give a sense of nature of trading in the derivatives market. Trading of the kind outlined here occurs in bursts, usually coinciding with the opening of one of the world markets. It happens very quickly. On the table of six or seven dealers it is not unusual for three trades to be underway at any moment, with other trades 'on the table' ready to be taken up by others. Dealers can be seen just before a market opens discussing which derivatives they will be buying and selling. These discussions are critical to make sense of the activities of colleagues whilst they are trading. Also in such a setting there is little time for traders to record what they are doing, so dealers are seen after a hectic period of trading discussing what deals took place so that they can record the trades undertaken on paper tickets. This can take some time. The activity at Deepdene's is a mixture of highly complex and parallel trading for short periods with longer periods of discussions and bureaucratic record keeping.

It may also be noticed that these dealers do not use computer systems whilst trading. As Richie does in these fragments, they sometimes refer to paper lists of prices on the desks, but do not refer to the one screen on the table. Indeed, the reliance on being able to produce and recognise each others' bodily conduct may be why so much trading is undertaken standing up. Having computer systems in front of them would both obscure this and provide another location to which they would have to direct attention. Deepdene's, therefore, has many similarities to 'open-cry' trading floors where stock-market dealing occurred up to the 'Big Bang' of 1986 and where some commodity trading is still accomplished. However, such trading floors are becoming more unusual both in the United Kingdom and abroad.

From the recorded materials of Deepdene's, we have seen how even a slight turn or gesture may be directed to one trader who is standing either near or further away, and this is done in relation to their previous turn. There are cases where these interactions become slightly problematic, and yet in their very production we can see how their actions are still shaped and designed for another. In contrast to the first regional

trading room described, these are highly complex multi-party interactions where we can have up to eight people with multiple orientations who may be constantly shifting their orientation and form of participation. Some of these shifts and subtleties may be picked up by the camera and it is possible to get some sense of the activity, but it is difficult to get a full sense. For example, a slight shift in body orientation may also change the voice contour so that it picks someone out at the end of the desk. One camera and microphone will not pick this up. In these video materials it is very hard to capture the multiple loci of activities at both ends of the desk, and to follow the ways in which they may be constantly shifting in relation to each other. This presents a problem for analysis and presentation of fragments as the analysis has also to follow these shifts and different loci of activities. Actions are shaped for participants in very delicate ways, often as they stand or sit very close to each other. They almost appear to be designed just for that participant so that others may not pick up on the precise nature of the action. These are often occurring in parallel, and it is very difficult to pick up these actions on a single camera that could provide both a focus on the local interactional details and the features that may be apparent to others on the outside.

We wish to focus our analyses on a setting that allows exploration of different forms of collaboration between dealers. Most particularly, we wish to investigate how dealers engage in different multiple activities and the ways in which talk is produced in interaction. Deepdene's data is valuable for looking at the production of multiple activities for multiple participants through visual conduct and the organisation of the local environment. This is not a theme that is explored in this thesis. Rather, we look at the relationship between visual conduct, talk and other activities in relation to material artefacts such as documents. We wish to examine issues of interest such as the interactional production of deals, how various dealers and others collaborate to produce deals, and the different forms their participations may take. We investigate how deals are recorded and we examine in more detail the complexity of talking numbers. In the materials from Deepdene's, it is difficult to unpick the parallel nature of talk; not only turns of talk, but also who they are oriented to and how they are utilised. In the remainder of this thesis we will focus on a third dealing room, the equities trading floor where we undertook longitudinal fieldwork, revisiting the setting at different points over the course of several years. The equities trading room provides for the possibility for circumscribing particular dealing activities and looking at them from the participants' orientations.

## 4.5 Dealing in an Equities Trading Room

The main part of our analysis investigates market makers on the equities desk of one dealing floor of a securities house, who deal in stocks on both the US and UK markets. This type of dealer has a continuous responsibility to buy shares at their

published bid price or to sell shares at their offered price whether or not they actually hold the shares. In this way market makers make a profit on the difference between the prices at which they buy and those at which they sell. Our study gathered materials from the ‘number one’ position on the equities desk which deals in the top ten stocks (for example, Hanson, ICI and Wellcome). Dealers currently work the stock collaboratively, and the position is managed by two dealers; one (John) being mainly responsible for dealing in registered stocks, that is, those that are listed on the UK Stock Exchange, and the other (Robert) for American Depositary Receipts (ADRs) that are certificates traded in the US, backed by registered holdings of shares in UK companies. As these dealers can effectively trade and hold stock in both sterling and dollars, they have to keep track of changes in the exchange rate and the current state of both markets. They must also ensure that the bank has enough of the appropriate currency to cover any deals done in ADRs (Figure 4.3 is a rough plan of the local area of the dealing room where John and Robert are located).

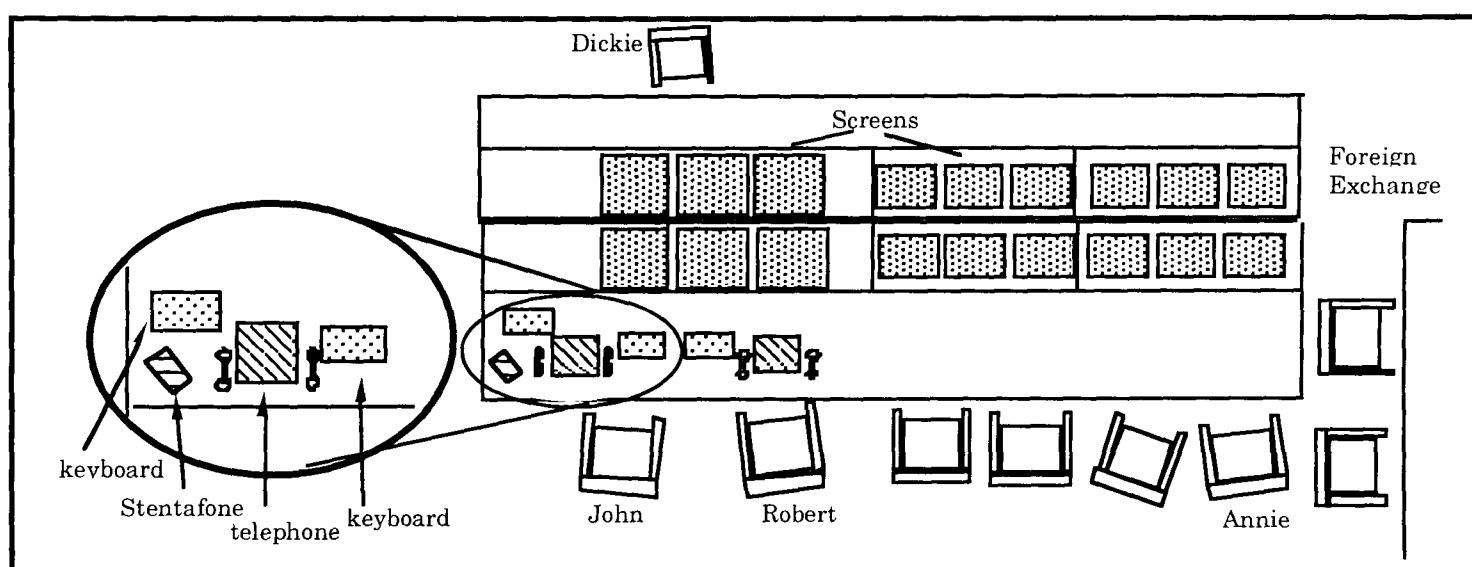


Figure 4.3. The ‘number one’ desk in the dealing room

#### 4.5.1. Deal capture

Primarily, dealing in shares takes place over the telephone between market makers in different trading rooms. However, other deals can occur within the trading room either through the stentofon (an intercom system), face-to-face or shouted across the trading floor. These types of deals may occur between a market maker and salespeople and may also include foreign currency dealers, depending on the type of deal. In the following instance, Giles (a salesman) calls John (the market maker in registered stocks) over the stentofon while John is on the telephone to another caller:

##### Fragment 5 Tape 2

BEEP  
 (0.3)  
 G: allo:↓  
 (1.2)  
 J: allo (Giles)

- (0.2)  
 G: I wanna sell: fi:ve o seven fi:ve shell fi:ve o seven fi:ve  
 shell for (Kleinwort↓)whatever>you>can>do>John↑  
 (0.2)  
 J: Eh (.) four ei:ghty three and a ha↓lf↑  
 (0.2)  
 G: That's very kind of you three one six thank you sir↓  
 (0.2)  
 BEEP

Very briefly, in this fragment, Giles a salesman calls John because he wants to sell 5075 Shell stock on behalf of his client Kleinwort and he asks John to quote a price. John provides a buying price of £4.83<sup>1</sup>/<sub>2</sub> per share. Giles accepts this and ends the call by giving John Kleinwort's customer number (316). We return to this fragment in Chapter 5, but at this point we simply wish to look at the key features of a deal: the buyer (John); the seller (Giles on behalf of Kleinwort); the price (£4. 83<sup>1</sup>/<sub>2</sub>); the shares being traded (Shell); the number of shares (5075) and the customer number (316). These six components of a deal, the stock, amount of stock, price, who is buying, who is selling and the customer number are the basic features of interest when trading. Fundamentally, these are the items that are being traded through the course of the ongoing deal. Dealers may be trading in various components such as different quantities of stock or different prices. They may be sometimes trading in the same stock in different markets and spotting where they can make money on the difference in prices across markets. Most commonly, they trade in some combination of these possibilities. The numbers that dealers use in these transactions are of different types and groupings. The actual transactions seem to happen very quickly, where large amounts of stocks are traded in deals that can occur anywhere between one every 5 to 30 seconds. In the above example, roughly £24,500 was traded in approximately ten seconds but the amount can obviously be far greater depending on the price of stock and amount being traded.

An immediately striking feature of these deals is that very little negotiation seems to occur over price. This is in contrast to other types of trading setting, for example in auctions. One explanation for this may be provided by Smith's (1989) analysis of auctions; he suggests that they are characterised by price-governed, public, competitive transactions where participants can respond to bidding or the lack of it, by adjusting their own bids. Contrary to conventional economic thinking that views all values as determined by price, Smith argues that it is not some principle of evaluation such as quality, scarcity or size that determines price, but rather that in auctions 'price determines value' (p.16); through competitive bidding they 'seek to establish standards of worth through price' (p.16). In the stock market there is little ambiguity regarding the value of stock at any particular moment, though there may be of course in terms of its future value. Nevertheless, Smith argues that the immediate

future will probably be similar to the present, therefore it is the 'market' or the 'ongoing collective transactions' (p.168) that prevail. In dealing rooms, decisions concerning value are made within the ongoing movement of the market. Prices are largely determined by the last price on that stock, but that price may be modified by market-makers who may be responding to various factors including supply and demand, whether they are long or short<sup>9</sup> of stock at various times, and other factors such as news or current affairs. So it is that, as in fragment 5, salespeople may approach market makers on behalf of clients who will quote a bid price (the price at which an investor can sell to the dealer) and/or an offer price (the higher of the two, and the price at which an investor will buy). These prices may be modified during the ongoing deal.

After a deal is made, whether through the telephone to another market maker or within the dealing room itself, a record of it must be made. This is essential for two main reasons. First, there is a requirement from the London Stock Exchange that the registration of deals occurs within sixty seconds of the deal having been done. Therefore, the critical components of the deal, the basic six items as well as any others, must be recorded and that information transferred to the Stock Exchange centralised database. A further important reason to record details of the deal is for the individual dealer's use, where the information is used to update a dealer's position (how much stock a dealer has or does not have along with their value). This information is critical for the dealer's management of risk, as decisions about buying and selling may be made according to present holdings. This process of recording deals in the trading room is currently known as deal capture and is done on paper 'tickets'. Each dealer has a book which holds the tickets on which he or she writes a record of the deal. The ticket is then removed from the book and picked up by 'trade input' staff who type the details into a separate computer system.

A trading room is usually segmented into three domains. The front office is where the market traders themselves are located. Often 70% of staff of the securities house work in this section. The middle office contains researchers and strategists who advise the bank or securities house on its trading policy and support the ongoing strategy. Finally, the back office is where transactions made on tickets in the front office are typed into the databases, settlements are organised, and accounts are produced. Thus these tickets are completed not just for an individual dealer's recording purpose; they are also recorded for others in the back office, where items must be read and typed

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<sup>9</sup> A dealer is short of shares if he does not own them at the time he sells them. This may occur because the dealer hopes to buy them before the following week when he has to deliver the stock. This would be preferable if shares are expected to fall in that week. Because of the risks due to the fact that the price may rise instead of fall traders do not like selling short. This is also known as a bear sale.

Long is the opposite.

correctly into the database, or where items must be checked against the counterparty's ticket of the deal to see if there are any discrepancies. As this checking may occur anytime until settlement, though usually they are checked the following day when the trading room receives matches and mismatches from the Stock Exchange, we can see that these tickets are not just relevant for the moment following the deal, but also over a longer period of time. In actual fact, the paper tickets are kept in the back office for checking purposes for a period of three years after the deal has been made.

#### 4.5.2. Multiple activities

As mentioned earlier, dealers trade over the phone, the stentofon and across the dealing-room floor. It is possible, as in the following instance, for dealers to carry out more than one deal concurrently. Here John is doing a deal in Glaxo on the stentofon whilst also engaged on the telephone.

##### Fragment 6

BEEP  
(0.2)  
S: Eh Glaxo for (Hambros) please  
(0.4)  
J: Ehhhh ((*John looks at screens*))  
(0.2) ni:ne(t)y (.) ffive ni:ne↓  
(0.7)  
S: Nine(t)y five↑ nine  
J: ((*John picks up receiver and is talking on the phone*))  
(6.3)  
S: Eh (.) fir(t)y>seven>thousan(d)>(you get)>at six nine five  
( seven one six)  
(.)  
J: Thirty seven thousand I buy at six nine five↑  
(0.2)  
S: That's right John  
(.)  
T: Thank you↓  
(.)  
BEEP

John is not only making deals over the phone and the stentofon, he is also monitoring the bank of eleven displays in front of him.

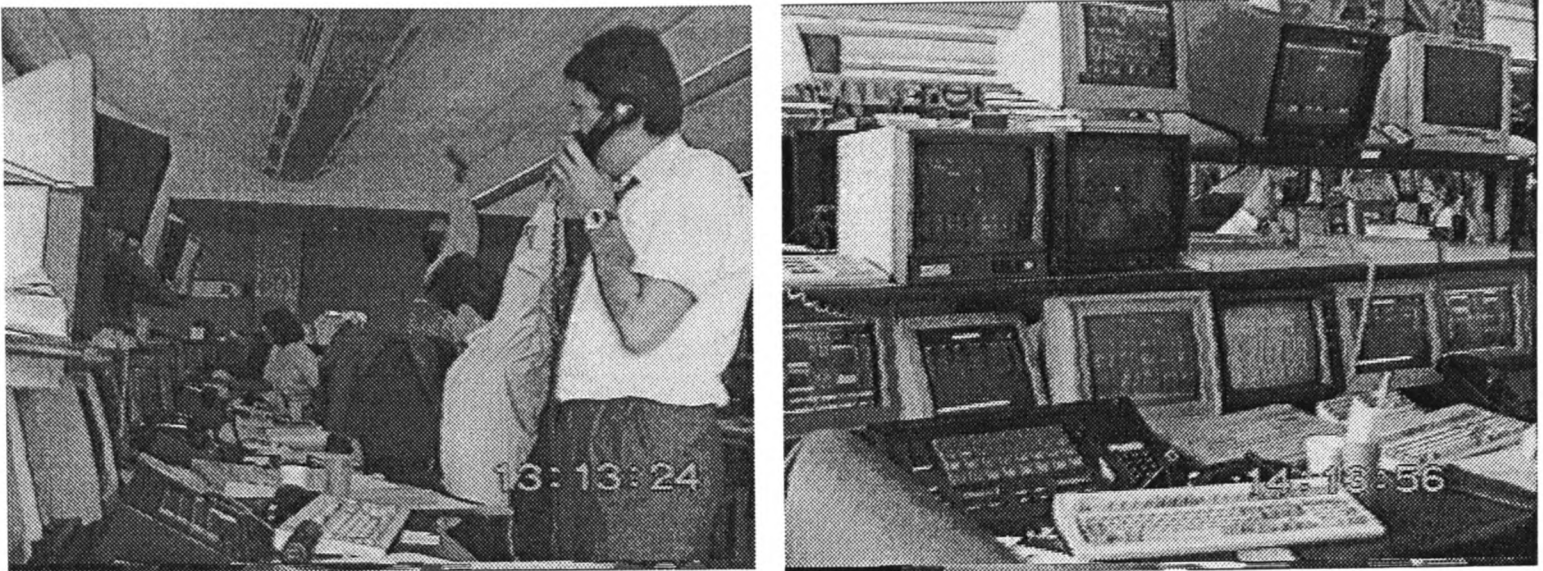


**Figure 4.4:** John monitoring the bank of screens and the 11 screens he uses

These screens supply information concerning: screen-based price and market news in the US and UK; prices from inter-dealer brokers that allow dealers to trade anonymously with each other; foreign exchange conversion rates; the dealer's own position - their holdings and value of their stock; a system that displays information on all stocks and City dealers' prices on those stock; and an in-house Rapide system which, by presenting a restricted amount of information, allows dealers to see 'at a glance' which competing market makers are 'on the strip', that is, offering the best bid and offer prices on a particular stock.

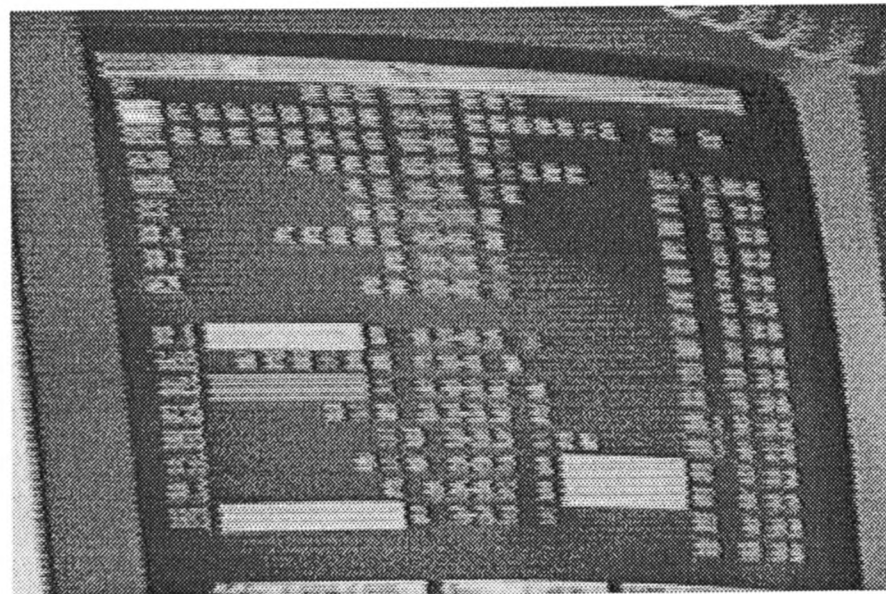


**Figure 4.5:** The Rapide Monitor showing the trading rooms on the strip for each stock

From all these resources, dealers must be able to discriminate what is relevant for them in order to make a deal in a complex changing market. Furthermore, the displays enable dealers to make sense of deals as they emerge, both to render intelligible the activities of others and, where they are mutually accessible, to rely upon as a resource in the interaction with others. For example, it is not uncommon for dealers to refer to stock in terms of a price rather than a name, in so doing relying upon others' awareness of the current market through the screens to make sense of a deal. In the fragment above, we can see that John utilises the screens to provide a price for Glaxo. This results in him buying 37,000 at £6.95 per share from the salesman selling on

behalf of Hambros whose customer number is 716. Once again, within a matter of seconds, a transaction worth £257,000 has been struck.

Dealers may be monitoring screens or on the telephone whilst trading on the stentafon or with other salespeople on the trading floor. More than one deal may be going on. It is not uncommon to see dealers engaged in two or more deals at different stages of the process. Thus, they may be recording a previous deal whilst engaged in a current deal on the telephone and awaiting other information to finish recording a third deal. All these activities are undertaken fairly unproblematically. Individuals in the trading room, be they salespeople, traders or back-office staff, can make sense of each other's actions and their activities are thoroughly collaborative.

#### 4.5.3. Collaborative dealing

Similar to Deepdene's trading, a number of deals may be built alongside each other and, at the right moment, a substantial amount of stock can be sold as it is being purchased, maximising profit and keeping the books balanced. These activities rely not only on being aware and informed about another individual's actions, but also on the active participation of others in the deal. Not only do dealers use screens and various activities to produce deals, but they also utilise how traders in other dealing rooms will treat these activities. Commonly, dealers can use the screens in conjunction with dealing to develop a 'ruse' to get the best price for the stock they are buying or selling. In the following example John and Robert discuss various possibilities for buying stock in Smith Klein Beecham (SBEs) before going on to collaborate on a deal.

##### Fragment 7

- R: (I don't know) Sh'll I buy em?  
((peers at screen))  
(0.2)
- J: Yeah  
((Nods))  
(0.5)
- J: ( )  
  
(0.3)
- R: Or sh'll I jus>go an deal directly with BZ?  
((picks up the receiver))

R J

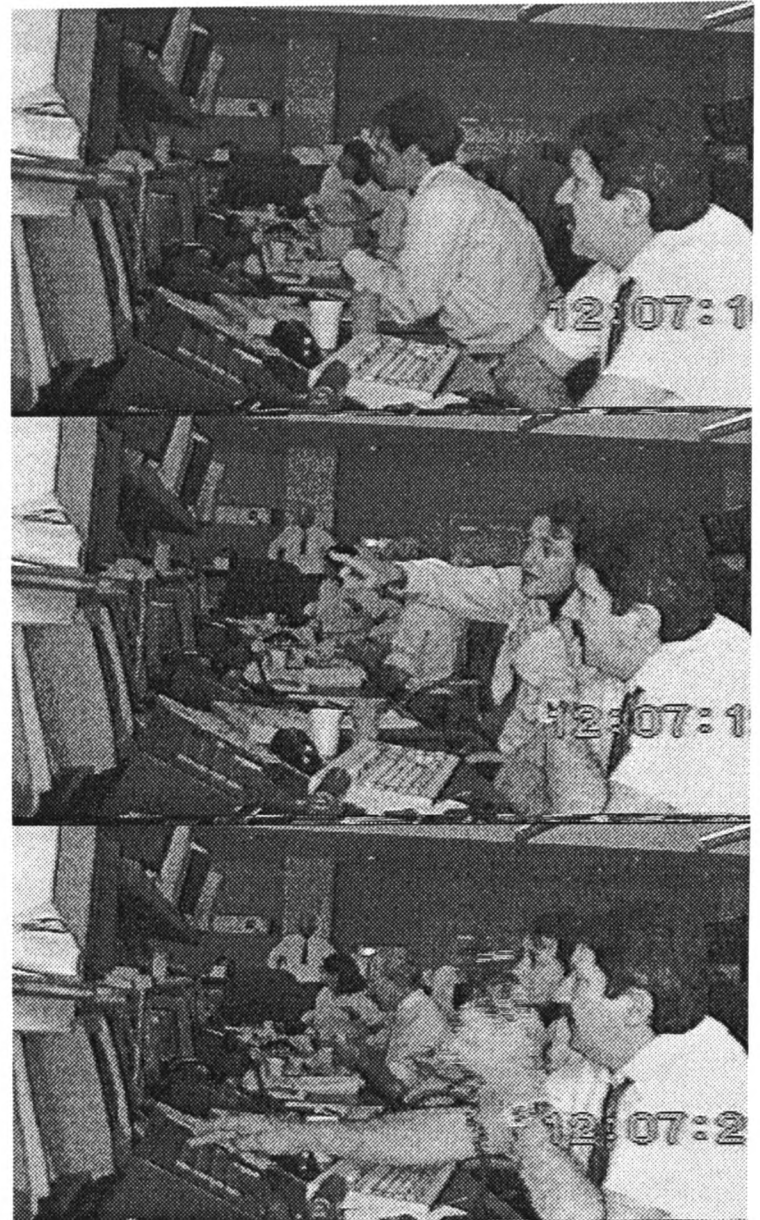


(0.2)  
J: (D)ye think its BZ yeah?  
(5.2)

R: ((points to John's screen))  
R: (Put down) an offer up there on the IDB (for me) a (four on one) offer so they sell them to me

((John picks up receiver))  
(2.2)  
J: (on phone) ( )  
(0.4)

J: I put up two offers (0.2) thhh  
(0.6)  
R: (on 'phone) Mi::ke? (0.6) Come>on then bo:y  
come>on then bo:y ow many of these em  
(0.2) SBEs (are you trying) to sell ( )?  
(5.3)  
R: (on 'phone) I(t) is but you had to do it ( )  
(0.2)  
R: (on 'phone) Is it many you didn't sell (there)?  
(1.2)  
R: Really?  
(3.0)  
R: Ei::ghty two hundred?  
(0.3)  
R: Lu:vly  
(0.3)  
R: Ei::ghty two hundred I buy (.) at seven six ( ),  
((peers at screen))



Within the dealing room, in order to secure a deal successfully, dealers may actively seek the collaboration of other dealers. While they are discussing the potential deal, John and Robert glance up to the top set of screens. These are presenting price information from Inter-Dealer Brokers which are anonymous (i.e. the buyer holding the stock or the seller bidding for it are not identified). From

monitoring the screens throughout the day, following the movement of stock and the activities of the other market makers on the strip, Robert suggests that the seller of stock on the IDB may be 'BZ' (or BZW - Barclays de Zoet Wedd). Potentially identifying anonymous traders will save money. If dealers 'take the offer' or their purchase is matched to the one who is offering the shares at a particular price through the inter-dealers broker, they must pay the broker an aggressor fee, whereas if they deal directly with BZ they do not. In addition, detecting the anonymous seller provides Robert and John with the opportunity to collaborate on a 'ruse', whereby John actually puts an offer to sell SBEs on the IDB at the same moment that Robert tries to buy some directly from BZW. John 'puts out' shares at a lower price than are currently being shown, in order to suggest to the market makers at BZW who see the new prices that SBEs might be falling in price. The ruse is that this will encourage BZW to either drop their own price, keep it stable or, at least, sell the shares quickly. In fact, John puts two offers out on the IDB which appears to secure the deal for Robert. The timing of this type of ruse is critical as not only must the price appear in time to have influence on BZW's market makers, but while these prices are on display on the IDB, John and Robert are potentially vulnerable in that if another market maker takes their offer they are obliged to sell their stock at that price. Thus, they must coordinate their activities very skilfully to conduct the ruse and cancel the offers on the IDB as quickly as possible. This is one of the many ways in which dealers make use of the technology available within the trading room. By utilising the screens to make sense of the moment-to-moment changes on the market, dealers are potentially able to secure a colleague's collaboration on the trading floor and can rely on market makers' use of the technology in other trading rooms in order to do a deal.

#### **4.5.4. Monitoring the local environment**

The previous fragment reveals how dealers may actively collaborate to influence the market in ways favourable to the particular deal they may be undertaking. There are also more subtle forms of collaboration between dealers. In the following fragment, Annie, who is sitting at the far end of the ADR desk shouts out information about Hanson shares:

## Fragment 8

4.6 A R J



4.7 R J



4.8 R J



A: HAN:SON. TWENTY OF AN EIGHTH, FORTY  
BY FIFTEEN:, (SHEARSON) ON THE BI:D

R: ((*Sitting down*))  
(0.2)

J: Are we going to hit 'em?  
(2.3)

R: ((*Peers at screen*))

R: Erm::↑ (.) YES::,

R: (0.9) WHO'S: THAT?  
(1.0)

R: Bernie? ((*Picks up phone*))  
(3.0)

R: We want to sell (forty:)

The way in which Robert and John collaborate on this deal, given the whole range of activities that are already underway, is very delicately achieved. So, when Annie shouts that Shearson is 'on the bid' (picture 4.6) or rather that Shearson, who are another market maker in the City, are buying Hanson stock, Robert is closing up a conversation on the telephone. As Robert sits in his chair, John turns momentarily towards his domain and asks whether they should try to 'hit them' (i.e. sell their Hanson shares to Shearson (picture 4.7). John's question presupposes that Robert has both heard the utterance and may be prepared to collaborate in selling the stock. It appeals to, and invokes a mutual orientation towards, selling stock and initiates collaboration with John. Robert has made no indication that he has heard Annie's utterance. But then, in later talk with John, Robert displays he has indeed heard Annie's utterance and made sense of it.

A second or so later, Robert grabs the telephone and shouts to Annie, asking who is actually on the phone (picture 4.8). A little later a substantial amount of stock is sold. Much of the skill of dealing is about being able to see at a glance from all the monitors when to take an appropriate action – whether to buy or sell, and whether to take action in relation to other information that may be shouted around the dealing room. Outlouds are shouted for others in the domain and do not demand collaboration. Outlouds like Annie's in this example are sensitively designed, whilst at first seeming potentially disruptive to others in the room. Although the initial utterance is shouted, this does not mean that it is necessarily insensitive to the conduct

of colleagues. Indeed, as has been mentioned elsewhere (Heath et al., 1993), the design of outlouds and other shouted utterances can be tailored to the demands of the local setting; they can be heard by a range of participants and in their very design they do not demand particular responses. The outloud also provides for potential collaboration as John can presuppose that colleagues for whom the information may be relevant will have heard it. Thus, whilst participants need to monitor the local environment of objects, such as screens, they also need to monitor the activities of their colleagues in relation to those objects. Such peripheral monitoring of activities seems to be an essential feature of both individual and collaborative work in a variety of different settings. Other studies such as London Underground Control Rooms (Heath and Luff, 1992a) and Air Traffic Control (Harper et al., 1991), have also noted that participants seem to be sensitive to and monitor colleagues' activities in the local domain, whilst at the same time being engaged in apparently distinct activities.

There are a whole set of activities going on in the trading room that are potentially relevant for dealers and can help them make sense of what is going on in the market, understand incoming calls and support them in making deals. These include news broadcasts, outlouds, and even information that is tagged onto forwarded phone calls by colleagues. Dealers refer to the need to become aware of these activities and their implications for trading as developing 'a third ear'. They have to remain sensitive to the local environment of action and to discriminate what may, or may not, be relevant. Furthermore, work within the dealing room demands that whilst they are engaged in one activity they may have to participate simultaneously in the activities of colleagues. So, for example, we find dealers who are apparently engaged on the telephone, making recommendations to a colleague as to what he should buy or sell. Indeed, a dealer may design a single utterance in such a way that it not only secures a sale on the telephone, but simultaneously publicises the purchase within the dealing room itself, encouraging a colleague to make the necessary currency arrangements without necessarily having to respond and abandon activities they may be currently involved in.

#### **4.5.5. The collaborative production of a deal**

The following fragment reveals the collaborative production of a deal between three dealers; Derek a salesman, John a market maker, and Steve another market maker. The deal itself is quite complex in that Derek attempts to negotiate a better price from John and Steve by combining deals in two separate stocks. We shall look at this fragment in more detail in Chapter 6, but for the purposes of this chapter we shall focus on how, through the talk and visual conduct, the dealers gradually come together to achieve the deal focused on the computer screens in front of them. The fragment begins as Derek shouts across the desk for the current price on 'BATS' (the abbreviation for British American Tobacco shares).

### Fragment 9 Transcript 1

Derek: What are Bats  
(1.0)  
Steve: [ That's us  
John: [ Bats  
(0.6)  
Derek: Bats  
(0.4)  
Steve: That's us  
(5.3) ((Derek comes round and looks at the screens))  
John: What have you got in mind sir  
(1.0)  
Derek: I want to sell a hundred  
(0.7)  
I want to sell fifty Orange D'you do Orange?

As we can see, Derek does not get a direct response to his question about the price of Bats. Instead, two traders John and Steve reply simultaneously with 'That's us' and 'Bats'. This response identifies them as the traders in the share, whilst also withholding actually giving a price. After his initial request Derek comes around to stand behind John and Steve, whilst repeating the name of the share, to which Steve replies again: 'that's us'. When Derek is stationery behind John, John turns around to briefly glance at him and then turns back to his screen.



John: What have you got in mind sir

Derek stands behind John for over four seconds before John asks 'what have you got in mind sir?' Only then does Derek say the amount he wants to sell, a hundred shares, and adds that he wants to sell fifty 'Orange' (a telecommunications company) stock as well.

Through various interactional devices, John, Steve and Derek come together to deal in some stock. Whether or not Derek wants a price, there and then, John and Steve's minimal responses to his initial shouted question 'What are BATS', at least selects for him potential co-participants in a trade. This gives him the resources to move into a more focused interaction with John and Steve. However, the repetition of his query only gets the same self-selection from John and Steve. Indeed, John actually turns towards Derek and asks him directly what he 'has in mind'. Derek's initial query is particularly vague, neither stating whether he wants to buy or sell the stock nor the amount he wants to trade – critical matters when dealing. John and Steve's

responses possibly reflect this vagueness. Indeed, it takes an explicit query from John for Derek to give more details of the trade he is proposing.

From the initial shouted query, Derek, John and Steve come to be oriented towards the screens in front of them. These screens, which give the current prices of various stocks become a resource in the subsequent trading.

#### Fragment 9 Transcript 2

Derek: I want to sell fifty Orange D'you do Orange?  
(0.3)

Steve: Yeah  
(2.0)

John: I can do them both on the prices Derek I (wouldn't )  
(5.0)

Derek: (Give) me a half penny in one of them  
(0.3)

John: No (i [ ts )

Steve: I'll give you three and a half for the Orange ((To Derek))  
(0.4)

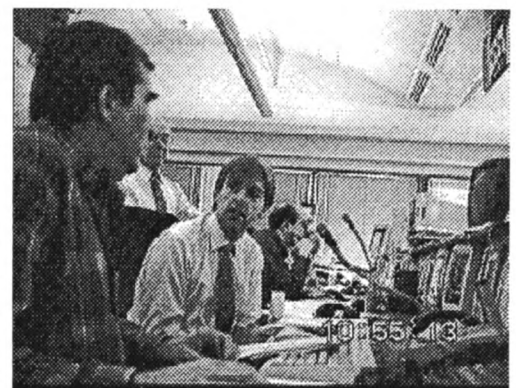
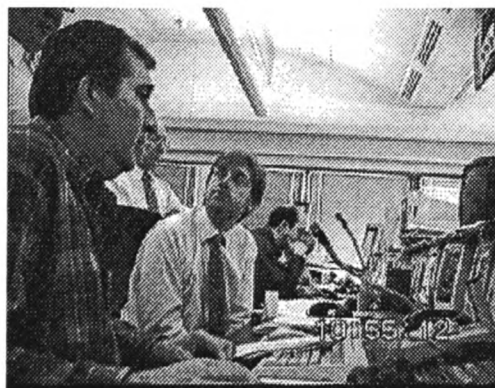
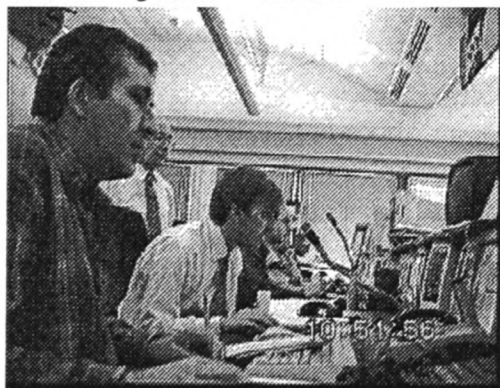
Derek: That's fair enough  
(0.3)

Derek: Three and a half for the Orange  
(0.3)

Derek: Three and a half for the Bats  
*((John turns to look at Steve, Steve looks at John))*

Derek: Thank you

Derek John Steve



Steve: I'll give you three and a half for the Orange

After Steve's confirmation that they deal in Orange shares, John says he can only buy at the prices on the screens, turning to Derek as he mentions his name. John relies on Derek's orientation towards the screen to make sense of his utterance 'I can do them both on the prices'. Derek appears to do this; however he does not seem happy with that price. Instead, he requests a higher price – '(give) me a halfpenny in one of them', which John rejects. As John begins to give an account of his rejection, Steve turns towards Derek and agrees to the proposal 'I'll give you three and a half for the Orange'. Derek confirms, in full, the prices on both shares and the deal seems done.

Although John and Steve deal in a common list of shares, they each keep individual accounts, or ‘books’. So, despite collaborating over many deals, they can also trade separately. Hence, there is an ambivalence to whom Derek’s request to sell is being made. It could be to John or Steve, or to both of them. It is only after John’s rejection of Derek’s suggestion that Steve discriminates himself as an alternative buyer. Indeed, up to this moment Steve’s participation appears to emphasise the joint nature of his dealing with John, repeating ‘that’s us’ in reply to Derek’s initial request.

However, each dealer maintains an orientation to their own individual responsibilities. Steve’s offer, at that moment, in the light of John’s rejection, discriminates his activity potentially on his own behalf from the foregoing talk by John. In doing this, it is interesting to note that he not only glances towards Derek, but also at John. Indeed, after the deal has been accomplished Steve asks which deal John will record as his own. So, even after the deal seems complete, there is some ambivalence to the ways in which activities are tied to the individuals in question; it is still open as to who will buy which stock. As they come to record the deals, it becomes apparent that it is unclear who has agreed to buy which stock.

### **Fragment 9 Transcript 3**

*((A short time later))*

Steve: Which one are you booking John  
(0.6)

John: Eh (1.5) I’ll buy the hundred Bats  
(0.3) ((Both start typing in their tickets))

Steve: All right. (0.5) I’ll buy the fifty Orange. (1.0) We’re short of ()  
(.) hundred an (.) I know they’re high but we’re short of a  
hundred and fifty Vodafone. If we can use th these fifty (.)  
Orange to em bash down at some point doesn’t matter does it.

Although the traders have individual responsibilities and can engage in individual tasks and activities, the distinctions between them and between these and ‘collaborative’ activities are produced in the ongoing interaction. The participants can delicately shift between an individual activity and a joint venture, and can even let which orientation they are engaged in remain open. Though it may not be clear in the above instance who has bought which stock, the precise buyer may not necessarily need to be explicit at the time of dealing.

We see how, through the talk and visual conduct, participants gradually come together to accomplish an activity focused on the artefacts in front of them: the computer screens. In the instance considered here, the shouted question is not only answered, but is a resource for a more collaborative activity. It should be noted, that the critical resources for the activity are the computer screens. The contents of these are utilised not only to accomplish particular activities, for example, to refer to a

specific price for a trade, but are essential in the production of activities. Through the screens, sense is made of the deals and of the ongoing interaction.

Though the participants in ‘the deal’ could be discriminated between seller and buyers, or between salespeople and market-makers, when the three participants come together jointly to accomplish the deal, they can, in a moment and through their talk and activities, delicately shift their orientations to these activities and responsibilities. It can be ambivalent whether participants are collaborating in a ‘group’ or engaged in a collaborative activity, or even how they are at any moment in time discriminating their participation from those of their colleagues: even a participant’s demarcation of an activity as his own can be sensitively produced with regard to the concerns of others. The participants in a group may be transformed for different purposes, as in the above instance when the dealers talk to each other and when they interact with Derek. Thus, even the notion of ‘group’ is sensitive to the interactional circumstances in which the deal is produced.

## 4.6 Discussion

Over the last few decades, major technological changes have occurred in the workplace that have radically transformed the ways in which people do their work. A critical area in which these changes have been most pervasive is in the financial sector, where a great amount of time, effort and money has been spent by the government, banks and the Stock Exchange in attempts to improve various aspects of the industry that seem most amenable to technological support or automation. These endeavours are undertaken in the hope that technological improvement will make work in the City more efficient and thus, provide an edge in dealing with others in markets both in the City and all over the world. A major part of these technological initiatives has occurred in financial trading rooms where vast amounts of money can be made or lost in an instant. Most recently, the notorious TAURUS<sup>10</sup> project was designed to replace paper certification in the London Stock Exchange with a computerised system, in order to make settlement practices more reliable and efficient.

As mentioned in Chapter 3, in the equities and other markets following the Big Bang in October 1986, there was a move from open cry trading to electronic dealing. In open cry trading, all deals are made in a central location, the trading floor, and the buying and selling of stock is achieved through a complex system of shouting and

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<sup>10</sup> It has been estimated that the TAURUS project cost the Exchange approximately £75 million and, with other interrelated systems, the total spent may have been as much as £400 (Collins and Bicknell, 1997).

signalling to other dealers. Until recently, the Liffe market was also of this type. With the move to electronic trading, various individual trading rooms developed and trading is now carried out on the telephone with computers and information systems providing information on the state of the markets of interest. In 1997, the exchange introduced the SETS trading system (Stock Exchange Electronic Trading System) which removed the tradition of market-making firms quoting constant 'buy' and 'sell' prices to transactions that are matched automatically. Investors would now place an order on an electronic book and wait for it to be matched by another order. It was an attempt to abolish the market maker's role. However, even in situations where a radical technology has been implemented to automate a set of activities and effectively transform the roles and responsibilities of a section of people, the market makers can still find opportunities for carrying out the activities they are familiar with. With SETS, dealers began to discover ways in which the timing of placing an order was critical and could be used effectively in attempts to manipulate the market.

Likewise, with more modest technology there may be scope for improvement. The equities trading room described above, still utilising a quote-drive system, developed their own in-house information systems that extracted various components of SEAQ (Stock Exchange Automated Quotation System) tailored to an individual dealer's information needs. The dealer uses the SEAQ system to see who is offering the best price in the stock of interest. He may then phone the chosen market maker and negotiate the deal.

Further technological initiatives were developed regarding the two activities of deal production and deal capture in attempts to improve the volume of trading. Though automating trades is seen to increase the volume of trades and also to eradicate the problem of deal capture, the quote-driven system remains resilient in various ways. Trading with salespeople for example, still takes place face-to-face and deals must then be recorded. Similarly, the recording of deals is still of interest, as quote-driven trading may still occur in other settings such as the derivatives markets. While this mixture of quote-driven and order-driven systems prevail, the recording of deals is still an issue of concern.

A range of solutions have been proposed to the problem of recording deals over the last few years, often involving additional activities on the part of participants. A particular solution was to make use of the fact that dealers' talk was mediated through a technology, the telephone, and to record the relevant information directly from those conversations (e.g. Howells and Crowley-Clough, 1991). Particular suggestions to support this process have included the addition of headphones to current systems to prevent interference from outside noise. A large telecommunications company expressed interest in such a solution; to use Voice Recognition Technology to detect the key details of a deal from the phone conversations and then automatically to transfer the information into the dealing-room database and update the individual

dealers' systems. The hope was that not only would the automated deal capture system make the process more efficient and narrow the risk for individual dealers, but would also give the securities house real-time knowledge of their overall position, information which at present is lacking. It is interesting to note that many of the justifications for the use of voice recognition systems in this domain arise from the constraints of the current state of voice recognition technology. It has been argued that the limitations on the size of the vocabulary which such systems can recognise is matched by the limited amount of information that the system needs to record, as reflected earlier in this chapter, and the small number of words and jargon that dealers use (e.g. suggested to be thirty key words plus numbers). In addition, the predominant use of the phone for dealing and the apparent limited movement of dealers around their local environment should make it possible to train these systems on individual dealers' voices using specific phones. It seems possible that looking at the details of the dealers' talk may help to understand the feasibility and potential requirements for such a technology.

Deal capture in this domain is critical and is an example of a more pervasive activity in organisations in general, that of recording activities, be they on paper forms or on computer screens. As mentioned in Chapter 2 this is an area of concern for social scientists, but it is also of major importance to those who design information systems and databases and the recording of ongoing activities. Thus, real-time naturalistic analyses of the recording practice and how it relates to the activities it is recording and the work of actually producing the record, may be of relevance in the potential design of systems to support or automate record keeping. We investigate the recording activity in the dealing room in more detail in the next chapter. Understanding the *in situ* production of a record may suggest how a technology could be designed to be more sensitive to the ongoing activity. Such an analysis may also provide resources for looking at how current practices may be transformed when such technologies are introduced into the work setting.

## 4.7 Summary

From our preliminary analysis of the very complex and dynamic setting of a dealing room, we have begun to reveal some of the collaborative nature of dealing. We have looked at three dealing rooms with varying configurations and numbers of personnel; using different types of technologies in various ways and, where the pacing of activities is produced in different ways, according to the work at hand.

We have seen how dealers can secure collaboration through the use of various resources such as information screens to conduct trades that rely on the close coordination of their activities. The contents of these screens are also used to

accomplish particular tasks such as to refer to a specific price for a trade, to make sense of particular deals, and as a resource to move into more focused collaboration. We have also revealed how various utterances such as outlouds may be designed for a number of individuals to hear the information, without demanding that all or even any of them actually respond. At the more local level, dealers may delicately design talk that can encourage any one of a number of people to respond, without demanding that anyone in particular address the utterance. The analysis has also revealed how dealers may be seemingly involved in one activity and may have to participate simultaneously in the activities of colleagues. This participation may take different forms, from simply overhearing that a deal has occurred to actively collaborating in the production of the deal. Dealers may adopt orientations that allow them to oversee or overhear the conduct of others. When they are seemingly engaged in various practices, they may still be sensitive to the conduct of colleagues, even designing their actions with respect to their colleagues' activities. The way that dealing is produced for others is inherently collaborative and produced through both visual and vocal conduct and interaction.

When designing technology to support the work of dealers, it is critical to consider how talk and interaction relates to the recording of deals whether this be on a paper ticket or on a computer screen. We will examine this in the following chapter and will also investigate in more detail how deals get done. This is critical for understanding the recording of deals but also how deals are produced, for example, how numbers themselves are used and understood by dealers and different configurations of numbers relate to the recording activity.

# Chapter 5

## Deal Production and Real Time Record Keeping

When you are first learning to trade, one of the hardest obstacles to face is simply understanding what the hell people are talking about....when markets are moving quickly seconds can be vital. They are dealing in incremental price movements on very large amounts of money and absolute precision is needed in communication. Every minute counts. In order to disseminate information very rapidly a short hand method of communication has developed.

(Davis 1997)

### 5.1 Introduction

The analysis in Chapter 4 reveals the ways in which deals are achieved collaboratively by traders and others in the trading room on a moment by moment basis. We have looked at the ways in which traders are constantly monitoring their local environment and that of their colleagues in order to assess when to take action and when to initiate collaborative activity. We have discussed the timely production of ruses that take place in dealing and how these are collaboratively achieved; and the multiple activities dealers are involved in and how they interleave and co-ordinate these activities with others. And we have distinguished between the activities of deal production and deal recording. We have highlighted these activities in relation to a particular technology for supporting ‘deal capture’, voice recognition systems, that attempts to capture details of the deal automatically from the talk of the traders. Designers of these systems did not initially seem to distinguish the work of doing the deal and that of recording it. Capturing deals is accomplished through the writing of paper tickets, and these are seen to embody a summary of a deal that requires very little vocabulary or interaction from dealers to achieve.

It is a central concern of this thesis that understanding certain socio-interactional resources can greatly increase the opportunities for system designers to improve both

the practice of analysis and ultimately to develop better systems to support or transform work practices. In this light, this chapter investigates in more detail the components of the dealing activity; the ways in which the deal and the critical elements of the deal are produced through talk by the many participants both within and outside the dealing room. The production of each of the components of the deal to be captured is crucial to our understanding of how the deal is achieved and, as such, is relevant for the design of systems that claim to support this activity. The analysis begins to suggest how an orientation that examines activities in interaction can influence the structure of system design in quite fundamental ways.

In Chapter 4, we described the different ways that dealing in stocks and shares can be undertaken, either over the telephone, face-to-face or through the intercom system (the stentafon). In Section 5.2, we describe in greater detail the interactions that take place through the stentafon. This type of intercom system provides access to both sides of the interaction for analysis. From the fragments we reveal different types of trading interactions. First, minimal trading (Section 5.2.1), where a deal can be agreed very quickly drawing upon a set of common interactional resources. ‘Ambivalent’ trading (Section 5.2.2), on the other hand, may not appear to be so concise. Displaying ambivalence in these trades provides for some flexibility and movement in the deal itself. It allows for some openness regarding certain items and is recognised as ambivalent by other traders. Deals are also an interactional achievement, where one turn of talk may provide the resources for another to produce the next move. This collaboration is shared over various turns of talk using minimal resources, and through these turns we can see how the deal is produced sequentially. Displaying some ambivalence through these interactional resources possibly allows for agreement to be reached. If dealers are precise regarding all components of the deal, this may engender disagreement, and therefore actually result in being less concise as the disagreements need to be resolved. Finally, open trading (Section 5.2.3) is characterised by dealers not even declaring if they are buyers or sellers of stock. They simply ask for the ‘spread’ (that is, both the buying price and the selling price). This is often done in a very brief way.

Section 5.3 looks at the world of numbers in which dealers live. These numbers provide the ‘raw material’ of dealers’ work, and the different groupings and types of numbers along with the components to which they may refer suggest that this world of numbers may be potentially confusing. Deals are produced through different groupings of numbers, and we examine the skills of producing and recognising numbers in the dealing activity. We look at the work of abbreviating numbers (Section 5.3.1), how they are produced and understood by the recipient, and suggest that although there does not seem to be any explicit ordering or markers, numbers are said so that one grouping of numbers can be distinguished from another. Increasing our understanding of how these numbers are produced may be relevant for the design

of systems, such as voice recognition technology that attempts to record components of deals as they are produced in talk. The analysis reveals that the positioning of various components within a turn in relation to certain words may imply whether the number said is a price, amount or customer number.

Section 5.3.2 suggests that dealers are not only orienting to economy of speech in number production, but that they are also attempting to disambiguate potentially problematic groupings of numbers. We examine the work of repeating numbers in Section 5.3.3, where it is suggested that repetition may not necessarily display a mishearing but has interactional uses. Section 5.3.4 considers the recipient design of numbers and suggests that, by avoiding placing words between numbers, dealers may be designing the numbers this way for the other to write the number down - thus assisting in the practice of deal recording itself. It is suggested that numbers are produced not just for economy of speech but interactionally for a hearer to understand and recognise what is relevant, and they may be designed this way to be written down and recorded.

Section 5.4 describes how the record-keeping activity is thoroughly intertwined with the deal production. We describe how an apparently individual activity, the writing of tickets, is actually produced thoroughly collaboratively and through interaction. The ways in which components are written seems to be tied to the order of items produced in the talk and the trajectory of the talk. Section 5.5 discusses record keeping as a bureaucratic activity and describes how social science analyses have been interested in revealing the organisational competencies, the underlying skills and understanding of the domain of how records are produced. We describe how such analyses may be relevant to determining requirements for record-keeping systems, with particular regard to aspects of: categorisation, interface components and interaction styles and the characterisation of activities. These aspects can provide a greater sensitivity to the domain and may provide a foundation for understanding what is likely to be transformed by technology.

## 5.2 Stentafon Talk

The analysis in Chapter 4 describes how deals can be done in a variety of different ways. They can be achieved face-to-face with other dealers on the trading floor, on the telephone with other dealers throughout the City, shouted across the trading floor, or done through a stentafon, an internal intercom system that facilitates communication between dealers across the trading room floor. Our interest in this section is on deals done through the stentafon fundamentally for analytic concerns. Most commonly, dealers trade with other dealers through the telephone. Recordings of these interactions provide only one half of the conversation. However, when

communication comes through the stentafon it is broadcast to the dealer and, as such, allows access by the analyst (and others within hearing distance) to both sides of the conversation.

Dealers and others use the stentafon technology for internal communication in the dealing rooms for several reasons. Salespeople will trade on behalf of clients with market makers through the stentafon and market makers may also use the stentafon to contact other dealers, such as foreign exchange, in order to cover their trades in sterling. The technology may also be used for contacting others, traders on futures for example, for information that may be needed at various times. What seems most remarkable, when first hearing a deal done through this technology, is how much work is achieved in a very short period of time and through very few turns at talk. Typically in a deal, an interaction is initiated; reciprocity is established; the details of the deal are proposed, confirmed and agreed by both parties; and all this is achieved in extremely compressed forms over four or five turns of talk. Thus, what is most striking is the speed at which deals may occur - and this is all the more apparent during periods when the market is busy in terms of the number of deals that can take place in minutes. Deals for thousands or millions of pounds can be made approximately every five seconds at peak times. The speed with which the deal is achieved is increased if we consider that the stentafon technology allows traders to deal over the distance of the trading floor in relation to the contingencies of particular deals. It is this feature of trading that we shall explore in this section, attempting to reveal the resources dealers draw upon to produce deals at such speed and volume.

### **5.2.1. Minimal trading**

The following fragments reveal just how short and compressed deals may be. Typically in stentafon talk, there is little or no opening or closing of the interaction, just a beep as the connection is made or closed. The first fragment is an example of a deal between John, a market maker, and Rick a salesman in twelve thousand Hanson stock. The fragment begins as Rick contacts John through the stentafon.

#### **Fragment 1      Twelve Hanson**

BEEP  
(0.4)  
S:      John=  
J:      =(What)  
(0.5)  
S:      Twelve Hanson you sell at four to Hambros please  
(0.5)  
J:      Thank you Rick  
(0.4)  
BEEP

In this short, somewhat curt interchange, it is immediately apparent how quickly and efficiently a deal can be achieved. The speed with which participants identify with whom the deal is to be done, what the components of the deal are, and then agree on the details of the deal itself is remarkable when we consider that these activities are all achieved within half a minute. This is all the more extraordinary when we reflect on the work that is being achieved through their interaction. The sequence starts off with the 'beep' followed by Rick the salesman saying 'John'. The beep combined with the first utterance 'John' seems to elicit John's 'what'. This acknowledgement not only reveals John's availability but also secures for Rick a counterparty to his deal, a critical activity for any dealer. Thus the calling, acknowledgement and display of availability provide the resources for Rick to move straight into the reason for the call, that is, that Rick is buying twelve thousand Hanson stock from John. The trade itself is presented to John with all the relevant details necessary for recording, 'Twelve Hanson you sell at four to Hambros please'. This is the very substance of the deal, the matter of: which stock is to be traded, Hanson; how much stock to be traded in this particular deal, twelve thousand; who the counterparty is, in this case Rick is trading on behalf of the client Hambros; whether it is a bid or offer, John is selling; and at what price each of these twelve thousand shares are to be traded, at '4'. This is the selling price for Hanson that John is displaying on the screens throughout the City at that moment. How much stock is being traded along with its value is critical for John to assess his position in that stock and decide future courses of action. John confirms this with a 'thank you Rick' and thus, through agreeing to the trade, the deal is closed. The beep at the end of the fragment indicates that the call is closed.

An interesting feature of the work of dealing through the stentafoon is that it seems routine for the caller to speak first. This may be contrasted with telephone talk where the recipient speaks first (Sacks, 1992b, p.542; Schegloff, 1968). In part this may be explained by considering the design of the summons through the technology. In telephone talk the continuous ringing of the telephone might be seen as a summons to the recipient, but in stentafoon talk there is no ringing, just a single beep that provides the summons. The beep alone does not seem to summon a particular other, but rather the beep combined with the first utterance from the caller. This utterance in conjunction with the beep allows the caller to quickly secure a counterparty to the trade. There must be two parties to a trade, and getting the right party to trade at the right time is crucial. The right time depends on the contingencies of the market in the particular stock being traded; however, as the price in stock can fluctuate rapidly moment-to-moment, it is critical that the deal is entered into at a time when the buyer or seller judges the market carries the best price.

Dealers need to close the deal as quickly as possible and move on rapidly to consider positions for the next deal. In fragment 1 Rick provides John with the details of the deal, that he is selling twelve thousand Hanson to Hambros. John's 'Thank you

Rick' not only thanks the salesman for the deal, but also acts as a closing to the deal and an agreement, though not necessarily an explicit agreement. In this one utterance multiple actions are being performed; what have been called double-duty activities. Typically, these actions are produced collaboratively, in this case by two dealers. The utterances are socially produced and recognised unproblematically from moment to moment in the course of their production.

The above fragment reveals the work that is done in making a deal. In very few turns of talk, the participants reveal who they are; that they are not unknown to each other. They then display their availability to trade, and agreement between the two parties is secured on the deal. The deal is achieved very quickly through the interactional components available to the participants through turns of talk. Similarly, in the next fragment a deal in 325 Shell stock is made. This deal is between John, the market maker in Shell stock, and a salesman summoning John through the stentafoon.

**Fragment 2      Three twenty five Shell**

- BEEP  
(0.4)
- S:      Johnny hello  
(0.7)
- J:      H↑ello↓::  
(0.5)
- S:      Three twenty five Shell in at six (.) booking six o one  
(0.4)
- J:      three twenty five six o one thank you::  
(0.3)
- S:      Thank you Johnno  
(0.4)  
BEEP

Similar to the previous fragment, the beep combined with the first 'Johnny hello' seems to provide a summons. However, the caller provides an identification of the recipient as a nickname of John's name, 'Johnny' and attaches a greeting 'hello' in the first turn. These together suggest a certain familiarity, reflected in the sing-song nature of John's hello. This displays his availability and secures John as the recipient of the call. Once again these resources provide the means for the salesman to establish his counterparty for the trade. The salesman can now move quickly and quite unproblematically into the reason for the call; John is buying 'three hundred and twenty five Shell' from the client 'six o one'. John repeats certain components of the deal, the amount to be traded, and the customer number back to the salesman. Recycling elements of the trade along with the 'thank you' seems to act as confirmation of the deal and may also suggest a move out of the deal itself. This is not treated as problematic by the salesman who simply says 'Thank you Johnno' and the

deal is achieved. The consequence for John is that he has succeeded in buying three hundred and twenty five shares in Shell in a short space of time.

The positioning of utterances and how they are understood is a critical issue. The work of dealing is achieved effectively by understanding these short forms of talk. These utterances are understood in terms of their position in the course of the interaction, particularly in relation to the prior utterance. In other words, one utterance is recognised and produced in terms of the previous turn of talk and sets up the context for the next utterance. The sequential nature of conduct is critical for understanding next actions and is tied into the moment-to-moment production and recognition of activities.

The previous fragments demonstrate the ways in which a deal can be agreed between two parties quickly and efficiently to the satisfaction of both. These are highly dynamic interactions, each drawing upon a set of common sense resources such as the sing-song intonation in fragment 2 suggesting familiarity and, therefore, also recognition. The actual components of the deals may look at first glance like a set of numbers and names, but each are achieving some interactional work. Even the summons along with the first utterance achieves the establishment of a counterparty to a deal; critical in a setting where market makers are constantly setting and changing prices of stock in response to the contingencies of the market place. Dealers, not just within the trading room, but also in the wider market place, must respond quickly to these changes and buy or sell stock accordingly while the prices are right - as we can see in the previous fragments where a deal is set up and agreed in a matter of seconds. Through the turn by turn sequential positioning of various utterances, the features of a trade such as recognising a summons, coming to an agreement and understanding the various components of the trade, can be produced quickly and economically. Thus trading is accomplished through interactional work, as understanding of the previous turn is displayed in the next and is shaped accordingly.

The salespeople in the previous fragments draw on the resources offered by the stentafon technology to secure a counterparty and do a trade over the distance of the trading floor as quickly as possible. Nevertheless, though deals may be achieved in a very short space of time, they may not always seem as clear and straightforward as the previous fragments suggest.

### **5.2.2. 'Ambivalent' trading**

The deals in 'twelve' Hanson and 'three twenty five' Shell appear to happen quite unproblematically between the salesperson and the market maker. However, dealing may not always have these characteristics and may not always be this concise. As the next fragment begins, John is already dealing on the telephone, yet he trades through the stentafon with Giles, a salesman, who is dealing on behalf of Kleinwort.

### Fragment 3      Five o seven five Shell

BEEP  
(0.3)  
S:      allo:↓  
(1.2)  
J:      allo (Giles)  
(0.2)  
S:      I wanna sell: fi:ve o seven fi:ve shell fi:ve o seven fi:ve  
shell for (Kleinwort↓)whatever>you>can>do>John↑  
(0.2)  
J:      Eh (.) four ei:ghty three and a ha↓lf↑  
(0.2)  
S:      That's very kind of you three one six thank you sir↓  
(0.2)  
BEEP

Here a deal has been struck in 5075 Shell where the dealers have come to an agreement on a price through similar conversational resources mentioned in the previous fragments. We see the familiar opening sequence as the stentafoon beeps and the salesman's voice comes over saying 'hello'. John's recognition of the caller provides Giles with the resources needed to move into the reason for the call; the deal in 'five o seven five Shell'.

In fragments 1 and 2, the salesperson provides a complete package of the deal to be done. In both, the caller begins the package with the amount of stock ('twelve', 'three twenty five') followed by the stock (Hanson, Shell), a component indicating that John is the seller/buyer ('you sell', 'in'), the price ('four' and 'six') and the customer he is selling to ('Hambros', 'six o one'). In fragment 3, Giles, having secured his counterparty, says 'I wanna sell five o seven five Shell, five o seven five Shell for Kleinwort whatever you can do John'. Giles immediately states that he is a seller of Shell and that he wants to sell five thousand and seventy five shares on behalf of the client Kleinwort. As we have seen in Chapter 4, normally traders must agree on various components of a deal, including the stock, the amount, the price, whether they are buying or selling, and the counterparty number. In this fragment, there is a component missing from the presentation; there is no price. Instead, Giles says 'whatever you can do John', suggesting that John is a buyer and that he would like a good price for selling his stock. Thus, they are not simply filling in the missing components. Rather, there is now some suggestion of an alternative price to that being displayed on the screen. Whether or not it is acceptable, Giles proposes some potential change to John around the price of the stock, but he does not say exactly what he wants. John displays that he is a buyer in the next turn and presents a buy price of 'four eighty three and a half', where some ambivalence seems to be reflected in the 'Eh' at the beginning of his turn. Certainly, Giles' response 'That's very kind of

you’ suggests that John has actually given him something in terms of a better price (i.e. that John may have raised his buying price).

From this fragment we can see that where certain components of a deal, such as price, may be missing, it is not a matter of simply filling in the price from the prices displayed on the screen. Rather, dealers are involved in the management of prices on their holdings and it is in this management, in subtle changes made on prices at the right time, that they make money. In this respect it is quite unlike bartering in auctions where interaction may be extended and drawn out; in this setting even negotiations around price and amounts can happen very quickly (Smith, 1989). Unlike negotiations, it is a rare occurrence for traders explicitly to pull out of deals. Traders in these settings have a commitment to deal and as such must do so. But there are resources for them effectively to discourage trading, such as setting their buying price very low or their selling price high.

The work of this deal has been achieved through seemingly mundane interactional resources: the ambivalence suggested through John’s ‘Eh’ and Giles’ ‘That’s very kind of you’. Thus, John is not just giving Giles a price for the stock, he is displaying that he is giving him a different price to the one on the screens, and Giles in return displays acceptance. Through these resources the collaborative nature of dealing is revealed. In these very subtle social resources, dealing around the price of stock is achieved. In one or two turns, some flexibility and openness regarding the deal is both suggested and responded to and is accomplished through simple resources such as ‘whatever you can do’ explicitly naming the client, price and hesitation

In the above instance, the opportunity for negotiation was suggested around the price of the stock. Giles was very precise about the amount he wanted to sell, ‘five o seven five’. However, the potential for negotiation may not always occur around price as can be seen in the following fragment of a deal in 15,000 Hanson stock.

**Fragment 4      Fifteen thousand Hanson**

BEEP  
(0.5)  
S: Jo↑::↓n↑  
J: Ye↑a:↓h↑  
(0.3)  
S: Eh::m (.) Looking to buy a small amount of Hanson (.) fifteen thousand↓  
(0.7)  
J: Eh:: fifteen thousand at two two fo↓ur↑  
(0.7)  
S: Thank you↓  
(0.3)  
J: (okey doke )  
(0.3)  
BEEP

Various components of this trade suggest that even from the first turn, the salesman is somewhat ambivalent about the amount to be traded. In this fragment, as in fragment 2, the sing-song aspect to the intonation of John's name suggests not only familiarity but also some hesitancy that is mirrored by the sing-song nature of John's 'yeah'. Even when the salesman has secured John as counterparty, he moves into the deal with some hesitation 'Ehm', followed by the statement that he is 'looking to buy a small amount of Hanson'. This would suggest some ambivalence about the amount he wishes to buy and displaying it in this way allows him to hold off giving the amount. This delay and reference to the 'small amount' perhaps reflects that the salesman may be willing to negotiate on the amount to be traded should it be necessary. This might be the case should John be short of stock (trading in stock that he does not own), which would have consequences on the amount he is willing to trade. As in the previous instance, the salesman does not state the price at which the stock will be traded. Not mentioning the price, and the uncertainty initially revealed around the amount to be traded, would suggest some ambivalence about these components. John repeats the 'fifteen thousand' followed by the price at which he will trade, 'two two four', thus, confirming the amount and offering a price on that amount. The salesman accepts both the price and amount in the 'thank you' and the deal is done.

Displaying ambivalence in these trades provides for some flexibility and movement in the deal itself and allows for some openness regarding certain items. Deals are also an interactional and collaborative achievement, where one turn of talk may provide the resources for another to produce the next move. This collaboration is shared over various turns of talk using minimal resources and, through these turns, we can see how the deal is produced sequentially, in the local context, as one turn of talk displays an understanding of the prior. The ambivalences may only be made sense of within the ongoing interaction. Rather than setting up the potential for some disagreement that must then be resolved, these ambivalencies allow for dealers to move through deals relatively unproblematically, leaving various components of the deal open as a resource for trading.

### **5.2.3. Open trading**

There are occasions where the deal neither consists of straightforward components of price, buying/selling, amount etc, nor even where some suggestion is made regarding negotiation. Rather, the deal may be initiated by a request for prices, both buying and selling prices. Therefore it is not clear if the individual requesting the prices wishes to buy or sell. These types of trades are much more open in nature. In the following fragment a salesman comes through on John's stentafoon making an enquiry about Glaxo stock. In fact he is asking for the spread, that is both the buying and selling prices on Glaxo. Typically, the spread is done in an extremely brief way.

### Fragment 5      The spread

- BEEP  
(0.2)  
S:      Eh Glaxo for (Hambros) please  
(0.4)  
J:      Ehhhh (0.2) ni:ne(t)y (.) ffīve ni:ne↓  
(0.7)  
S:      Nine(t)y five↑ nine  
J:      ((J picks up receiver and is talking on the phone))

In this example we do not see even the minimal opening of previous instances. Instead, after a slight gearing into the turn with an ‘Eh’ the salesman moves straight into the reason for the call with a request for the price at which John is trading Glaxo for the salesman’s client Hambros. He does not declare himself a buyer or seller of the stock, he is simply asking for the spread, that is the amount at which John is buying and selling Glaxo. John then offers the spread ‘ninety five nine’, that is, he is buying Glaxo stock at 95 and selling it at 99.

John has not said ‘95’- ‘99’ but rather ‘95’ ‘9’. The price at which John is buying Glaxo stock is actually £6.95 and he is selling the stock for £6.99. Dealers will often abbreviate prices in this way. The big number, six in this case, changes less frequently than the smaller pence and half pennies, and thus, is often omitted in transactions. Typically market makers elide the ‘big number’ (£6 here), but also note that they elide the small number also where it shows the range of prices (9 in this case).

John displays his understanding of the prior request ‘Eh Glaxo for (Hambros) please’ as a request for a spread that he produces with these subtle abbreviations. The salesman reveals his understanding of John’s utterance in his repetition of the spread ‘ninety five nine’. These requests and abbreviations are recognisably understood, not just for this occasion.

John proceeds to talk on the phone whilst the salesman talks to his client.

- (6.3)  
S:      Eh (.) fir(t)y>seven>thousan(d)>(you get)>at six nine five  
( seven one six)  
(.)  
T:      Thirty seven thousand I buy at six nine five↑  
(0.2)  
S:      That's right John  
(.)  
T:      Thank you↓  
(.)  
BEEP

Some six seconds later the salesman comes through the stentafoon again emphasising more general aspects of the deal. The deal is for a client who is selling (‘you get’) 37,000 Glaxo shares at £6.95 per share and the customer number is 716.

We have noted that the original utterance was understood as a request for a spread. Mentioning the name of the client (Hambros) whose stock is being traded may indicate to John that this may be a special client in some way that may have consequences for the deal.

Traders are constantly monitoring the market for changes in prices or movements in stock that may have relevance for them as to when to buy and sell their own stock. This moment-to-moment activity results in dealers needing to establish counterparties to deal at exact times and in various circumstances to enter into subtle interactions to get the best price or amount. These may have organisational consequences for a turn in each component; for example, naming the client (Hambros or Kleinwort) may indicate a special deal.

In general, the work of dealing may be characterised as quick and achieved in a timely manner. This is reflected in the brevity of the interactions and also the economy of the individual components. Requests to deal are done in brief ways with critical aspects, such as amounts of shares and prices being abbreviated in certain systematic ways.

## 5.3 Talking Numbers

There's a whole nomenclature of trading that is almost indecipherable to the layman. If you listen to a phone call you would wonder what those people are saying. They're talking at the speed of light. I remember when I first started, I would madly write down what people were saying and say, OK, I'll call you back, hang up. And then sit there and say, OK, he said this is bid an eighth, five up and twenty five up and that meant and what did this mean. It was tough. I made mistakes, everybody does.

(Stark in Davis, 1997)

A critical part of doing the deal is achieved through a very practical and subtle use of numbers that allows dealers and others to recognise and differentiate not only amounts, prices and customer numbers on particular deals, but also minute fluctuations on markets that can be crucial to the speed at which trades occur. Numbers, as can be seen in the previous fragments, are organised in different ways; they can be abbreviated in various ways and different elements can be left out. However, they are still understood and displayed as understood by traders and others in the dealing room. Numbers themselves actually perform activities within the work of dealing. A closer examination as to how this works in practice is discussed in this section, where we focus on some of the ways dealers distinguish numbers and how they are produced and understood in different ways for various purposes<sup>11</sup>.

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<sup>11</sup> This reflects an interest of ordinary language philosophers such as Austin (1962) and Ryle (1949), particularly with respect to concerns of language and performative acts achieved by

From the fragments examined in the previous sections, we can see that numbers are used for a variety of purposes. They are used as amounts, prices, spread of prices, customer identifiers and, as we have seen, deals can be done extremely quickly over a few turns of talk. Thus, as very large deals can be done so quickly and the major part of the deal to be agreed lies in the ways numbers are identified, it is not at all clear how these numbers are distinguished as amounts, prices or other identifiers, either for participants or one from the other. It is a crucial part of the dealing activity that numbers are not only recognised as particular numbers but that they are also identified as types of ‘things’ – quantities, prices, or identifications – all performing different actions. Thus, it must be immediately recognisable, even though they may be of similar magnitudes, that client numbers do not get confused with amounts and prices. This issue becomes most critical when we consider that a great deal of money can be made or lost through an incorrect understanding of a half penny, and the effect that misunderstanding an amount may have on the dealer’s position. Dealers on both sides of the transaction must record the details of the deal and those details must match at settlement time. Consequently, the question of how these numbers come to be understood and recognised, through these very brief transactions and in such a short period of time, is most pertinent to understanding how a deal is done.

Numbers are the ‘raw material’ of dealing and there may be various difficulties for participants in the need to both recognise and produce numbers in the dealing activity. The correct production and understanding of numbers is critical not only to the work of dealing but also to technologies designed for dealing rooms. For example, understanding numbers might also apply to recording technologies like Voice Recognition Systems that attempt to extract automatically the components of a deal from dealers’ interactions. A technology like voice recognition would have to be able to discriminate between these different types of numbers in terms of recognising and understanding them. Different sets of numbers may be produced depending on whether they are prices, amounts, times, or customer identities. A great variety of numbers can be produced in different configurations that may range from very high to very low. In addition, the many different ways that numbers can be used must be distinguished very quickly.

Let us briefly consider an utterance from a fragment in a previous chapter. Annie, a salesperson across the trading room, is shouting out some information to John and Robert.

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statements i.e. Speech Act Theory (Austin, 1962) and (Searle, 1969). In this work a major concern is how individual utterances perform certain acts. This concern is extended in conversation analysis where analysts look at the social activities that are achieved through utterances, particularly with respect to the moment-to-moment production and design for recipients. The use of numbers in this section reflects issues raised in Schegloff’s work on the formulation of place and locations (Schegloff, 1972).

A:     HANSON. TWENTY OF AN EIGHTH, FORTY BY FIFTEEN:(SHEARSON) ON THE BID

To an outsider, the above utterance may mean little. It may not be obvious that Shearson, the market makers, are buying (on the bid) Hanson stock, but it is recognisable to participants. There are certain resources we can draw upon to make sense of this.

For example, the numbers in terms of fractions suggest that this trade relates to the US stock market which typically trades in fractions on prices; the deal is being done on the New York market - the amount (forty by fifteen) and price (twenty of an eighth). The time the outloud is shouted is also consistent with the opening of the New York market (it is after 2.30pm in this country). Most of the examples taken in this section come from the UK market, and here we will not consider the additional complexity of dealing with fractions in much detail.

The numbers used are digits, but these digits are produced in talk and consequently require an understanding of both. To this end, a table is produced below containing examples from the corpus of data that attempts to give a brief illustration of the contrast between the number in the deal and the way the number is said in the deal. The first column shows how this number is said in the ongoing deal. The second column shows the number that is used in the deal itself. Towards the end of this section we will examine how these examples are produced and understood in the dealer’s interactions.

We can see in the following table that some amounts may be quite straightforward, not always abbreviated. Rather they may be said as *complete numbers* such as ‘two hundred’ or ‘five hundred’.

| number said in deal   | number in deal |
|-----------------------|----------------|
| ‘two hundred’         | 200            |
| ‘five hundred’        | 500            |
| ‘fifty eight hundred’ | 5800           |

But, as in the third example, how such large numbers are said may not always be so straightforward. In the dealing room large numbers are typically said in hundreds, so 5800 is commonly said as ‘fifty eight hundred’ rather than ‘five thousand eight hundred’. Quantities may also be expressed as *collections of digits* rather than complete numbers. In the following example, 1622 is expressed as ‘sixteen twenty-two’.

| number said in deal  | number in deal |
|----------------------|----------------|
| 'sixteen twenty two' | 1622           |
| 'six nine five'      | 6.95           |
| 'five o seven five'  | 5075           |

Prices and amounts may also be read out *digit by digit*, for example, 'six nine five', or 'five o seven five'. Customer numbers are also usually digits read out such as 'seven one six' (fragment 5) or 'three one six' (fragment 3). Most commonly, as these are unique identifiers rather than quantities, they are treated as such and the digits are read out one by one.

The spread, as we saw in fragment 5, is made up of two sets of numbers representing the prices at which the market maker is buying and selling stock, for example '95-9'.

| number said in deal | number in deal |
|---------------------|----------------|
| 'ninety-five nine'  | 6.95-6.99      |
| 'twelve'            | 12,000         |

Here, the numbers represent pence sterling. Depending on the state of the market at any one time, the spread in any stock might include half pennies. As noted earlier, trading on the American market in ADRs (American Depository Receipts) adds more complexity through its use of fractions in the dealing room. Prices may be abbreviated quite flexibly within the deal interaction without ever seeming to lose their reference. So it is that in fragment 5 of the previous section where John gives the salesman the quote on Glaxo, John can quite safely omit both the big number (6) and the repetition of ninety and simply say 'ninety-five nine', also omitting any reference to pounds and pence. He can rely on the fact that the salesman can make sense of those numbers, in the light of looking at the monitors in front of him displaying the price of Glaxo in full, and to judge what kind of price John is quoting him and his client. Price quotes for individual trades can also be made in this way, by providing only the small number that represents the price per share.

Amounts of stock are often understood in hundreds and thousands that may also be abbreviated. So, for example, in fragment 1, the salesman is trading in 'twelve Hanson' that is 12,000 Hanson. Typically in this position, dealers do not trade in less than a hundred or so of stock, and the greatest amount traded in was observed to be three hundred thousand (300,000).

Finally, numbers may not be referred to in any conventional sense, but rather through some specialist jargon

| number said in deal | number in deal |
|---------------------|----------------|
| 'five bits'         | 500            |
| 'a couple'          | 200            |

For example, five bits may be 500 or a couple may be two hundred.

For prices and amounts there do not appear to be any simple rules of how to speak out the numbers; different configurations will appear in a variety of different deals. The way that numbers are utilised is complex yet, nonetheless, certain patterns can be identified through which the various types of work of dealing is accomplished. As we have seen, dealers utilise different types of abbreviations and numbers either as complete numbers, digit by digit, or sets of digits. These abbreviations are produced to be recognised and understood by participants. There is an assumption that in their production they can be parsed by a recipient. Numbers are said very quickly and in a way to distinguish one from the other for recipients. There is no explicit ordering and no obvious markers that explicitly show what each component is. Thus it is interesting to look at how this work of talking about numbers is achieved; to reveal what some of the dealer's practices are. This is directly of relevance for the design of systems to support dealing, for example, those mentioned in previous chapters. The analysis could inform a technology, such as voice recognition systems that seek to recognise, from constrained vocabularies, the critical components of the deal. Other issues may be relevant for technologies that just take isolated turns of talk or individual digits, or perhaps even systems that attempt to perform transformations on these strings of numbers given the state of the market.

### 5.3.1. The work of abbreviating numbers

As a starting point to our analysis we take the first few fragments of this chapter. As we saw in fragment 1, the salesman approached John to deal in twelve thousand Hanson stock.

#### Fragment 1 Twelve Hanson (reproduced)

BEEP  
(0.4)  
St: John=  
J: =(What)  
(0.5)  
→St: Twelve Hanson you sell at four to Hambros please  
(0.5)  
J: Thank you Rick  
(0.3)  
BEEP

A first observation is that a number may be understood in relation to its positioning, before or after various words or implicit markers like prepositions actually within a turn. In the above utterance, the fact that the number twelve is said immediately before Hanson with no pause or change in contour implies that this is the amount of stock to be traded. Typically, in deals where the amount to be traded is not

being negotiated, and the package includes all the details of the deal, the amount is presented as the number followed by the stock.

Similarly in fragment 2, the amount of three twenty-five precedes the stock. Note that ‘three twenty five’ is not a conventional way of abbreviating 325.

**Fragment 2      Three twenty five Hanson (abridged)**

St:      Three twenty five Shell in at six (.) booking six o one

Occasionally, the stock name may be said first immediately followed by the amount, for example,

**Fragment 4      Fifteen thousand Hanson (abridged)**

S:      Eh::m (.) Looking to buy a small amount of Hanson (.) fifteen thousand↓

However, this may not always be the case as we can see in the fragment below, where the name of the stock and the amount to be bought are separated. Thus even the precise ordering of the name of the stock and amount of stock is open to the contingencies of the deal.

**Fragment 6      Seven thousand Hanson**

BEEP

(0.2)

→St:      John Tolger (.) the stock is Hanson (.) it's a seller (0.2) I'll sell you seven thousand shares please at two o four and a half booking three one six  
(0.4)

J:      Frankie Dicks (.) thank you very much and good afternoon  
(0.2)

BEEP

We might note that the above fragment is an exception to those more commonly observed. It seems to be done in a joking manner displayed in the sing-song tone of voice. The way the deal is done seems to reflect an earlier discussion or trade between the two dealers. It is rare that all the components of the deal, along with the use of christian and surnames of the person being addressed, are produced.

Other such markers may include the use of ‘buy’ and ‘sell’ or other words that imply the same, followed by prepositions. In fragment 1, the salesman says ‘you sell at four’; thus, the price is often preceded by the preposition ‘at’. In fragment 2 the salesman says ‘in at six’, and in the above fragment the salesman says ‘I’ll sell you seven thousand shares please at two o four and a half’. The use of either the complete number in the price, or the abbreviations to the small number, may also often be implicitly marked off within a turn from the other components. It may seem a curious way of saying prices, but they are distinguished so that any competent dealer with the information he or she has at the time can parse and understand what is said and how it is said.

Similarly, the customer number, as stated previously, is often a set of numbers read out as single digits that may be understood as such by their positioning behind a preposition like ‘to’ or explicitly adding ‘booking number’ or ‘booking’. Use of these words may set up the expectation that the next word should be a number, and that number will be a price, amount or the booking number.

The ordering of particular components and their location in the talk may also act as a resource for making sense of the numbers being uttered. Often, as we can see in the fragments presented so far in this section, the customer number or client is presented at the end of the package. In fact, in the first two fragments, the components of the deal are packaged in the same way. The utterances begin with the amount of stock, followed by the name of the stock, then whether John is buying or selling, followed by the price and ending with the customer number. However, the ordering of individual components, their positioning within the ongoing is not fixed. Consider the following fragment:

**Fragment 7      Sixteen hundred Smith Kleins**

BEEP

(0.4)

→St: Ehh (.) Booking number three one six sells you sixteen hundred Smith Kleins at six  
(0.3)

J: Sixteen hundred at six thank you  
(0.2)  
BEEP

Here, the salesman on the stentafoon begins the package with the customer number, and with an entire phrase, not just booking, but ‘booking number three one six’. He then mentions that the customer is selling an amount of sixteen hundred followed by the stock, Smith Klein, and finally the price ‘at six’. Whilst there does not appear to be any fixed ordering of components of the deal, there are some minimal markers, such as prepositions, that seem to do a substantial amount of the work of marking out the different components. In addition, different types of numbers are not all produced in the same way; client and identification numbers are typically spoken digit by digit, whereas amounts and prices may be abbreviated, grouped together or spoken as magnitudes. They may be 1) spoken out completely digit by digit; 2) abbreviated where large numbers and ranges are elided; 3) sometimes they may be said in terms of magnitudes (as in terms of hundreds and thousands); and 4) conventional numbers may be used. As can be seen, distinguishing numbers is not straightforward. What appears to be critical is the positioning of the number and what is going on within a turn.

### **5.3.2.      Distinguishing numbers**

In saying amounts, we saw from tables in the introduction to Section 5.3 the various ways that dealers may produce the numbers, from speaking out the complete number

to using a jargon term. In fragment 3 we saw how Giles spoke out the amount 'five o seven five Shell' digit by digit. It is interesting to note that he might also have said 'five thousand and seventy five' or 'fifty seventy five'. Indeed, counting in hundreds appears quite a common way to deal with thousands of shares as in the following case:

**Fragment 8      Fifty eight hundred Glaxo (abridged)**

BEEP

(0.3)

→St: John (.) I wanna buy fifty eight hundred Glaxo for (Thamesway) please

(0.3)

J: Eh hh (.) fifty eight hundred at four↓

It may be tempting to assume that dealers are orienting to economy of speech, as speed of dealing is a key issue in this setting; seconds can be vital as to whether a dealer makes or loses millions of pounds or dollars. However, it is nearly always quicker to speak out digit by digit (e.g. 'five o seven five'), than to use more conventional forms. Taking 5075 as an example, saying 'five thousand and seventy five' takes eight syllables; 'fifty seventy five' takes six syllables; 'five o seventy five' also takes six syllables and 'five o seven five' takes five syllables. But, this form is not always favoured over the one that counts hundreds as we can see in the previous fragment. Here, the dealer could also have said 'five eight o o'. Thus, dealers may not just be oriented to saying things as quickly as possible. It is clear from all the fragments that dealers do not always say numbers in full or package the numbers in thousands, and they also do not always orient to a simple counting in terms of hundreds.

Thus, though the brief and somewhat clipped interactions that characterise a deal may be in part explained by a need for economy, it is not clear that dealers are orienting solely to economy of production when speaking numbers. It is true that prices are abbreviated, as are amounts. However, when dealing in various different amounts, it may be critical that the dealer you are trading with recognises immediately the amount in terms of the price he is willing to trade for. Whether a dealer is long or short of stock is a fundamental consideration. Depending on their strategy and position at the time, dealers may not want to buy too much stock if they are long and it is difficult to sell later; neither will they want to sell stock if they are short and are trying to accumulate more. Because it is critical that dealers accurately recognise an amount, participants may then be striving to disambiguate potentially confusing sets of numbers. It is interesting that dealers find ways to say these numbers without producing problems in understanding. It is possible that there are ways in which these numbers are said or packaged that make them easily distinguishable as, for example, their position within a turn. There may, in addition, be ways that the actual number is produced to reduce the possibility for a recipient to hear that a number has been

completed. That is to say, if the speaker adds hundreds or thousands in the middle of a number as in fragment 8 where the number might have been said as ‘five thousand eight hundred Glaxo’. By saying ‘fifty eight hundred’, the ‘hundred’ acts as a completion of the number as well as the magnitude. Similarly, when saying prices for example, using the full numbers 6.95 – 6.99 might be heard to be completed at various places (e.g. 6.95-6 where the spread might then be taken for buying stock at 6.95 and selling at 6.96). Whereas, using the small number 95-9 does not lead to the possibility for projecting the end of the number itself, where what is in fact the initial part of the number might be misheard or missed. Though numbers are produced in relation to what is being said, the way that they are said can help to disambiguate various packages of numbers and critical parts of these numbers can be heard as relevant for the recipient.

We have suggested that numbers representing amounts are produced by traders for others participating in the deal, and the analysis begins to suggest that the various forms may be utilised in order to disambiguate different types of numbers. Therefore, it may also be that various combinations of numbers are selected for their ability to communicate accurately and as unambiguously as possible the amount to be traded or the price to be paid on a deal.

### 5.3.3. The work of repeating numbers

The orientation to accuracy lies not only in the production of the number but also the way in which it is heard. Consider the way in which John responds to these numbers in the previous fragment.

#### Fragment 8 Fifty eight hundred Glaxo (abridged)

BEEP

(0.3)

St: John (.) I wanna buy fifty eight hundred Glaxo for (Thamesway) please

(0.3)

→J: Eh hh (.) fifty eight hundred at four↓

In this fragment, the salesman has proposed a deal in 5800 Glaxo for the client Thamesway and has asked John for a price. Typically, in the deals where the potential is opened up for a different price to be offered, the dealer will recycle the amount to be traded and offer a price on that amount. Using repetition may have interactional purposes not simply to clarify mistakes or mishearings.

In addition, in instances where some ambiguity arises, various transformations may occur to clarify the amounts. In the following example John is dealing with a salesman on 500 Glaxo stock.

### Fragment 9      Five hundred Glaxo

BEEP  
(0.3)  
St: Eh Joh↑n  
(0.7)  
J: Yeah↑  
(0.5)  
→St: Glaxo (.) I wanna sell about hhh (I don>know) five (at five) share(s) for six o one  
(0.3)  
J: HOW MANY SHARES↑  
(0.3)  
St: About five bits for six>o>one  
(0.7)  
J: Is that four hundred or five hundred  
(.)  
St: About five hundred  
(0.3)  
J: About five hundred () okay man  
(1.8)  
T: six nine four

The hearing of the salesman's first utterance is somewhat problematic both for the analysis and for John. The salesman appears to be trying to sell Glaxo stock for client 'six o one' and there is also a suggestion in his utterance of the price that he wishes to sell at ('at five'). But it is not clear how many he wishes to sell. In fact the ambivalence with regard to the amount is displayed further by the use of 'about' used in this package. As seen in previous fragments, dealers may be quite precise about the amounts of stock they want to buy or sell. Here, the salesman seems to be uncertain about the amount of Glaxo he wants to sell, perhaps suggesting that he is flexible over the amount to be traded should it be necessary. As we have seen in previous fragments, some components may be left open or flexible in some way to allow for negotiation over price and amount.

However, the salesman's utterance is problematic for John who displays his difficulty in hearing by asking the salesman to repeat how many shares he is interested in selling. John's question is completed using a rising intonation, suggesting that he has misheard or not quite heard the amount stated, rather than being a request for new information. The salesman repeats the amount 'five bits' and repeats the customer number 'for six o one', though this was not requested. The salesman also reintroduces the ambivalence in that the utterance also begins with the word 'about'. It almost seems that John does not orient to this ambivalence and even pursues an accurate amount saying 'Is that four hundred or five hundred'. John's question, not only offers a choice of two amounts, but also transforms the 'bits' to 'hundreds' allowing both aspects to be checked and confirmed. John hears '400'

despite the repetition of ‘five’ in ‘five bits’. The salesman says ‘about five hundred’, repeating the amount whilst still suggesting that it could be negotiated further.

It may be the case that John’s question ‘is that four hundred or five hundred’ is not so much a mishearing as suggesting the possibility of buying 400 rather than 500 which he might buy at a higher price. In the end John does not sell at five but at ‘six nine four’; therefore he buys at a lower price.

Complex numbers are designed to be heard in terms of packages in order to be recognised and understood, and they usually are. Speakers may abbreviate or transform numbers, not just for speed but also for the hearer. And these are normally unproblematic for the hearer. Subtle differences in price and amount may occur where numbers can be used in quite flexible ways to display ambivalence, disambiguate confusing areas, or project an accurate figure. There are also ways in which the recipient trader picks up on the initial bid and offer and what elements of the initial utterance may be recycled, or indeed left out. Thus, the analysis begins to reveal that numbers themselves are doing work in the deal and that others hear numbers that way and respond appropriately.

#### **5.3.4. The recipient design of numbers**

Dealers are not just dealing in packets of hundreds but indeed are dealing right down to a single share in the precision; for example,

St: I wanna sell seven one six three Hanson

In these cases there is no simple way to abbreviate the amount as in ‘twelve Hanson’ (12,000) or five bits for (500). In the next fragment John is dealing in sixteen twenty two Glaxo with a salesman.

#### **Fragment 10 Transcript 1 Sixteen twenty two Hanson**

BEEP  
(0.5)  
St: John↑  
(0.5) ((John leans forward))  
J: Hello Nicholas::  
(1.0)  
N: Can I sell you sixteen twenty two Glaxo please for five o two  
J: Ehhhh (.) sixteen twenty two at ehhhh (0.5) six fif(.)ty (.) one↓

In this relatively straightforward deal, Nicholas wants to sell 1622 Glaxo for client ‘five o two’. The numbers are produced in the abbreviated form ‘sixteen twenty two’. John recycles the amount form ‘sixteen twenty two’ and adds a price of ‘six fifty one’.

Interestingly, as the deal is produced John writes down the numbers. We can see how this emerges in a more detailed transcript below.

**Fragment 10      Transcript 2 Sixteen twenty two Hanson**

BEEP  
(0.5)  
St: John↑  
(0.5) ((John leans forward))  
J: Hello Nicholas::  
(1.0)  
  
((T takes pen)) ((J writes **one six**  
N: Can I sell you sixteen twenty two Glaxo please for five o two  
  
**two two** **six five one-----**)  
J: Ehbbb (.) sixteen twenty two at ehbbb (0.5) six fif(.)ty (.) one↓

As the salesman reaches the second set of numbers in 'sixteen twenty two' John reaches for a pen and starts to write 1622 on his jotter. When John writes the second part of the number 'two two' he then glances at the screen, repeats the amount 'sixteen twenty two' and provides the salesman with the price for stock 'six fifty one'.

There are many ways this amount could be produced. Curiously, 1622 is here produced as two sets of numbers that make up the amount (not as ‘one thousand six hundred and twenty two’). As suggested previously, dealers seem to avoid placing words in between numbers. Designing the utterances in this way for the other may be useful in terms of providing help in calculating prices and to see what the scale of the deal is. But it may also assist in recording the deal itself, writing out various components of the deal - an activity that must be done for all deals. This is revealed in the pacing and timing of various parts of the writing in relation to the deal talk.

Dealers work in a world of numbers and, as the quote cited at the beginning of this chapter states,

If you listen to a phone call you would wonder what those people are saying. They're talking at the speed of light. I remember when I first started, I would madly write down what people were saying and say, OK, I'll call you back, hang up. And then sit there and say, OK, he said this is bid an eighth, five up and twenty five up and that meant and what did this mean.

Understanding these numbers is not solely in terms of a complex parsing on the part of dealers. Numbers are also produced for others, recognising where they are positioned and what work they are doing within a turn. It is not just a curious language, but done for good reasons - so that, in breaking apart these numbers for others, individuals can distinguish various components quickly or may be able to perform calculations in terms of the overall deal more efficiently. We have also seen a further critical issue in the production of numbers, i.e. they may be said in ways that facilitates their recording. It is suggested that numbers are produced not just for economy of speech but interactionally, for a hearer to understand and recognise what is relevant, and they may be designed this way to be written down and recorded.

## 5.4 Real Time Record Keeping

Writing records of deals made throughout the day is necessary in the dealing room for cross checking for settlement purposes and is a typical example of bureaucratic work found in many settings. In this section we look in some detail at the relationship between the recording of deals and their production. We describe how the record-keeping activity is interleaved with the activity of dealing, a feature of work in this setting that has important technological consequences discussed in Chapter 7.

As mentioned in Chapter 4, a deal must be recorded for settlement purposes; the information is distributed over two parties and is recorded by them on tickets to be matched overnight, where any discrepancies will be reported and must be dealt with the following day. Typically, once a deal has been completed - or perhaps even before - a dealer will write out the details of the deal onto a paper ticket that is put into a pot to be picked up at regular intervals by trade input staff. These individuals are responsible for reading the information off the ticket and typing it into the bank's database. The information is then used to update the dealer's own position and also to register the deal with the stock exchange. Therefore, the immediate recording of the deal is done by traders either on paper tickets or on computer systems. Where paper tickets are used, back-office staff take responsibility for inputting the information into the database for the stock exchange.

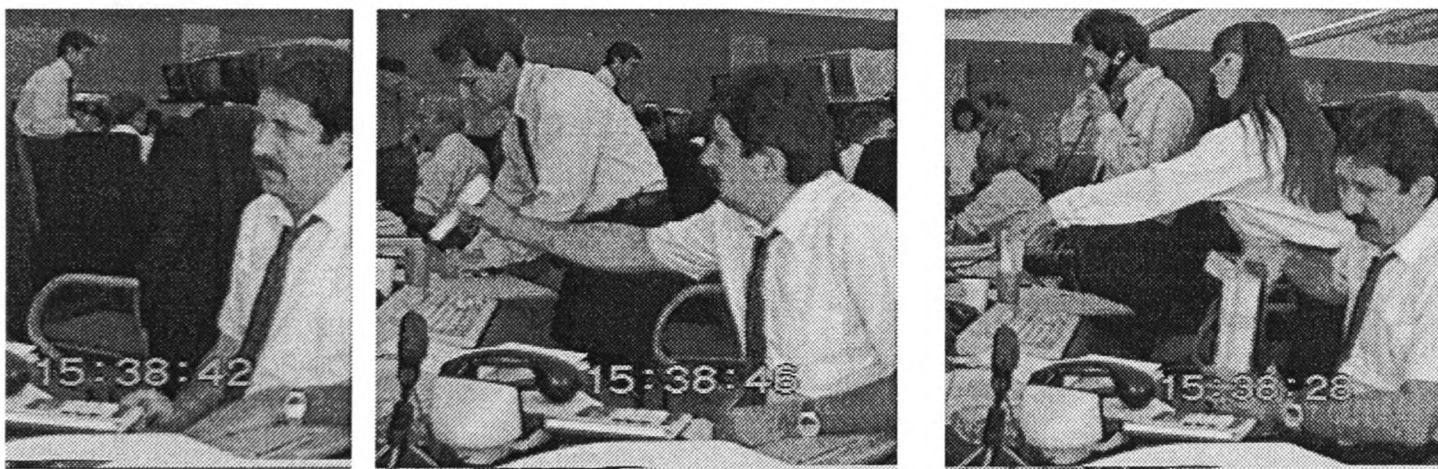


**Figure 5.1** A dealer writing a record of the deal on a ticket, putting it in the pot and a member of the trade input staff picking it up.

In this setting, as in others, the dealer needs to record particular components of the deal. A closer look at the paper ticket will illustrate some of these components. Dealers divide the stocks they are responsible for trading into 'books' where, for example, one book may contain pharmaceuticals, and this book will be divided further into Wellcome and Smith Klein Beechams stock. These books contain the paper tickets, four on a page, that are completed with the various components of the deal and then ripped out and put into a pot to be picked up by back-office staff (See Figure 5.1)

| Bwd/Fwd Positions |       | Dividend Rate |              | Dividend |             |
|-------------------|-------|---------------|--------------|----------|-------------|
| Buy               | Sell  | SecID         | CtPty        | Price    | Condits N/R |
| 25/-              | (0.5) | GCB           | (0.3)        | 176.09   |             |
|                   |       |               | 269          |          |             |
|                   |       |               | Salesman     |          | Bargain No  |
| Time              |       | SAEF          | Dolstra Rate | Curr     | Input by    |
|                   |       |               |              |          |             |

**Figure 5.2** A ticket used in the dealing room for recording deals

Figure 5.2 shows the type of ticket used for recording deals in the securities house in this setting. Paper tickets are kept by the back office in order to be scrutinised should any errors appear in the matching process. The following is an explanation of the types of information to be contained in the different fields.

- Buy/Sell** This field requires the dealer to state whether s/he has bought or sold a particular stock. Typically, the appropriate field ‘B’ or ‘S’ is filled in with the amount the dealer has bought e.g. 20/-. This abbreviation typically means thousands so in this case the dealer has traded in a quantity of 20,000.
- Sec Id** This field requires the unique identification of the stock, e.g. ICI, BATS.
- Ct Pty** This field requires the counterparty to the deal. This may be a unique name representing another market maker, a client name, a unique number, or a wash. A wash trade occurs between traders in the same dealing room when they want to balance their positions in stocks. Each market maker and client has a unique recognisable number.
- Price** This field requires the price the stock was traded at. This might be represented as ‘188 1/2’ (one pound eighty-eight and a halfpenny) or ‘334’ (three pounds forty four) or ‘204’ (two pounds four pence).
- Salesman** This field requires the name of the market maker that did the deal. This field is rarely filled in.

|                     |                                                                                                                                                                                                     |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Time</b>         | This field requires the dealer to state at what time the deal was done. This is often not filled in, and even when it is the time given is not always accurate.                                     |
| <b>Condit</b>       | These are special conditions that apply to certain bargains. For example, 'SS' means Special Settlement. There are many different types and conditions and some conditions may not be put together. |
| <b>N/R</b>          | An indication that the bargain has not been reported to the LSE.                                                                                                                                    |
| <b>SAEF</b>         | These are automatic deals which only occur on equities, not on ADRs and are usually only for small trades, seldom over 1000.                                                                        |
| <b>Dolstra Rate</b> | The rate for changing currency on a wash or swap exchange deal (e.g. A\$ .7745).                                                                                                                    |
| <b>Currency</b>     | What currency the dolstra rate is, for example, AUD (Australian Dollars). Often the currency is left out and the information is filled in as above.                                                 |
| <b>Bargain No</b>   | This is generated by the computer and is hand-written on the ticket after the details have been entered into the trade-input system.                                                                |
| <b>Input By</b>     | This is rarely filled in as the printout of the ticket automatically generates the name of the trade-input person.                                                                                  |

On the paper ticket the dealer is required to record at least six critical components of a deal: price, amount, stock, party, counterparty, and time. It is virtually irrelevant which field or component of the deal is recorded first, as long as the information is correct and completed within ninety seconds.

At first glance, the production of the ticket appears to be a quite straightforward collaboration between the trade-input person and the dealer. Dealers fill in the tickets, and trade-input staff may rely on hearing the ticket being ripped out of the book to know that a deal has been recorded and thus to go and pick up the ticket.

The ticket seems to match the components of dealing, that is, buying and selling. However, on closer examination various interrelationships exist between fields that dealers can rely on when filling in the information, in order for others reading these tickets at later times to be able to extract the relevant information. The most obvious of these is that a deal is either buy or sell. This is marked by the amount being written into the B or S field. Trade-input personnel reading this ticket at a later time, read the amount of stock traded and can infer from its position if it is a buy or a sell. A more complex example can be seen when trading occurs in other currencies. In these cases, not only are the six items of the deal recorded, but also the currency of the deal along with the interest rate at the time. If the interest rate is filled in, the currency should be

completed also. In practice, dealers commonly put this information together in one field (e.g. dolstra A\$ 7745). This then is read by the trade-input staff as a deal done in Australian dollars at an interest rate on the currency exchange of 7745. In addition, traders may omit various components of the deal, such as the time the deal was done, in the knowledge that trade input staff can recover this information when collecting the ticket. Various relationships exist between the fields, and skilled trade-input staff would expect to see these related components filled in when typing in the information. Typically, trade-input staff come to know what information is missing and then approach individual dealers to get that information if it cannot be recovered by other means.

From initial observations of ticket writing and indeed from the previous fragments, it may seem that the details of the deal are written up after the deal has been made, and are written in a straightforward manner following the trajectory of the ticket. We could expect the amount to be bought or sold to be filled in first, followed by the stock, the counter party, the price and finally the time the deal was done. This occurs in the following fragment where a market maker, Steve, has just bought 30,000 British Airways stock at £5.28 a share. He completes the deal on the telephone and, when he has closed the call and completed the deal, he goes on to fill in the ticket from left to right. The trajectory of the deal is as follows:

| Bwd/Fwd Positions |         | Dividend Rate |              | Dividend |             |
|-------------------|---------|---------------|--------------|----------|-------------|
| Buy               | Sell    | SecID         | CtPty        | Price    | Condits N/R |
|                   | 30/ →   | BAY →         | WASH →       | 528      |             |
|                   |         |               | Salesman     |          | Bargain No  |
| Time              | 15.00 ← | SAEF          | Dolstra Rate | Curr     | Input by    |
|                   |         |               |              |          |             |

Figure 5.3                      A ticket-writing trajectory from left to right

Steve completes the sell field using the abbreviation 30/- to represent thirty thousand. This abbreviation is recognised and understood by trade-input staff, who can also see from the field that is filled in that he has sold the stocks. Steve moves next to the adjacent box and fills in the identifier of the stock British Airways which is BAY. Next he moves to fill in the counterparty and we see that it is a wash deal. A wash trade occurs between traders on the same floor when they want to clear their

positions in stock. Steve then fills in the price ‘528’ before moving down to fill in the time that he recorded as 15.00 hours. Thus, Steve quite unproblematically fills in the ticket from left to right after the deal has been done.

However, closer examination of ticket writing, reveals that it is not always the case that ticket writing is this straightforward. The following instance shows Steve doing a deal on the phone in GCB, talking to a dealer who is acting for Steve on the New York market. Steve wants to buy 25,000 GCB stock.

Fragment 11

Just twenty-five

S: Yeah take them

(7.7)

S: I just want twenty five

(2.3)

?

( )

(5.0)

S: ((puts book on table))

(4.0)

((opens book at GCB))

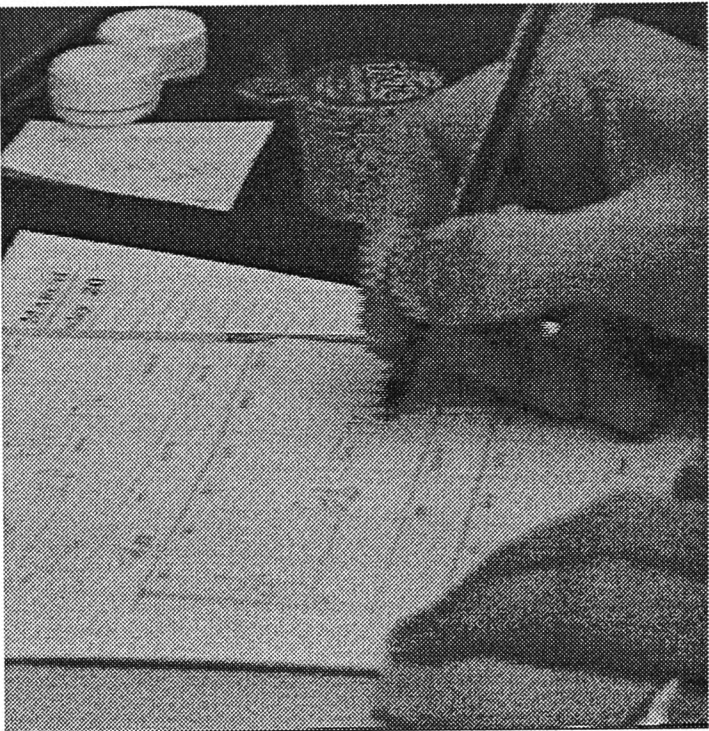
S: Thank you very much (.) Cheers bye

(.2)

S: Yeah bid out (Thank you)

S: ((puts phone down))

(1.3)



| Bwd/Fwd Positions |       | Dividend Rate |              | Dividend |             |
|-------------------|-------|---------------|--------------|----------|-------------|
| Buy               | Sell  | SecID         | CtPty        | Price    | Condits N/R |
| 25/-              | (0.5) | GCB           | (0.3)        | 176.09   |             |
|                   |       |               | 269          |          |             |
|                   |       |               | Salesman     |          | Bargain No  |
| Time              |       | SAEF          | Dolstra Rate | Curr     | Input by    |
| 13.41             |       |               |              |          |             |
|                   |       |               |              |          |             |

(1.0)

Figure 5.4 The trajectory around the ticket following the trade for 25,000 GCB

Here Steve is instructing another dealer in New York to take 25,000 GCB stock. At this point he gets the book and puts it on the table, opens it at the relevant stock partition and says 'thank you very much. Cheers bye'. However, the interaction is not yet completed as he seems to reply to the dealer 'yeah bid out' that is instructing him

to cancel his bids. After Steve has secured the amount he wants to buy, he starts filling in that amount, twenty five thousand, in the buy field. He moves to the adjacent field and fills in the stock, seemingly following the same trajectory. But after he has filled in the stock he then moves to the price, filling in ‘176.09’, and thus by-passing the counterparty. He then moves down to fill in the time and finally fills in the counterparty field. We begin to see from this instance that filling in the ticket may not be a straightforward activity of moving from left to right, but rather there are certain perturbations. These perturbations are not idiosyncratic. There might be good reasons at the local level why the ticket is written out in this way.

It may also be noted that Steve starts moving into the recording activity very early on in the deal, seemingly before the deal is completed. He picks up the book and opens it at the right segment for this stock even before the deal seems to be agreed. Thus, it is not simply that the activity of recording may begin while the deal is still going on, but that the recording itself may be more finely interleaved with the ongoing deal. Consider the following fragment where Steve is selling BATS (British American Tobacco) stock to a salesman Duncan through the stentafoon.

**Fragment 12**                      **Five hundred and thirty six bits of BATS**

BEEP  
(.)  
D: Hello  
S: Hello  
(.2)  
  
D: Bats (.) I wanna buy five hundred and  
thirty six bits ( )  
  
S: five hundred and thirty six bits of bats  
(.7)  
S: you get at eh four eighty eight and a half  
Duncan  
  
D: Thanks Steve

((Steve puts book on desk))  
(1.5)  
((opens book))

| Bwd/Fwd Positions |      | Dividend Rate |              | Dividend |             |
|-------------------|------|---------------|--------------|----------|-------------|
| Buy               | Sell | SecID         | CtPty        | Price    | Condits N/R |
|                   | 536  | (0.5)         |              | 488      |             |
|                   |      |               | Salesman     |          | Bargain No  |
| Time              |      | SAEF          | Dolstra Rate | Curr     | Input by    |
|                   |      |               |              |          |             |

| Bwd/Fwd Positions |       | Dividend Rate |              | Dividend |             |
|-------------------|-------|---------------|--------------|----------|-------------|
| Buy               | Sell  | SecID         | CtPty        | Price    | Condits N/R |
|                   | 536   | (0.5)<br>BATS | (0.3)<br>601 | 488 1/2  |             |
|                   |       |               | Salesman     |          | Bargain No  |
| Time              | 13.15 | SAEF          | Dolstra Rate | Curr     | Input by    |
|                   |       |               |              |          |             |

(1.7)

In this fragment, Duncan contacts Steve through the stentafoon wanting to buy 53,600 shares in BATS. Steve offers him a price of £4.881/2 to which Duncan agrees with ‘Thanks Steve’. Through the course of the deal we see how the recording and dealing activities emerge.

It is not just that dealers may or may not be filling in the ticket from left to right, but they may be filling in the details that are related to the way in which the deal emerges through talk. For example, the way in which Duncan packages the components of the bid seems to shape the way the deal progresses. Duncan proceeds by naming the stock he is interested in, BATS. He then projects that he wants to buy ‘five hundred and thirty six bits’ of this stock. Note that the way the number is broken down from 53,600 to 536 bits is reflected later in the number Steve writes down on the ticket (‘536’). Steve reformulates the initial request ‘five hundred and thirty six bits of BATS’ and continues by quoting a price ‘you get at four eighty eight and a half Duncan’. The ‘buy’ of Duncan’s initial turn gets transformed to ‘you get’ in Steve’s utterance and the stock name BATS is moved after the amount. This reformulation provides Steve with the time needed to get the book, open it at the right place, and decide what price to quote Duncan for the stock. Interestingly, Steve appears to start filling in the ticket before the deal is agreed. In fact the two fields of price and quantity are filled in before Duncan says ‘Thanks Steve’.

When Duncan states that he wants to buy the stock, it may be that he is not just stating a desire, but it projects a strong likelihood that the deal will occur, thereby making it possible for Steve to start writing out the ticket. The turn seems to be designed to provide Steve with the opportunity to move into recording various components. Steve writes ‘536’ on the ticket as he is quoting a price of 4881/2 to Duncan. The final number Steve writes, ‘601’, comes from Duncan’s customer number. Thus, the written record is not begun after the deal but as the deal is being produced. Indeed it is critical that dealers can write on tickets while they are talking, so that they can undertake parallel activities and interleave trading work with recording. This allows them to do the work quickly and move onto the next deal.

Dealers can move into writing the ticket very early on in the deal talk, and the elements that are filled in may be closely related to the ongoing talk. This is further highlighted in the following fragment where Steve is buying British Airways stock on the telephone.

Fragment 13 Twenty thousand BAY

(2.1)  
S: five twenty seven and three quarters on thirty thousand

((opens book))

| Bwd/Fwd Positions |      | Dividend Rate |              | Dividend |             |
|-------------------|------|---------------|--------------|----------|-------------|
| Buy               | Sell | SecID         | CtPty        | Price    | Condits N/R |
|                   |      | BAY           |              | 527 3/4  |             |
|                   |      |               | Salesman     |          | Bargain No  |
| Time              |      | SAEF          | Dolstra Rate | Curr     | Input by    |
|                   |      |               |              |          |             |

((writes over 7 again))

(0.3)

((hesitation))

(0.5)

| Bwd/Fwd Positions |      | Dividend Rate |              | Dividend |             |
|-------------------|------|---------------|--------------|----------|-------------|
| Buy               | Sell | SecID         | CtPty        | Price    | Condits N/R |
|                   |      | BAY           | 826          | 527 3/4  |             |
|                   |      |               | Salesman     |          | Bargain No  |
| Time              |      | SAEF          | Dolstra Rate | Curr     | Input by    |
|                   |      |               |              |          |             |

Diagram annotations: Arrows indicate movement of the pen. One arrow points from the 'Time' field to the 'Buy' field, labeled (1.0). Another arrow points from the 'Buy' field to the 'CtPty' field, labeled (0.3). A third arrow points from the 'CtPty' field to the 'Price' field, labeled (0.3). The value 14.59 is written in the 'Time' field.

((tapping pen on the ticket book))

(4.1)

((writing over 7 and 3/4))

(3.0)

S: No problem mate. Twenty I buy (.)

| Bwd/Fwd Positions |      | Dividend Rate |              | Dividend |             |
|-------------------|------|---------------|--------------|----------|-------------|
| Buy               | Sell | SecID         | CtPty        | Price    | Condits N/R |
| 20/-              |      | BAY           | 826          | 527 3/4  |             |
|                   |      |               | Salesman     |          | Bargain No  |
| Time              |      | SAEF          | Dolstra Rate | Curr     | Input by    |
|                   |      |               |              |          |             |

Diagram annotations: Arrows indicate movement of the pen. One arrow points from the 'Buy' field to the 'CtPty' field, labeled (18.1). Another arrow points from the 'CtPty' field to the 'Price' field, labeled (1.0). A third arrow points from the 'Price' field to the 'Condits N/R' field, labeled (0.3). The value 14.59 is written in the 'Time' field.

S: Thanks very much. Cheers Bye

((puts phone down))

((rips out ticket))

The fragment begins as Steve is on the phone to a trader in New York. He opens the book and says 'five twenty seven and three quarters on thirty thousand' and also begins to write the price '527<sup>3</sup>/<sub>4</sub>'. He then writes over the seven again and then moves down to write in the time '14.59'. He then moves to the customer number '826' and starts tapping his pen on the book. He writes over '7<sup>3</sup>/<sub>4</sub>' again before writing '20/-' in the buy field as he says 'No problem mate twenty I buy'.

Once again Steve begins to write out the details before they seem to have agreed on the deal itself. This time he starts writing on the right-hand side of the ticket, filling in the price field as he is saying 'five twenty seven and three quarters on three thousand'. However, he does not go on to fill in the amount bought. After some delay, he moves down to fill in the time field and then the counterparty. There is some suggestion from his tapping of the pen and the repetition of writing over the seven and three quarters that he is actually waiting for something. Eventually he fills in the buy field with 20,000 and says 'No problem mate twenty I buy'.

In what initially appears to be a straightforward deal with minimal dealing (providing both amount and price), it seems strange that Steve does not go straight on to record the amount to be bought; the quantity of thirty thousand. Though there is no access to the other side of the phone call, there are other examples where there is some holding off of the price or amount and some 'negotiation' occurs. Steve fills in the other fields, displaying a waiting through tapping the pen and overwriting the digits and then finally says 'No problem mate twenty I buy' - further evidence that the quantity has changed from thirty to twenty. From this fragment we can see how the actual ordering of the writing of the components is tied into the talk as it emerges. The constantly unfolding nature of recording is related to the very practical issues of dealing; dealers must get a deal on price and quantity.

Of course it may be possible that when and how individual components are written down may be related to issues of individual memory, that the way deals are recorded may be in terms of items dealers need to remember or that may be difficult to recover later on. However, it is not clear that such a simple explanation is the case; in some complex real-time dealing activities the information is not immediately written down nor is it systematically organised as such. It does not seem from the analysis that they are organising their writing so they do not forget what was heard on the phone. It is not just the way that a ticket is written that is of importance. An apparently individual activity is actually produced thoroughly collaboratively and through interaction. The ways in which components are written seems to be tied to the order of items produced in the talk and the trajectory of the talk – what comes later and what has yet to be decided. Thus what is written down may be more to do with the interactional resources provided from the turns at talk, what is actually done in these turns, and what dealers can make use of to record.

## 5.5 Discussion

The analysis reveals that the ways in which numbers are abbreviated may not be done for the individual dealer, but shaped in particular ways for others. Numbers are spoken in particular ways in the deal talk for others to distinguish the different components quickly. They are also produced in ways that are sensitive to the local circumstances of other dealers, for example, in relation to what can be seen on the screens or the activities the other may be engaged in. If numbers are not produced in recognisable ways, the deal will not be accomplished in such a quick and efficient way. The organisation of numbers is not strict, but is shaped according to the contingencies of the market and the moment-to-moment production of talk. The analysis has revealed a further critical issue in the production of numbers. They are spoken in ways that are sensitive to the activities of the other dealer, in that they may be said in ways that facilitate their recording. Thus, numbers are not simply produced for economy of speech, but also for a recipient to distinguish and recognise what is relevant, and they may be designed to be written down and recorded. It may be seen that numbers in deal talk perform actions, and an apparently individual activity like writing is shaped with respect to the conduct of others.

Making a record of a deal is a straightforward example of a bureaucratic activity. From Weber's analysis (1947) concerning the role and nature of large organisations, and their reliance on certain kinds of bureaucratic communication, record keeping and the use of documents has been of interest to researchers from various analytic orientations within the social sciences. For example, Yates (1989) has revealed how particular forms and documents, such as memos, emerged with different developments in the management of large organisations, whilst others have been concerned with revealing the skills and practices associated with both reading and writing bureaucratic forms (e.g. Garfinkel, 1967; Heath, 1982; Raffel, 1979). Such analyses reveal the organisational competencies, the underlying skills and understanding of the domain in how records are produced. The analyses also reveal the interactional production of 'improvised work'. Records may be written in an open slightly ambivalent manner so that they are defeasible (Heath, 1982) and open to the contingencies, thus allowing items to be altered later. But records are also produced for others, so that they may recognise this ambivalence. To understand and recognise the ambivalence is a skilled practice within the domain and there are good organisational reasons why such flexibility is required.

The social scientific understanding of record keeping could well be relevant to those developing requirements for different technologies, in terms of how these record-keeping practices are analysed. Rather than focusing on individual practices, these approaches focus on the organisational resources through which people keep records (Bowker and Leigh Star, 2000). These analyses look at how categorisation

systems and the organisation of records are shaped for various professional purposes. Those developing systems for record keeping may want to be sensitive to those types of practices. For example, if a system is being developed that incorporates categories which cover different professionals (Bowker and Leigh Star, 2000), the designers may neglect the different purposes in which these various categories are used. In healthcare, for example, various types of professionals have good reasons for having different types of record cards and recording different features in differing levels of detail. Requirements analysis may need to understand how people put records together. The information recorded has various organisational relevancies. Failing to take account of these may have certain consequences. For example, the systems developed may be too rigid to use, or they may be used in conjunction with other forms of record keeping being kept alongside the computerised record-keeping system (Heath and Luff, 1996b).

In the materials considered here, it appears that record keeping is produced for others and in its course is accomplished interactionally. The consequences of not taking this into account in the design of computer systems to support record keeping is that the technology will not fit into the ongoing moment-to-moment nature of the activity at hand. For example, a computer system to assist traders in typing in deals must allow dealers to input the components in a flexible way. Ordering is sensitive to the production of talk and talk itself does not occur in any fixed way. Therefore, if systems are to be sensitive to the practices in this domain they should not demand a rigid ordering of items.

Not providing this flexibility can also lead to disturbances to the actual talk as an individual has to move to various positions on the system in order to record (Whalen, 1995). A given technology may also transform the ordering in which people produce items in talk. This may not be desirable, transforming the nature of work practice not just for individual dealers but also for remote traders with access to the technology being used.

Recording and dealing are not distinct activities. The design of the voice recognition systems did not seem to treat these as separate tasks. But it is only when we see how they are interrelated that we may understand what aspects need to be supported by technology. Thus requirements for record-keeping systems might be informed by the following aspects.

- Categorisation – a sensitivity to how information is broken down in relevant ways for the participants themselves and a consideration of what the ‘valid’ items are to be entered into various portions of the record.
- Interface components and interaction styles – for example, a sensitivity to what is displayed and at the same time what aspects may be placed

close together. If interface components are in spatially distinct locations, on different screens and they require keyboard or other input actions, these may have consequences for the ongoing talk. Designers, therefore, may want to organise the component of the interface in a manner that resonates with the organisation of the talk. Components might appear with others that they are related to in the talk. For example, stock and buy/sell together, price and amount together. More analysis would be required to consider the exact layout, but could certainly suggest an initial configuration

- Characterisation of activities – to consider whether it is feasible to automate various processes by capturing the information directly from the activity itself (in this case the items of a record).

These analyses described in Chapter 4 and 5 formed the basis for design discussions with requirements engineers interested in developing computer systems to support deal capture. The effectiveness of these discussions lay in the presentation of video – not solely the fragments selected but accompanied by the analysis. It is interesting to note that, common to many system development exercises, these designers had never been in a dealing room. Instead, they relied on the expertise of a business analyst to provide relevant information regarding the work of dealers. Video and accompanying analysis provided designers with access to the setting and enabled them to see for themselves how the details of work practices, such as the nature of deal talk, the flexibility of work practices and the use of artefacts, in the dealing room emerged through interaction. Issues associated with this process will be raised in Chapters 7 and 8.

## 5.6 Summary

The analyses have revealed the detailed interactional production of deals that include: minimal trading where deals are agreed very quickly between participants; ambivalent trading that allows for some openness regarding various components of the deal and provides flexibility and movement in the interaction; and open trading where dealers may not even declare whether they are buying or selling stock. We have also looked at the skilled practices of producing numbers in deal talk. The analysis suggests that numbers are produced in various groupings so that they may easily be distinguished one from the other and that the positioning of these components in relation to certain words within a turn of talk can imply if the number is a price, amount or customer number. The analysis not only suggests that dealers, in the way they say numbers, may be attempting to disambiguate potentially confusing groupings of numbers, but

also that they may be shaped in particular ways in the ongoing interaction for the other to write down.

These numbers are written down as part of the deal-recording activity. The analysis has revealed how deals are not necessarily recorded after the deal talk. Rather, the ways in which components are written seems to be tied to the order of items produced in the talk and the trajectory of the talk itself. A seemingly individual activity like writing is produced thoroughly collaboratively and through interaction. And what is written seems to be related to the interactional resources provided from the turns at talk, what is actually done in these turns, and what dealers can make use of to record.

We have examined the details of these practices in terms of the ways in which information is segmented, how it is displayed, and even in terms of what a system to support deal recording should do. Revealing the interactional details provides resources for understanding the domain that are necessary to convey to requirements analysts in order to develop systems that may be more sensitive to these work practices. Considering the implications for requirements for technology will be the focus of the next two chapters.

# Chapter 6

## Investigations into Modelling Interactional and Collaborative Resources

### 6.1 Introduction

In this chapter, we consider one of the ways in which findings from studies of workplace and organisational activities can be transformed so they are relevant for system developers – through modelling. Modelling is a common technique in engineering generally and computer system development in particular. Whether it is undertaken formally or informally, its usefulness is considered as a way of focusing on critical aspects of a design problem, of clarifying complex mechanisms and processes, and of communicating particular issues, problems and solutions between members of a design team. It is also seen as a useful way of providing a more systematic method of transforming an analysis of a current problem or activity into a specification of a solution, and thence into the actual design of a solution. We explore these objectives with respect to the issues arising when seeking to transform analyses of collaborative activities into the design of computer systems to support collaborative work, particularly with respect to determining the requirements for such systems. Providing designers with an orientation to particular aspects of the ways in which people collaborate and coordinate their activities in the workplace is critical to informing system design appropriately and may lead to more sensitive designs for supporting collaborative work. Attendance to such aspects can improve requirements practice, and may improve the results of the system design process leading to the development of more appropriate systems. By utilising the analyses of collaborative activities in the dealing room described in Chapters 4 and 5, we aim to illustrate how aspects of interactional and collaborative resources may be developed to become

suitable for use in the design of computer systems to support cooperative work. In examining how to model the details revealed by analyses of collaborative work and interaction, we look at several recent proposals for modelling social and organisational activities. When looking at these models we argue that by not capturing and communicating certain information, they are failing to realise opportunities to improve system design. More critical information from naturalistic analyses can be communicated if attendance is given to interactional achievements in the workplace.

We discuss the particular aspects on which it may be useful to focus, specifically with respect to the different purposes to which models can be put, and suggest some ways in which the richness of the analysis could be preserved through the system development process.

Section 6.2 details some of the critical aspects of modelling techniques in requirements; we consider three examples that each claim to focus on some aspect of social and organisational practice, but drawn from quite different modelling resources. Thus, Form Analysis (Choobineh et al., 1988), Section 6.3, draws upon conventional entity-relationship techniques to model communicative and organisational relationships and activities. The resources for these models come from analyses of users, other people in the process, and artefacts utilised in the domain. The second example (Section 6.4) uses a widely known technique, the Universal Modelling Language (UML) (Rational Software Corporation, 1997) that aims to be a general object-oriented tool for analysis and design. In particular, we discuss a recent case where UML has been utilised to explore specific complex and subtle collaborative activities revealed by a workplace study (Viller and Sommerville, 1999). The third example (Section 6.5) attempts to extend this research into complex naturalistic activities and investigates modelling the details of collaborative organisational practices, specifically situated activities (Goguen, 1994). We draw upon the investigation of these exercises to consider aspects of modelling organisational communication, awareness, situated action and sequential and parallel activities, and discuss the extent to which these models may be successful in communicating these hard problems. Drawing upon Goguen's study, we then attempt a simple modelling exercise to investigate some of the issues involved in modelling the contingent, local and open nature of local workplace interactions, and the use of organisational artefacts. From this exercise, very different resources emerge that can be utilised for modelling social and organisational activities. Section 6.6 considers how such resources particularly relating to sequential, multiple and parallel activities might be modelled in a more formal language such as CSP. The exercises in modelling collaborative work in the dealing room are an investigation into the issues that arise as we reflect on producing the models themselves; they are not intended to be fully worked through or complete models. We conclude by discussing these efforts in

Section 6.7, both with respect to their aims to represent social and organisational action and to develop resources suitable for the system development process.

## 6.2 Background: Modelling Organisational Activities and Social Interaction

It is often claimed that the activity of modelling is attractive to all engineering disciplines because the building of models appeals to the principles of decomposition, abstraction and hierarchy; features that are perceived to be critical for the design of large and complex systems (cf. Booch, 1991a). Thus, models are seen as useful to describe particular parts of the system being considered and hide or downplay less important features. New models can be constructed on the understanding of previous proven models and can be tested in various situations. Booch further argues that software designers also find modelling useful for these reasons and, as software systems are inherently complex, and in order to describe and investigate this complexity, more than one kind of model is commonly developed. Each model within a software design may describe some particular aspect of the system. Jackson (1995) suggests that a model may be more than just description, possibly being seen as analogues of the thing that it models. In this way it is argued that models may share various properties and structure of the system being modelled. Generally speaking, models are considered to be a product of software design that allows analysts to reason about structures, make trade-offs, and overall give some projection for implementation. In practice, software engineers may draw upon a range of modelling techniques; however, as yet there are still only a few studies that have looked at the actual use of these techniques in design. Those that have been carried out imply that modelling techniques are used in different ways to those developers initially intended (Bellotti, 1988; Button and Sharrock, 1994). Nonetheless, modelling, whether adopted as part of some formal process or an informal activity, does seem to be an intrinsic part of the practices of software development.

In the earliest phases of software development, those phases characterised as requirements engineering, modelling has been considered as a way of understanding and communicating aspects of the physical and social world for the purposes of clarifying what is required from a new system (Myopoulos, 1992). The expectation in the requirements process is that various models may be constructed that will communicate some feature of the computer system under investigation. Models may be developed and used at various phases: for example, they may be used in a requirements document to supplement natural language descriptions of computer system requirements, or they may be developed during the requirements elicitation and analysis stage to help better understand the requirements (See for example, Yu,

1993). The models produced as part of a requirements exercise are perceived to allow analysts to investigate, represent and communicate various aspects of the technical system. These might include hard process problems, particular system and domain issues or particular communication patterns, and may assist analysts in determining the system's capabilities and assessing trade-offs when requirements conflict. Similar to the expectations in design, models are undertaken in requirements in the hope that analysts will be able to reason about aspects of the desired computer system in such a way that they may be able to predict system behaviour. However, as models are also utilised to communicate information not only to software designers and testers, but also to customers, managers and users who may not be familiar with the various techniques and notations, there is also a need for them to be very clear and relatively easy to understand.

Various different forms of modelling techniques are available to the requirements analyst in such endeavours. As Sommerville and Sawyer (1997) describe, these techniques may range from very formal approaches to structured methods, and are perceived to be more or less appropriate for modelling different aspects of the system. For example, a critical problem within requirements engineering is the specification of requirements that are seen to be complete, consistent and unambiguous, particularly in safety or security critical embedded systems where errors have led to various system failures. Thus, it has been proposed that utilising formal techniques alongside natural language specifications may be useful for addressing these issues (Lutz, 1993). Other research has indicated the use of formal techniques for requirements, tackling aspects such as specifying temporal constraints and error recovery (Kent, et al., 1993), documenting requirements (Van Schouwen et al., 1993), and using domain knowledge to initiate the development of formal requirements models (Bolton et al., 1994). Formal techniques based on the use of mathematics, most commonly set theory, logic and algebra, are often used in requirements to model aspects of the technical system, typically functional or concurrent behaviour (Sommerville and Sawyer, 1997). Most formal techniques are not strictly methods that provide analysts with notations and guidelines about systematic application. Rather, they are notations that allow requirements to be encoded and reasoned about. The techniques themselves may differ in the aspects of the technical system they orient towards modelling. Thus, techniques such as Z (Woodcock and Davies, 1996; Spivey, 1989) typically model aspects of functionality, whereas CSP (Hoare, 1985; Roscoe, 1998) is oriented towards modelling concurrent properties necessary for the development of communications and distributed systems.

In contrast to formal approaches, structured methods have attempted systematically to impose a structure on both the system, and the activity of developing the system models. There are numerous types of methods, including: Structured Analysis and Design Technique (SADT) (Ross, 1977); Structured Analysis and System

Specification (SASS) (DeMarco, 1979); and Jackson System Development (JSD) (Jackson, 1983). Structured methods have been categorised as supporting two different viewpoints in modelling: structural or behavioural (Loucopoulos and Karakostas, 1995; Sommerville and Sawyer, 1997). Thus, the structural viewpoint tends to stress the modelling of the structures of the entities in the application and any constraints on the allowable states of these structures. In order to do this, two basic approaches have been predominant: the entity-relationship-attribute (Bachman, 1969) and object role approaches (Abrial, 1974). The behavioural viewpoint focuses on the activities operating on these structures and the events that initiate these activities. Data-flow models have been used predominantly to specify the activities that have been decomposed.

The techniques available to the requirements analyst seem to be oriented to supporting different concerns within the process of determining, specifying and communicating requirements. Where safety and security issues are predominant and reducing error is critical, formal techniques have played a major role. If concerns are oriented towards modelling the interrelationships between the various functional activities of an application, structured methods may be useful. And where it may be important to model both structural and behavioural aspects of systems uniformly, object-oriented approaches have been suggested (Booch, 1991b; Wieringa, 1991).

A more recent concern in requirements has been the analysis of social, collaborative and organisational behaviour in order to develop an understanding of how such information can be made to fit into the requirements process. Research has been concerned with the problem of communicating this type of information to designers and how to integrate an understanding of these aspects when making trade-offs between different and possibly conflicting requirements. The techniques for modelling aspects of the social and/or the technical system under investigation in the requirements exercise have fundamentally been drawn from the methods utilised in the software development process itself. Therefore, in their endeavours to make social and organisational practices available to system designers, many analysts have attempted to use existing techniques that have been developed specifically for modelling particular aspects of computer system behaviour. It is the appropriateness of this practice that we investigate here, particularly with regard to modelling aspects of social interaction and collaborative work, where critical resources for producing and recognising activities might be lost in the representations that may not adequately describe them. It is argued that providing requirements analysts with a sensitivity to these features is crucial to improve both the process and produce more sensitive designs for supporting work in these settings. A consideration of these features can also provide a foundation for considering how work practice may be transformed through the design or deployment of technology.

It may be the case that modelling work practices may yet prove to be intractable. If so, approaches that attempt to improve the sensitivities of requirements engineers to the complex and subtle features of work practices may be the most useful way forward. Some of these sensitivities are described in Chapter 7. Nonetheless, the prospect of improving modelling languages and practices are serious and interesting enough to deserve exploration.

In this chapter we first look at three modelling exercises that have attempted to address these concerns and indicate the types of opportunities the modelling can provide. As suggested previously, the modelling techniques utilised within requirements have not necessarily been defined as a resilient part of the requirements process. Moreover, the modelling of social and organisational practices is still in the early stages; models judged appropriate to this activity have not yet been identified. Therefore, in Sections 6.3, 6.4 and 6.5, we take three proposals that provide ways of modelling organisational and social behaviour and consider them with a specific focus on interactional and communicative aspects. It seems possible that even seemingly straightforward modelling activities such as those that attempt to break apart the nature of a problem, or structure the problem domain in some way, may lose critical areas of concern in the analysis of social and organisational conduct. These proposals suggest very different resources that can be utilised for modelling social and organisational activities; they focus on different aspects of organisational behaviour, utilise quite different modelling techniques, and draw upon different analytic frameworks.

We continue investigating the issues involved by modelling aspects of the fieldwork and analyses described in Chapters 4 and 5. We begin the investigation by attempting to model contingent, open and collaborative activities in a simple notation in order not to be committed to the structures provided by a more powerful language too early in the modelling process. From the issues that emerge, in Section 6.6 we describe by way of illustrative examples, the potential for modelling the multiple, sequential, parallel and interleaved nature of collaborative practices in a notation that is oriented towards describing concurrent systems, CSP. We reflect on the examples provided and discuss in what ways they have communicated the interactional resources drawn upon in the achievement of collaborative activities. These modelling exercises are not to be seen as complete models; rather we wish to describe the issues that arise when attempting to model aspects of collaborative behaviour. We conclude by outlining critical issues to be addressed in modelling that may imply consequences not only for requirements and computer science in general, but also for social scientific investigations.

## 6.3 Modelling Organisational Artefacts

Generally, there are difficulties in eliciting aspects of social and organisational practices. This is well recognised in social research methods and is reflected in concerns within requirements. Eliciting requirements from people in organisations, be they users, managers or customers, is a complex process. The nature of this complexity lies in developing sound ways of securing an individual's views or multiple views regarding people's own social and organisational practices, and yet not being sure to what extent these views truly represent what occurs in practice. Even if it is possible to identify the individuals or representatives of particular groups of individuals from which to elicit requirements, the enterprise is still fraught with problems. Eliciting people's views about a particular technical or social system, hypothetical or otherwise, runs the risk of eliciting only views or operationalised versions on the subject at hand rather than information on real activities as they occur in practice. This is so, not simply because people may withhold information or misunderstand questions asked of them, but also because many of the activities they are required to provide an account of are often tacit in nature, and thus may not easily be described. In addition, the analyst often has little idea of the context within which individuals are making these statements; as they have little sense of the work practices, they may not be able to evaluate statements made in the context of that understanding. These problems exist in a situation where the predominant techniques used to elicit requirements, such as interviews and questionnaires, are themselves related to the context in which they are read and interpreted (Goguen and Linde, 1993; Suchman and Jordan, 1990). The issues surrounding the use of these techniques have been discussed in Chapters 2 and 3.

In attempts to gain access to organisational work practices, some analysts have examined in detail the types of documents used in everyday work practices such as invoices, letters and forms. The first investigation in this chapter recognises some of the difficulties of eliciting information from users and other organisational members. Rather than treating users as primary sources of knowledge about a problem domain, Form Analysis (Choobineh et al., 1988), concentrates investigation on the knowledge that can be elicited from various documents, such as forms, that are used in the problem domain. In contrast to methods requiring object analysis where the analyst is required to identify and focus on various objects in the world, form analysis is more specific requiring the investigation of a particular commonplace object, the form as an organisational artefact. The technique, used primarily in data intensive applications for database design, views the form as a data model itself, where not just the items on the form are analysed but also the instructions for completing them. Underlying this approach is an assumption that the structure of forms can provide the basis for the structural components of the functional model (Loucopoulos and Karakostas, 1995).

Typically, forms are seen to provide input to semi-formal models such as entity-relationship models (Chen, 1976). Choobineh et al. (1988) argue that forms provide suitable input for such models that are designed to describe the data layout of a system at a high level of abstraction; indeed, they argue that forms are superior to natural language requirements gathering. A claim supported by Loucopoulos and Karakostas (1995), who state that a form ‘is a formal model and thus, less ambiguous and inconsistent than equivalent knowledge expressed in natural language’ (p. 41).

If we consider the analyses of the dealing room, we might see the paper ticket described in Chapter 5 as one such form used within financial trading rooms for bureaucratic communication. We have seen how the basic fields of the ticket include the following elements needed for recording a deal:

- the name of the stock that has been traded
- the counterparty (who the trade was with)
- the time of the deal
- the price of the stock
- the amount of stock traded
- if the stock was bought
- if the stock was sold

One way we could model the aspects of the form might be through using a simple entity-relationship diagram. In representing the deal-capture form we model the deal itself as an entity that is made by a dealer (entity) with a counterparty (entity). The deal has various attributes of stock, amount, time, buy, sell, and price.

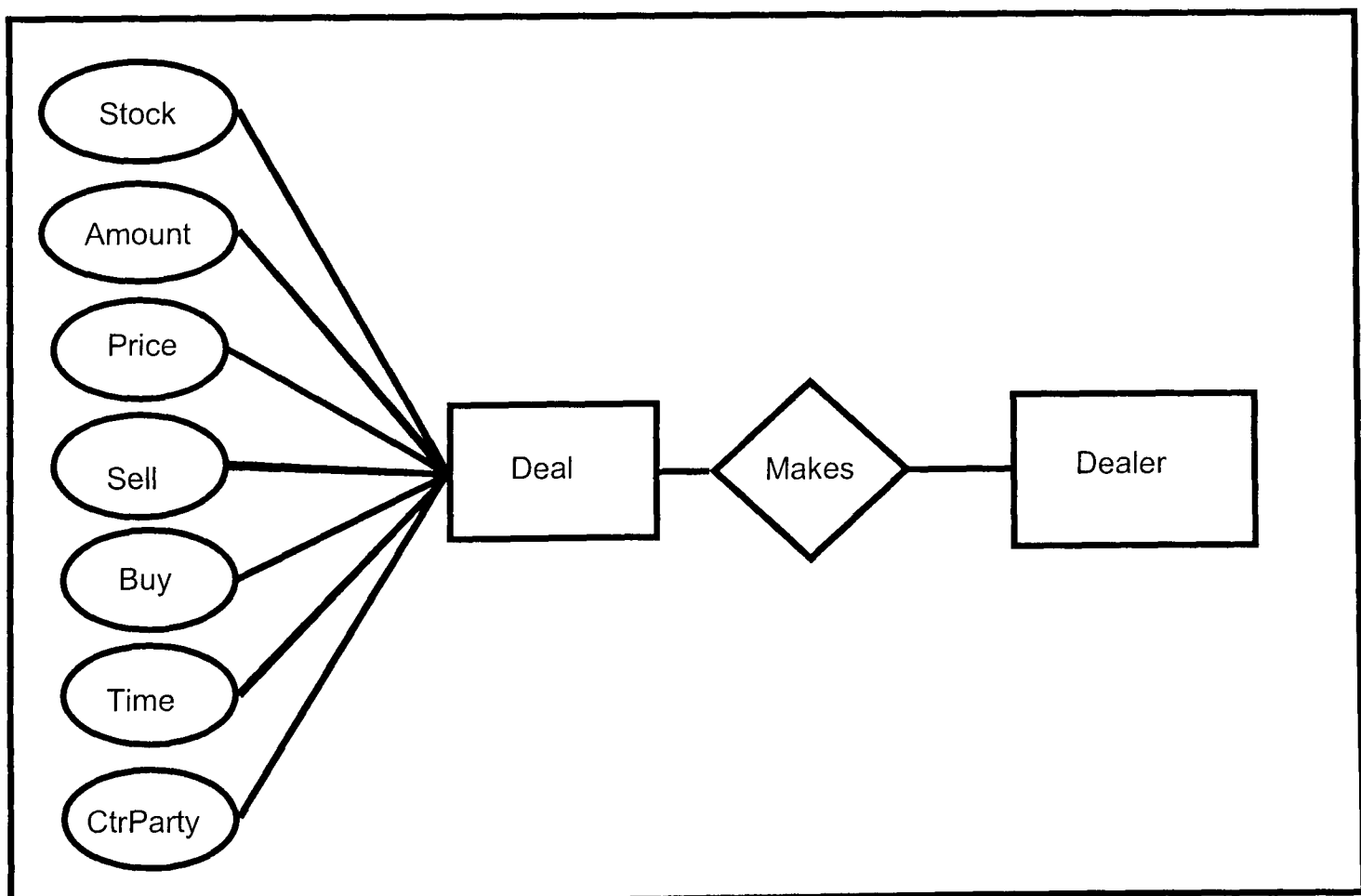


**Figure 6.1** A simple E-R model for the deal-capture form

In form analysis, mapping the concepts hidden in the form is seen to be the task of the analyst. No clear rules exist to suggest what might correspond to an entity, and different approaches favour different tactics. Some rely on the analyst's judgement; for example, Chen (1976) suggests an entity is a thing that can be distinctly identified; other researchers attempt to automate the process by applying heuristics to match forms with constructs. The process of analysing forms and identifying entities may be automated to match form contents with constructs through the use of heuristic rules based on the cardinality, origin, name and grouping of form fields. In such an approach, the system incrementally builds a schema diagram by analysing each form separately. A collection of rules is used to determine the order in which the forms may be analysed and to identify the entities, attributes and relationships that represent the forms. Once the model has been constructed, it is validated by the user in the organisation.

The simple E-R model above presents a view of deal capture in terms of the data that must be filled in so that the information in a dealer's ticket may be matched successfully with the corresponding information on the counterparty's ticket. The entities and attributes identified in the model may be useful to determine the requirements for a system to support recording deals. For example, the model may represent the various fields in the form - what information such as stock, price, amount, whether the dealer is buying or selling and the time of the deal needs to be communicated. These items may then be used in determining the types of data structures that need to be present in a system to support deal capture. However, the features revealed by the analysis of Chapter 5 looking at the details of the production of the ticket may be problematic to reveal just by looking at the ticket itself. The analysis highlights how participants utilise various parts of the form, how various items may be left open, or half filled in with abbreviations and annotations. Thus, we have seen how dealers have great flexibility in how and when they fill out the paper tickets. Not all the details are filled in; they may leave open the time, for example, as they can rely on trade-input staff logging the time when they pick up of the ticket. They may also use certain abbreviated forms such as 20/- (20,000), relying again on the competencies of trade-input personnel to recover the necessary information that this is twenty thousand shares that are bought or sold depending on which field contains the information.

Dealers can start to fill in parts of tickets before the deal has taken place, during the deal, or can wait until the deal talk is over. They can also be filling in three or four paper tickets interleaved, whilst at different stages of the ongoing deals that may be taking place through the technology or face-to-face. Dealers can also easily correct fields on the tickets during the ongoing deal. Filling out tickets can be interleaved with many other activities, including: trading on the telephone on another deal; talking face to face with a colleague; watching various screens for changes in the

market; monitoring another colleague's activities and producing an activity such that the colleague is or becomes aware of it. This might include the ways in which writing out the ticket is a display to other dealers that a deal has taken place. More critically, the actual talk of the deal can shape the way that fields of the ticket are filled in. Thus, we see how various fields are filled in with respect to the ongoing interaction.

It is not at all straightforward to transform information obtained by analysing a form and its associated form-filling instructions into models of organisational communication. The model based on a static form captures the information at one moment of time. It remains unclear which particular moment of time this should be. The information captured from an uncompleted form, say, could suggest a set of prescriptions and procedures concerning what information should be entered and how, but little about what actually is communicated in practice and what is considered necessary and useful by the participants rather than the form designer. Examining a corpus of filled-in forms from the setting may indeed suggest some of this information, but even if these captured different stages of the form-filling process this material would only reflect particular communication practices of the writers of the forms. The analysis of the production of the deal-capture ticket has stressed the ways in which the writing and reading of the ticket is produced with respect to the ongoing interaction. Critical to this is how the talk between a dealer, a counterparty and other participants can shape how and in what order the fields of a ticket are filled. In terms of the form-analysis approach, what is difficult to obtain from the form is the interpretative practices of the participants; how the forms are produced and understood in the context of work.

The issues discussed above reflect more general arguments within sociology regarding the production of forms and rules and procedures in organisational settings. As mentioned in Chapter 5, various researchers from different analytic perspectives within the social sciences have been interested in analysing the use of documents as bureaucratic communication. Previous naturalistic studies in a range of settings have revealed how forms and other bureaucratic documents are produced in the light of other activities, in coordination with the ongoing activities of others, and how contributions to them are designed with respect to the particular concerns of other participants. Thus, analyses have revealed how rules for filling in forms may be improvised, left open and interpreted within a whole range of organisational concerns in order to get the work done of filling in the form (Garfinkel, 1967). Other studies have outlined how participants interleave the filling-out of forms with other organisational activities, including: talking on the telephone; talking face-to-face with a colleague or client; or watching various monitors or computer screens (Heath and Luff, 1996b; Whalen, 1995; Whalen and Vinkhuyzen, 2000).

In assuming that forms are 'easy to read and understand' (Choobineh et al., 1988, p. 242), the technique views the form as a static representation of communication, and

concentrates analyses on how it is designed to be filled in rather than its use. Indeed, when considered in more detail, it may not be straightforward to read and understand a form. Participants may make sense of particular items with respect to other entries and may take for granted items and entries which are elided (Heath, 1982). Making sense of forms relies upon a set of interpretative practices and organisational competencies both by the reader and the writer, so that entries are understood with respect to the circumstances, of how they were written or how they should be read.

Despite recognising that particular documents are critical for the accomplishment of social and organisational activities, by assuming that form filling or any documentary activity is based on a set of explicit and formalisable rules, there is a danger of missing critical aspects of communication and work activities, even surrounding the very object being examined. It may be that by focusing on these rules and procedures the technology to emerge from such requirements can be considered too rigid and inflexible when put into use. A case in point is a particular computer system designed to support medical record-keeping by primary-care practitioners (Heath and Luff, 1996b). A system was developed that mirrored the information entered on paper forms. However, by concentrating on the 'formal' categories that needed to be recorded and ignoring the tacit ways in which medical records were written and read, the resulting system required users to enter information in ways that had none of the subtlety of the paper record. For example, particular items on the computer system had to be entered that were previously elided, entries had to be made explicit whose ambivalence could previously be 'understood' by any competent practitioner, and pairs or sets of items that were previously 'read' and 'understood' together were separated in different screens of the system. It is therefore not surprising that practitioners continued to use the paper records alongside the newly developed computer system.

## 6.4 Modelling Collaborative Activities

Other researchers have explicitly considered how to draw from ethnographic workplace studies that reveal the informal, implicit and tacit aspects of collaborative work, in order to develop models to communicate the details of these work practices. Their concern lies in considering how to make accessible the complexity and richness of the analysis in a form appropriate for system developers. For example, Viller and Sommerville (1999) have undertaken a modelling exercise focusing on issues surrounding the concept of awareness that draws on an earlier framework developed through a collaboration between social scientists and computer scientists (Hughes et al., 1997; Hughes et al., 1995). They utilise an established system design notation called Universal Modelling Language (UML). The research concentrates on one aspect of a framework for structuring ethnographic findings, also aimed at supporting

the communication between ethnographers and designers. This framework structures analyses, developed from an ethnomethodological orientation, in three main areas: *distributed coordination* to describe how people coordinate their activities in the workplace; the *plans and procedures* through which people practically coordinate their activities both co-present and distributed; and *awareness of work* for how certain activities may be made visible or intelligible to others in the workplace. Though the original framework was intended for use by social scientists to structure their ethnographic findings in order to make them accessible for design, Viller and Sommerville adapt the framework in order also to provide a means of structuring a systems analysis. This extension is seen as necessary in order to focus systems designers' efforts during systems analysis, and thus make the whole approach more accessible. A principal aspect of their approach is an attempt to communicate hard problems to designers such as tacit activities in the workplace. They illustrate how a transformation from an ethnographic study to systems analysis can take place by modelling 'awareness of work' using UML. For the purposes of the modelling exercise, they draw on a study that reveals various examples of awareness of work activities in a training-centre office (Rouncefield et al., 1995).

Such explicit modelling exercises are seen as a recognition that 'the design process must not only build up an understanding of the social aspects of the system but also be able to record them in such a way that they can be communicated to other stakeholders and ultimately feed into design itself' (Viller and Sommerville, 1999, p. 12). The use of UML then is warranted by its conforming to designers' current work practices, rather than for example requiring them to learn new methods or techniques. Their exercise seeks to overcome the constraints of other modelling approaches, form analysis for example that focus only on the structural components of communication, and are thus constrained by presenting a severely limited view of collaborative work. Awareness, as revealed in the ethnographic study, is complex and dynamic in nature. The topic of awareness itself seems to require specific clarification (Benford and Fahlén, 1993; Rodden, 1996). A range of workplace studies have revealed practices that seem to rely on the peripheral awareness of participants, for example, overhearing the activities of others (e.g. Goodwin, 1996; Heath and Luff, 1992a), overseeing another's conduct (e.g. Goodwin and Goodwin, 1996; Heath et al., 1994-5), or monitoring the state of artefacts, tools and displays in work settings (e.g. Harper and Hughes, 1993; Suchman, 1993). Particularly in the domains studied, control rooms and the like, these activities seem complex and modelling might assist in unpacking issues of relevance for technological design.

In their example, Viller and Sommerville seek to examine an apparently straightforward example of awareness in a training-centre office: that is, how participants can be aware of the progress others are making through the paperwork by monitoring the pile of forms, as well as be aware what current activity their

colleagues may be engaged in ('it is the fact that a form is on the top of a pile that is significant, as well as how many forms are left to be processed in the pile', p.33). Viller and Sommerville utilise a basic object-oriented notation to model the properties of the pile of forms, or its affordances for awareness (i.e. that the pile, and the form on the top, are visible for others to see).

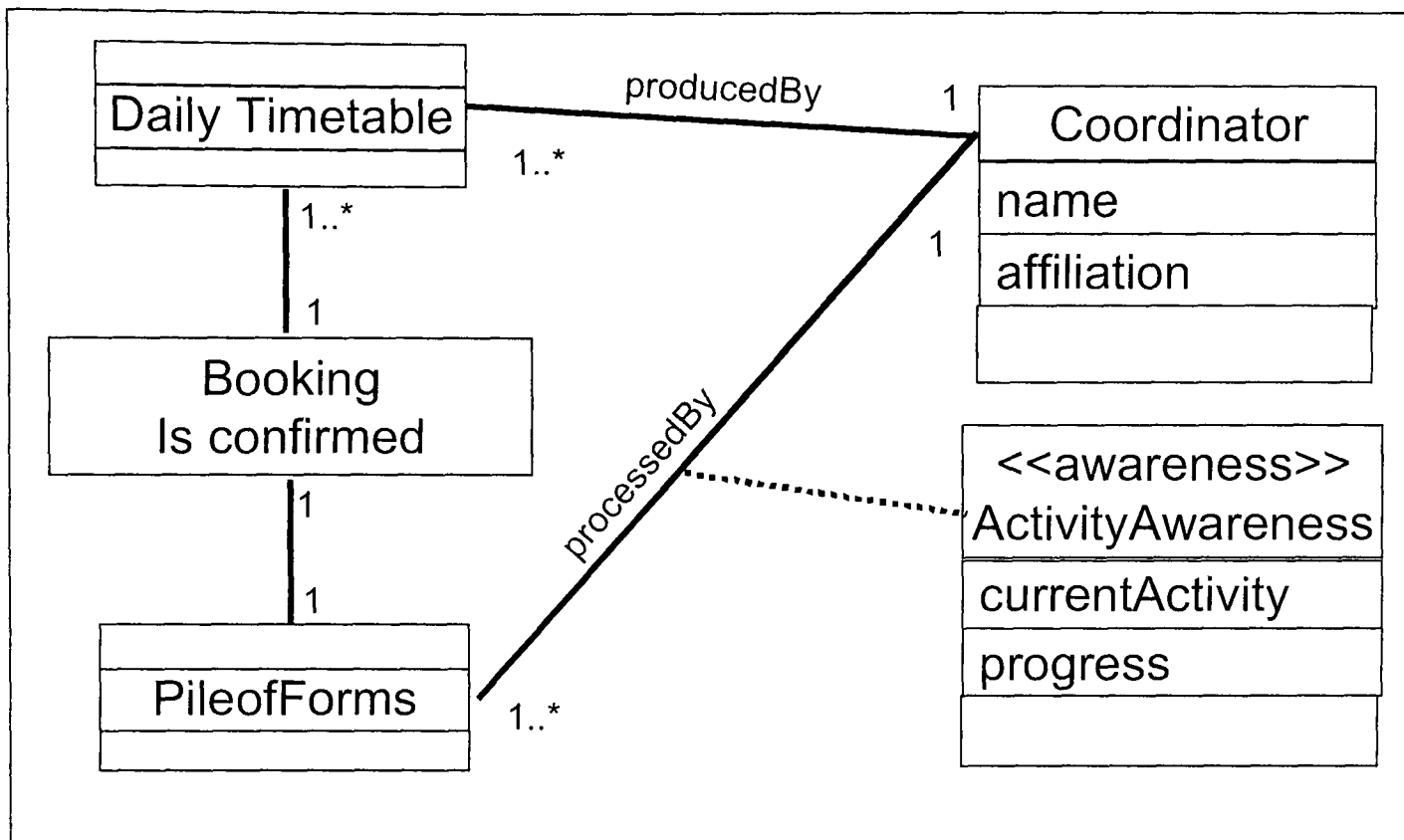


**Figure 6.2** reproduced (Viller and Sommerville, 1999, p. 34) showing how paperwork affords awareness of a coordinator's activity

Through what may appear a straightforward example, Viller and Sommerville reveal some of the complexities of attempting to model results developed from ethnographic studies. In transforming a description of the practices of the participants, practices that are emergent and situated within the work of the office, into a notation, the practices are rendered curiously static and divorced from the context in which they are produced. No doubt one of the objectives of the analysis is to provide a clear and perhaps generalisable characterisation of awareness. However, in doing this it may be that critical aspects of awareness fail to be communicated through the design process, or at least are hidden from view. Thus the model produced seems to communicate that because the form is on the top of the pile it affords awareness because it is visible. However, what appears to be missing is any relation to how such awareness is achieved as a collaborative activity. While it may indeed be important for others in the working environment to see a form is at the top of a pile, what may be critical is not simply that a colleague can see a particular form is at the top, but when and how it is seen. *At certain times in relation to certain activities of others, it may become relevant that a form is at the top of the pile.* When such an activity becomes relevant, and how it is made so to others, is critical in the achievement of such awareness. It may not be the case that participants in a setting always need to be aware of the activity.

As Viller and Sommerville point out, in the naturalistic studies and the derived modelling exercises, awareness appears to be a particularly vague concept to explore. The social scientific studies reveal a complex set of resources that appear to be of relevance for the participants: the public nature of physical displays; the bodily conduct, gaze direction and talk of participants; and the local ecology of the workplace, amongst others. Some models (e.g. Benford and Fahlén, 1993) have begun to try to model more sophisticated aspects of awareness related to the particular orientations of individuals at certain times. However, more commonly, when transformed into a modelling language or a more complex diagrammatic or formal notation, critical aspects fall from view; for example, how and when particular artefacts and actions are brought to the notice of others; how ‘awareness’ emerges through the collaborative conduct of the participants; and the particular resources through which awareness is produced and recognised. It may be possible to argue that the efforts of Viller and Sommerville, as with earlier models of awareness by others (e.g. Fuchs, et al., 1995; Rodden, 1996), are thwarted by the deficiencies in their notation techniques or modelling apparatus. However, these efforts, by transforming accounts from ethnographic studies into other formulations, do raise critical issues for design. Through the process of attempting to model work practices, questions are raised that suggest directions to deepen the analysis for social scientists. Thus, what may be necessary to communicate to designers is not a representation that one person in a work setting is aware of another, but *how* they are aware; *how* awareness is important in collaboration and *how* it is achieved interactionally, implying the sequential and concurrent nature of activities. The eventual system design itself may support such awareness tacitly, or more explicitly. But what is critical at this stage is to communicate a sense of the resources and practices of individuals in the setting; how activities integrate different resources to accomplish collaborative activities, and how this is produced and recognised moment-to-moment in the local context for the subsequent activities of others.

Characterising ‘awareness’ in terms of such a semi-formal model may misrepresent the very features that the model is meant to communicate. Awareness is not a discrete activity tied to particular objects and individuals, but rather a gloss for a disparate set of emerging collaborative practices (cf. Goodwin and Goodwin, 1996; Heath and Luff, 1996a). Such models may convey the *knowledge that* an activity is accomplished, but neglect the *knowledge how* it is accomplished (Ryle, 1949). The model might therefore neglect what it is endeavouring to convey: the situated and contingent features of everyday work. This might then lead to undesirable consequences when the requirements are transformed into design. It may be possible unduly to develop systems that focus on providing information to make colleagues aware ‘of’ particular activities and events, neglecting ‘how’ this needs to be accomplished in the domain. It could be seen that various ‘awareness servers’ focus

on the information that needs to be presented to others, rather than the ways in which this provision can be made apparent and relevant (Fuchs et al., 1995; Hayashi et al., 1999). In a similar vein, the development of media spaces and some collaborative virtual environments have focused on providing additional resources concerning co-participants rather than how these resources can be better integrated into the everyday practices and interactions of users.

The modelling exercise described may be considered successful in terms of beginning to unravel a hard problem; by reflecting on awareness, the process provides opportunities to look at a topic which as Viller and Sommerville state is still vague within the social sciences, and thus can potentially be used to identify aspects for further study<sup>12</sup>.

## 6.5 Modelling Situated Activities

Goguen (1994) recognises explicitly that much of the information that requirements engineers need to elicit and then communicate to others in the software design process is embedded in the social world of managers and users. The origin of this information is seen to be very informal and highly dependent on its social context for interpretation. He argues that in order to build systems that meet business needs, analysts must understand what managers and users actually do in the workplace. In common with Viller and Sommerville, Goguen is interested in examining naturally occurring information, as it is maintained and distributed in an organisational setting. The focus of his study lies in modelling situated activity that he defines as actions that “occur in some interaction (and) can only be understood in relation to the particular, concrete situation in which they actually occur”. (p.168). Goguen provides a list of the qualities of situatedness that includes the following; social activities are *emergent* in that they are jointly constructed by participants through their ongoing interactions; actions are produced and made intelligible in a *local* context; they are *contingent* in that their production and interpretation depend on the current situation as it unfolds; actions are *open* as they may not have a final and complete form.

He suggests that the practice of requirements engineering necessarily includes both forming an understanding of the contextual situated nature of activities in the workplace, and building models that may include some of this information in the design of computer systems. He argues that many of the models for constructing and

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<sup>12</sup> For example, Benford and Fahlen (1993) have stated that other features, such as the actual activity participants are engaged in, must also be examined and not just bodily conduct. Such features can provide a resource for communication between social scientists and requirements engineers.

using computer systems are formal. That is, they are defined by the formal syntactic and semantic rules of computers and computer languages so that their interpretation is relatively independent of social context. Thus, as requirements engineers must in practice deal with both these areas, it must be in their interest to attempt to reconcile them in some practical way. Though Goguen cautions against the limitations of formalisation, he nevertheless identifies the principles of accountability (participants are held accountable for certain actions) and orderliness (social interactions have some order) as offering some potential for formalising social action. However, he also points out that as requirements cannot be separated from their social context it is impossible to formalise them completely. He argues that abstracting will always diminish the connection of the formal structure to its original social context.

Drawing upon a fundamental organising feature of computer science, Goguen outlines a mathematical theory of abstract data types in an attempt to model the structure of a 'managed' naturally occurring activity (in his exercise he uses the Henley regatta). This concept of an abstract data type is understood in the wide sense, i.e. to encompass notions of 'object' familiar from object-oriented approaches. From this exercise he concludes that instances of abstract data types occur in everyday social life, as different representations of the same abstract structure are displayed on scoreboards, printed in newspapers and found in social interaction. In an attempt to develop a richer form of abstract data type, he goes on to posit the notion of a Situated Abstract Data Type that embodies the tacit presence of an abstract structure that is situated in different ways and that can form the basis of descriptions from within the practice of how interaction is organised. Fundamentally, this type of model would be attempting to reflect the emergent character of activities from the many different types of interactions between participants and between participants and artefacts in the workplace. The model should communicate the resources that participants use that allow for the production and recognition of activities. The strength of the analysis, and thus what should be reflected in the model, is the emergent nature of context, produced by participants in the workplace in the developing course of an interaction. These interactions also reflect the different forms of participation that may occur and the ways in which people change participation statuses moment-to-moment, depending on the contingencies of the situation at hand (cf. Goffman, 1963)

Goguen utilises the concept of Abstract Data Types to model the structure of situated action in naturally occurring activities. He develops a formal model that endeavours to represent how various abstract constructs are oriented to in everyday conduct. He therefore takes a particularly constrained conception of situated and contingent action 'in context'. This contrasts with analyses such as those by Suchman (1987b) or Heath and Luff (2000) which focus on the local and interactional context of the accomplishment of actions, where the production and intelligibility of an activity is situated with respect to the immediately prior actions of co-participants;

where the context is continually being shaped with respect to the prior actions of others and renewed through the ongoing activity. There may be a danger in any formal analysis such as the kind Goguen produces, of concentrating on aspects that resonate with the modelling notation used. In endeavouring to model collaborative or organisational activities in terms of data types, for example, there may be a tendency to focus on the objects and rules in question rather than the situated practices through which these are made appropriate and relevant to co-participants. In a different way to the form analysis approach discussed in Section 6.3, it may be that the resulting model unduly focuses on those objects and ‘abstractions’ rather than on the collaborative and interactional practices through which these are produced and rendered intelligible. It is these practices that we argue are critical for informing requirements analysis and ultimately system development. Models that do not convey these features may fail to realise opportunities to improve system design.

Modelling activities revealed by naturalistic analyses, such as those undertaken in workplace studies, may be fraught with difficulties. Recent attempts have sought to provide frameworks for describing, representing and communicating the social and organisational aspects of work; the contingent and the tacit practices, and the collaborative and the situated nature of activities. By their very nature these are hard to delineate, formalise and represent. The kinds of activities we are seeking to convey are produced through informal, interpretative and interactional practices. It is perhaps not surprising that diagrammatic and formal notations may not seem appropriate to present the complexity revealed through detailed analyses. Nevertheless, these models do not necessarily have to provide complete or unambiguous models of workplace activities; the motivations of their designers lie in developing ways to communicate issues of concern to others in the design process.

In this section we develop a model informed by Goguen’s study in order to investigate what is involved in attempting to model interactionally produced collaborative action. To do this we draw upon our analyses of work and interaction in a financial dealing room. The purpose of this investigation is not to provide a complete or in any way unambiguous model of the activities, but through the investigation, to suggest what types of issues analysts might need to be sensitive to when building models of collaborative activities. Thus we are concerned to move towards ways of communicating what has been termed the ‘hard problems’ (Viller and Sommerville, 1999) to others in the design process. In this investigation, rather than selecting awareness as a topic, we focus on collaborative activities as they emerge in interaction with other people and with artefacts in local settings. We attempt to describe the production of naturally occurring data in a detailed way using a formal language. We do not attempt to draw upon Goguen’s formalism explicitly in our modelling. Rather, initially, we choose a very simple notation that involves very few assumptions at the outset. We then consider aspects of what has been achieved in

the model in terms of interactionally produced activities and how the notation has supported these efforts. We then go on to develop the sequential nature of these activities in the light of a more complex notation, CSP (Communicating Sequential Processes) (Hoare, 1985). Drawing upon this language we consider how the notion of situated action may be characterised, what aspects may be modelled and how these may be communicated to others in the design process.

The exercise considers modelling in relation to the activities occurring in a fragment introduced in Chapter 4, which illustrates how a deal is produced moment-to-moment through the emerging interaction between two dealers and a salesman. This particular fragment has been selected because it reveals the complex and dynamic nature of collaborative activities in the dealing room. We reproduce the fragment below.

#### Fragment 1

1      Derek: What are Bats  
2                    (1.0)  
3      Steve: [ Thats us  
4      John:    [ Bats  
5                    (0.6)  
6      Derek: Bats  
7                    (0.4)  
8      Steve: Thats us  
9                    (5.3)      ((Derek comes round and looks at the screens))  
10     John: What have you got in mind sir  
11                    (1.0)  
12     Derek: I want to sell a hundred  
13                    (0.7)  
14     Derek: I want to sell fifty Orange D'you do Orange?  
15                    (0.3)  
16     Steve: Yeah  
17                    (2.0)  
18     John: I can do them both on the prices Derek I (wouldn't      )  
19                    (5.0)  
20     Derek: (Give) me a half penny in one of them  
21                    (0.3)  
22     John: No (if ts )  
23     Steve:      [ ((To Derek) )Orange I'll give you three and a half for the  
24                    (0.4)  
25     Derek: That's fair enough  
26                    (0.3)  
27     Derek: Three and a half for the Orange  
28                    (0.3)  
29     Derek: Three and a half for the Bats  
30                    ((John turns to look at Steve, Steve looks at John))  
31     Derek: Thank you Steve and John

*((A short time later))*

- 32 Steve: Which one are you booking John  
33 (0.6)  
34 John: Eh (1.5) I'll buy the hundred Bats  
35 (0.3) *((Both start typing in their tickets))*  
36 Steve: All right. (0.5) I'll buy the fifty Orange. (1.0) We're short of ()  
(.) hundred an (.) I know they're high but we're short of a  
hundred and fifty Vodafone. If we can use th these fifty (.)  
Orange to em bash down at some point doesn't matter does it.

Briefly, the deal involves a negotiation between the salesman and two dealers as the salesman tries to secure a better price by linking two stocks together. We see at the beginning of the instance how the salesman through his initial shouted question selects the co-participants in the trade, but that this initial query is also particularly vague and reveals some ambivalence regarding whether he wants to buy or sell stock and about the amount he wishes to trade (line 1). Having secured his deal on both stock at the price he wanted, he has all the information to record his deal (line 31). But, even after the deal seems done there is some ambivalence to the ways in which activities are tied to the individuals in question; it is still open as to which dealer will buy which share (line 32).

#### **6.5.1. The outline model**

We now attempt to model aspects of the activities discussed in the fragment. We begin by circumscribing some key objects along with their attributes, and define some discrete behaviour of these objects in the form of operations. The behaviour of these objects can be seen by observing the results of applying operations. We then run through an exercise attempting to develop a more dynamic model and to capture the emergent character of context. This part of the exercise is represented in the form of a table.

#### **6.5.2. Definitions of objects and operators**

We begin the exercise by focusing the model on the deal itself. The deal is a recurrent activity throughout the data, as seen in Chapters 4 and 5, and it is a activity in the dealing-room setting around which traders orient much of their work. In describing the deal object we identify the basic components of the activity of dealing from the components that are agreed by dealers when trading. These are fairly standardised definitions of the deal object. It is interesting to note here that, currently, the deal is considered to be an object not an activity.

From the fieldwork we note that a deal must include (at least) the following components:

A particular stock  
An amount of stock  
A price for the stock  
A buyer of stock  
A seller of stock  
The time the deal was done  
CounterParty (name of institution)

However, when we look at the production of a deal, we see that each deal is recorded by both the buyer and seller on their own paper tickets to be matched at a later date for settlement purposes. These paper tickets include the following information that must be captured and recorded by each dealer:

Stock Name  
Buyer  
Seller  
Price  
Amount  
CounterParty (name of institution)

In addition, from the investigation of the interactional production of the deal this seems to be the minimum information that must be captured in our model about any particular deal, so we define these as the attributes of our deal object.

However, we also wish to model the emergent properties of a deal, that is, how a deal is produced collaboratively in context. To begin modelling the process through which deals are made, we introduce the following:

A Deal is an object representing a completed deal.

A Deal? is an object that represents a possibly not yet completed deal. (Any potential deal that may or may not end up as a deal)

We set up Deal? in an attempt to capture the elements of openness and possible deliberate ambiguity often displayed in dealing. In our model all Deals will at some point also be Deal?s. However to determine Deal? we must define what is meant by a completed deal. The issue of completeness is not a straightforward matter, as different participants in the dealing room orient to the notion of completeness in different ways. There are aspects of the deal that continue on and beyond the end of the deal talk, such as settlement of deals weeks later. For the dealers themselves, when one says ‘thank you’ and the conversation is brought to a close, the deal may be seen to be agreed and completed. This relies on common-sense understandings of what work is being done in the setting based almost on interactional resources such as ‘thank you’ and repeating prices that may be modelled. But completing a deal is a collaborative accomplishment between two participants and is not achieved through any particular utterance though it may be displayed in one. If we were attempting to build a fuller model we might represent different stages of completeness in an attempt to capture some of these subtleties. For our present purposes, the deal is seen as complete when it has been agreed by the dealers.

While the simplistic view of a deal (with buyer and seller) may be adequate for recording a completed deal, it is not so for describing the process by which deals are struck. During the production of the deal (the ‘Orange’ deal here), there may be more participants involved than the final buyer and seller (John has offered a price and Steve has offered a price). Other dealers with varying degrees of participation in the ongoing deal must be included in the model. We therefore introduce an object `DealTrajectory` that describes the trajectory of just one party to the deal.

A `DealTrajectory` has (at least) the following components:

```

Stock
Party
Price
Amount
BuyOrSell

```

(When matching the components of deal trajectory onto the attributes of our deal object, if `BuyOrSell` is buy, the value of buyer in our deal object becomes the value of party in `DealTrajectory`. If `BuyOrSell` is sell, the value of seller in the deal object becomes the value of party in `DealTrajectory`.)

During the production of a deal, the various participants' deal trajectories may have different prices and amounts. And in fact some of these may even be left unspecified. From the fieldwork and the analyses in Chapters 4 and 5, it seems that price and amount are the two main components of a deal that are actually traded and around which some negotiation may occur. Whether a trader is buying or selling may be withheld in order to negotiate a better price and, sometimes, stocks may be grouped or coupled for the same purpose. However, price and amount are the components that may move up or down during the overall negotiations. Thus, in our model we define amount and price as follows:

- the `amount` is the number of stock that this dealer has shown that he is willing to trade.
- the `price` is the price that this dealer has shown he is willing to trade. (This may be tacit, e.g. through a reference to a screen or more explicitly through talk.)

In order to maintain openness we also need a `DealTrajectory?` for a possibly not fully specified `DealTrajectory`.

Even with a `DealTrajectory?` it is necessary to have at least the party and the stock specified, given that the main objective of a deal trajectory is to show a participant's involvement in trading a particular stock at any one time.

There are various situations in which we may want to create a new `DealTrajectory?` in our model. For example, introducing the name of stock may initiate a deal trajectory:

```
introduceStock : Stock Person → DealTrajectory?
```

`introduceStock` is an operation that takes a `stock` and a `person` and returns a `DealTrajectory?`

Person here is the person who says the name of the stock. If there is no response, the deal trajectory stops. (There is an assumption that we always need the name of a stock to initiate a deal in this way.)

There are many ways of bringing deal trajectories into existence. For example, responding to a participant's question or looking at or pointing to a screen where the price of a particular stock is going down, may result in a new party joining existing participants in a deal.

`joinDealParticipants : DealTrajectory? Person → DealTrajectory?`

`joinDealParticipants` is an operation that takes an existing deal trajectory and a person who is joining and returns a new deal trajectory for that person. The newly created deal trajectory will be concerned with the same stock as the existing one. For example, if we use this operation for the dealer John to join the salesman Derek in an existing deal, then we have

`pdtJohn := joinDealParticipants (pdtDerek, "John")`

after which we have

`pdtJohn.Party = "John"`

`pdtJohn.Stock = pdtDerek.Stock`

where `A.B` denotes attribute `B` of object `A`

In order to summarise the initial definitions, there are certain key points to emphasise in establishing the relationship between the deal trajectory and the deal.

- a `Deal?` contains at least a pair of `DealTrajectory?s`; one for the buyer and one for the seller.
- deal trajectories can exist on their own without deals. This is because some deal trajectories may not result in an agreed deal.
- deal trajectories exist with deals when the deal trajectories of the buyer and seller match and they have agreed on the trade. (Thus, we are using the existence of a `Deal` object to imply agreement.)
- at the point of agreement there must be a buyer and a seller who have confirmed the amount and the price of the stock.

However, agreement is also not a straightforward matter. It is obvious that dealers orient to a deal having been agreed, but there is not necessarily an explicit place where agreement happens in the talk<sup>13</sup>. Agreement may reside in the fact that because

---

<sup>13</sup> Sacks (1992c) in his Lectures on Conversation outlines some ways in which agreement can be considered social action, for example, how the collaborative completion of an utterance by another can be seen to align the speaker of the previous talk.

a dealer is trading on the stock exchange he is legally bound to trade at the price he is displaying. Thus, it might initially seem that some deals are straightforward. But, in practice, negotiation goes on around price and amount. Agreement might be taken to be the point where the trader says 'thank you' to a price quoted or recycles the amount and price. However, dealers may also start writing out tickets at the point when the amount or price is first mentioned, before the deal seems to be agreed formally. In this fragment Derek says both, 'thats fair enough', and then later recycles stock and price and then says 'thank you'. It is also interesting to note that there is no explicit place where disagreement occurs<sup>14</sup>. After John says 'I can do them on the prices', Derek says 'Give me a halfpenny in one of them' that implies he is not happy with 'doing it on the prices' and offers a suggestion of a price he would accept.

Though this is an extremely simple model, issues arise that do need fuller investigation. In a domain where it is critical that participants make agreements to record that a deal was done, it seems difficult to ascertain where and when in the talk

---

Pomerantz (1984) has further examined the ways in which agreements and disagreements are produced in turns at talk, particularly with respect to the preference for agreement (and sometimes disagreement) and how these are marked. For example, she observes that often there is no explicit agreement in the next turn as these are preferred responses. As in the following:

A: Isn't he cute

→B: O:h he::s a::DORable

In fact it has been suggested by Pomerantz that the preferred orientation to agreement is reflected in implicit utterances whilst dispreferred are marked in some way in the next turn. A dispreferred response can often be prefigured by what would seem at the time to be an agreement. For example,

A: Well, oh uh I think Alice ha uh::I-may-and  
maybe as you say, slightly different, but I  
think she has a good sense of humor

(2.0)

→B: [Yeh I think she  
does too but she has a different type.

Where, despite being prefigured by 'Yeh', the subsequent talk is taken to disagree with A's prior turn.

<sup>14</sup> Pomerantz (1984) also describes how similar resources are utilised when disagreement is preferred. For example,

A: ...I feel like uh her and I play alike hehh

→B: No you play beautifully

She discusses how difficult it is to analyse a 'non-activity' like disagreement, particularly if an activity is not explicitly produced. Button and Sharrock (1993) contrast how this examination of the social production of agreement through talk differs from studies that consider agreement in terms of the negotiation of 'meanings'.

the deal was actually struck. There are points where participants may say ‘Thank you’ or in other closings of talk where it seems that agreement has been reached. There are also points where dealers return to the trade after a long pause and agreement may be done in the returning by filling in details like price and amount that were previously not known. Frequently, there is no explicit agreement and it is unclear when the deal is completed.

For our model we attempt to get some notion of agreement that is explicit rather than as a consequence of deal trajectories matching. In this case we take it where a deal is closed and there is no explicit disagreement.

We now look at some other operations that will be useful when exploring this modelling exercise.

At any moment in time, we may want to select the price for buying or selling some stock. This may be taken from the price displayed on a screen:

```
screenPrice : Stock BuyOrSell → Price
```

(screenPrice is an operation that takes a stock, BuyOrSell and returns a Price)

In a spread you have two operations, one for buy and one for sell. If the dealer gives a spread, we would model this by creating two deal trajectories one for buying and one for selling. One of these would be deleted before the deal could be completed

We need to model some other aspects regarding price, for example using small numbers. The analysis in Chapter 5 reveals that when dealers talk about price, they often refer to the ‘small number’ (the least significant part of the number); e.g. ‘three and a half’ may mean ‘573.5’. This assumes prior knowledge about the approximate price, usually by knowing what is displayed on the screen. We could use the following operation to go from the abbreviated price to the complete price:

```
completePrice : Stock BuyOrSell Number (stateOfMarket) → Price
```

completeprice is an operation, which takes the name of the Stock, BuyorSell, the Number (abbreviated), and some information regarding the state of the market, and it will return the full Price.

Providing a price on stock is not simply a mechanical process of generating the price from the stock name and from the screen, but rather is produced through the work of dealers transforming prices in particular ways. How prices are transformed depends on issues such as what other dealers are doing or on the state of the market at particular moments. It is not our intention to model this, but we leave a marker in to give an indication of these types of processes.

During negotiations, the shape of a deal may change. We will use operations changeThis and changeThat here. For example:

```

changeAmount: Amount DealTrajectory? → DealTrajectory?
changePrice: Price DealTrajectory? → DealTrajectory?
changeBuyOrSell: BuyOrSell DealTrajectory? → DealTrajectory?
(changeAmount is an operation which takes the Amount, and a DealTrajectory?,
and returns a DealTrajectory?)

```

### 6.5.3.       Modelling the production of the deal

We look at the production of a deal in terms of a set of state-based transformations in order to see what the model reveals about naturalistic and collaborative activities. We are attempting to produce a model that illuminates the nature of sequentiality and the ways in which activities are produced and shaped for others and recognised as such. Thus, we also attempt to model multiple and parallel activities and the subtle ways such activities are interleaved. We use a simple notation in order to make as few assumptions as possible from the start of the modelling activity. But, by doing so, it may be necessary in the course of producing the model, to consider introducing more structure into the notation as critical characteristics of the analysis become clearer. In this way, we hope to raise some issues relating to the requirements for a notation to model collaborative and situated activities.

The model itself is represented in the form of a table. The transcript of the talk of the deal is on the left-hand side, the model to the right and a commentary on the model beneath. The final part of the exercise considers how various aspects of situated action have been modelled and what remains problematic to represent.

To begin we introduce some notation to trace the evolution of a deal trajectory.

E.g. {Party => Derek, Stock => BATS} denotes the deal trajectory with their values. All other values, e.g. Counterparty, Amount, Price, BuyOrSell, Time are undefined.

We also introduce some variables for partial deal trajectories and partial deals to maintain context within the model:

```

pdtJohn, pdtDerek, pdtSteve, pdt2John, pdt2Steve,
pdt2Derek: DealTrajectory?
pd: Deal?
stevesOffer: price

```

| Transcript                       | Model                                                                          |
|----------------------------------|--------------------------------------------------------------------------------|
| Derek:   What are Bats?<br>(1.0) | pdtDerek := introduceStock("BATS", "Derek")<br>{Party => Derek, Stock => BATS} |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Derek introduces a possible deal. We open up his deal trajectory which contains the stock BATS and the Party Derek.</p> <p>But, in fact, this utterance does more than this in that it is directed to John and Steve, and sets up the anticipation that they will negotiate.</p> <p>The fact that Derek does not mention the quantity or whether he is interested in buying or selling sets up the next turn. Thus, at this point Derek may be leaving parts of the deal open as part of his bargaining technique and this may be recognised as so by other colleagues.</p>                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <p>Steve: <i>That's us</i></p> <p>John: <i>BATS</i><br/>(0.6)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <pre>pdtJohn := joinDealParticipants (pdtDerek, "John") {Party =&gt; John, Stock =&gt; pdtDerek.Stock} i.e. {Party =&gt; John, Stock =&gt; BATS}  pdtSteve := joinDealParticipants (pdtDerek, "Steve") {Party =&gt; Steve, Stock =&gt; pdtDerek.Stock} i.e. {Party =&gt; Steve, Stock =&gt; BATS}  {Party =&gt; Derek, Stock =&gt; BATS} {Party =&gt; John, Stock =&gt; BATS} {Party =&gt; Steve, Stock =&gt; BATS}</pre> |
| <p>Two traders, Steve and John select themselves as traders in the stock. In selecting themselves as co-participants they join the deal participants and open up their deal trajectories. <code>joinDealParticipants</code> takes 2 parameters - the name of the person joining the deal, and the deal trajectory of the participant already in the deal. We now have three deal trajectories, Derek's, John's and Steve's. These represent each participant's viewpoint; each have independent trajectories related to individual activities and this allows us to see how they relate.</p> <p>Steve's reference to "us" probably sets up another sub-group of participants, i.e. him and John as co-negotiators</p> <p>Both responses are minimal and don't answer Derek's question in that no spread price is given; they seem vague and possibly project a withhold, but allow both trajectories to be created.</p> |                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <p>Derek: <i>BATS</i><br/>(0.4)</p> <p>Steve: <i>that's us</i><br/>(5.3) <i>((Derek comes round and looks at screens))</i></p> <p>John: <i>what have you got in mind sir</i><br/>(1.0)</p> <p>Derek: <i>I want to sell a hundred</i><br/>(0.7)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <pre>pdtDerek := changeAmount(100, pdtDerek) pdtDerek := changeBuyOrSell (SELL, pdtDerek)  {Party =&gt; Derek, Stock =&gt; BATS, Amount =&gt; 100, BuyOrSell =&gt; SELL} {Party =&gt; John, Stock =&gt; BATS} {Party =&gt; Steve, Stock =&gt; BATS}</pre>                                                                                                                                                                 |
| <p>Derek has changed the amount of BATS (from being unspecified) to 100, so the possible deal changes. The amount 100 and SELL is added to Derek's deal trajectory.</p> <p>The deal trajectories now progress.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                           |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Derek: <i>I want to sell fifty ( )<br/>Orange D'you do<br/>Orange?<br/>(0.3)</i></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <pre>pdt2Derek := introduceStock("Orange", "Derek") pdt2Derek := changeBuyOrSell(SELL, pdt2Derek) pdt2Derek := changeAmount(50, pdt2Derek)  {Party =&gt; Derek, Stock =&gt; Orange, Amount =&gt; 50, BuyOrSell =&gt; SELL}</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <p>Derek also introduces a new possible deal on the Orange stock. In doing so, he also mentions the amount, which we model and change from being unspecified. A new deal trajectory is opened for Derek containing: 50, Orange, SELL.</p> <p>Note that this model fails to capture the possible relationship between the two deals - how Derek uses them in the negotiation to get a better price. Perhaps a new sort for the group of Deals may be useful in the model. However, the model does capture the transformations to partial deals.</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <p>Steve: <i>Yeah</i></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <pre>pdt2Steve := joinDealParticipants("Steve", pdt2Derek)</pre>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <p>Steve acknowledges he trades in Orange; therefore a potential deal trajectory is set up and he joins the deal participants in the Orange deal.</p>                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <p>John: <i>I can do them both<br/>on the prices Derek (I<br/>wouldn't )<br/>(5.0)</i></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <pre>pdtJohn := changeBuyOrSell(BUY, pdtJohn) pdtJohn := changePrice(screenPrice("BATS", BUY), pdtJohn) pdtJohn := changeAmount(100, pdtJohn)  pdt2John := joinDealParticipants("John", pdt2Derek) pdt2John := changeBuyOrSell(BUY, pdt2John) pdt2John := changePrice(screenPrice("Orange", BUY), pdt2John) pdt2John := changeAmount(50, pdt2John)  {Party =&gt; Derek, Stock =&gt; BATS, Amount =&gt; 100, BuyOrSell =&gt; SELL} {Party =&gt; John, Stock =&gt; BATS, Amount =&gt; 100, BuyOrSell =&gt; BUY, Price =&gt; screenPrice("BATS", BUY)} {Party =&gt; Steve, Stock =&gt; BATS}  {Party =&gt; Derek, Stock =&gt; Orange, Amount =&gt; 50, BuyOrSell =&gt; SELL} {Party =&gt; John, Stock =&gt; Orange, Amount =&gt; 50, BuyOrSell =&gt; BUY, Price =&gt; screenPrice("Orange", BUY)} {Party =&gt; Steve, Stock =&gt; Orange}</pre> |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>John offers to pay the price on both stock that is being displayed on the screens. This changes the price in BATS stock in his trajectory to the screen price, and completes the trajectory by adding the amount 100 and BUY.</p> <p>The utterance also allows him to join the deal participants in the Orange deal and creates a deal trajectory for the Orange stock containing the amount 50 BUY and the price containing the price that is being displayed on the screen.</p> <p>A number of deal trajectories may exist at any point.</p> <p>Note that we are not yet in a position to create a Deal? object as we do not yet know the buyers of BATS or Orange. It may be John or Steve or neither as they have not agreed. Derek has made no indication of the price at which he is prepared to sell.</p> <p>The model has captured the nature of the deal being open in terms of partial deals and deal trajectories. (For brevity, we are no longer explicitly writing down the operations but noting on the resulting deal trajectories.)</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <p><i>Derek: (Give) me a halfpenny in one of them (0.3)</i></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <pre>{Party =&gt; Derek, Stock =&gt; BATS, Amount =&gt; 100,   BuyOrSell =&gt; SELL, Price =&gt; screenPrice +0.5}  {Party =&gt; Derek, Stock =&gt; Orange, Amount =&gt; 50,   BuyOrSell =&gt; SELL, Price =&gt; screenPrice}  Or  {Party =&gt; Derek, Stock =&gt; BATS, Amount =&gt; 100,   BuyOrSell =&gt; SELL, Price =&gt; screenPrice}  {Party =&gt; Derek, Stock =&gt; Orange, Amount =&gt; 50,   BuyOrSell =&gt; SELL, Price =&gt; screenPrice +0.5}</pre> |
| <p>In the model Derek is presenting two alternative deal trajectories that he is willing to follow.</p> <p>Here we need to capture the fact that Derek has indicated that he would agree to an additional halfpenny on either stock to sell both. The resulting alternative deal trajectories have been represented above.</p> <p>But, as above (when Derek introduced the Orange stock), ideally we would recognise in our model that the deals on the two stocks were related.</p> <p>In terms of the participations mentioned above, Derek becomes a definite seller of both stocks if he gets his extra halfpenny in either, so the model for taking on the role of “definite buyer/seller at a given price” needs to encapsulate this openness.</p>                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <p><i>John: No (its )</i><br/> <i>Steve: I'll give you three and a half for the Orange ((To Derek)) (0.4)</i></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <pre>{Party =&gt; Steve, Stock =&gt; Orange, Amount =&gt; 50,   BuyOrSell =&gt; BUY, Price =&gt;   screenPrice("Orange", BUY)}  stevesOffer := completePrice(screenPrice("Orange",   SELL), 3.5)  pdt2Steve := changePrice(stevesOffer, pdt2Steve)</pre>                                                                                                                                                                                                          |
| <p>John has already said he'll buy the BATS at the screen price. Derek says he'll deal in both if he gets a halfpenny on one of them. Steve agrees, perhaps on behalf of both himself and John. He discriminates himself as a buyer for Orange and increases the price by a halfpenny over the screen price.</p> <p>Steve does not refer to the absolute price, but to the small number. This only makes sense if you know the price of the stock. We use the <code>completePrice</code> operation to achieve this.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                           |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| <i>Derek: That's fair enough</i><br><i>(0.3)</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <pre>{Party =&gt; Derek, Stock =&gt; BATS, Amount =&gt; 100,   BuyOrSell =&gt; SELL, Price =&gt; screenPrice("BATS",   BUY)}</pre><br><pre>{Party =&gt; John, Stock =&gt; BATS, Amount =&gt; 100,   BuyOrSell =&gt; BUY, Price =&gt; screenPrice("BATS",   BUY)}</pre><br><pre>{Party =&gt; Derek, Stock =&gt; Orange, Amount =&gt; 50,   BuyOrSell =&gt; SELL, Price =&gt; stevesOffer}</pre><br><pre>{Party =&gt; Steve, Stock =&gt; Orange, Amount =&gt; 50,   BuyOrSell =&gt; BUY, Price =&gt; stevesOffer}</pre> |                                                                                                           |
| <p>With Derek's seeming agreement we now have two deals between Derek and John in BATS, and between Derek and Steve in Orange with matching deal trajectories.</p> <p>As far as Derek is concerned, the deal is now complete. Note, however, the name of the buyer (who books the deal) is still not finally determined between John and Steve.</p> <p>This should be captured in any attempt to model completeness of a deal.</p>                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                           |
| <i>Derek: Three and a half for</i><br><i>the Orange</i><br><i>(0.3)</i><br><br><i>Derek Three and a half for</i><br><i>the BATS</i><br><i>((John turns to look at</i><br><i>Steve, Steve looks at</i><br><i>John))</i><br><br><i>Derek: Thank you Steve and</i><br><i>John</i>                                                                                                                                                                                                                     | <pre>{Party =&gt; Derek, Stock =&gt; BATS, Amount =&gt; 100,   BuyOrSell =&gt; SELL, Price =&gt; screenPrice("BATS",   BUY)}</pre><br><pre>{Party =&gt; John, Stock =&gt; BATS, Amount =&gt; 100,   BuyOrSell =&gt; BUY, Price =&gt; screenPrice("BATS",   BUY)}</pre><br><pre>{Party =&gt; Derek, Stock =&gt; Orange, Amount =&gt; 50,   BuyOrSell =&gt; SELL, Price =&gt; stevesOffer}</pre><br><pre>{Party =&gt; Steve, Stock =&gt; Orange, Amount =&gt; 50,   BuyOrSell =&gt; BUY, Price =&gt; stevesOffer}</pre> |                                                                                                           |
| <p>Derek views that he has made a deal with both Steve and John and can record the buyer as being the counterparty number. He does not need to distinguish between them for the purposes of his recording.</p> <p>At this point we might create the two new Deal? objects from the matching pairs of deal trajectories. We would do this by projecting the values of attributes in the matching DealTrajectories? Onto the corresponding attributes in the new Deal? This would be as follows:</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                           |
| Party - Derek<br>Stock - Orange<br>Amount - 50<br>BuyOrSell - SELL<br>Price - stevesOffer                                                                                                                                                                                                                                                                                                                                                                                                          | Party - Steve<br>Stock - Orange<br>Amount - 50<br>BuyOrSell - BUY<br>Price - stevesOffer                                                                                                                                                                                                                                                                                                                                                                                                                              | Stock Name - Orange<br>Buyer - Steve<br>Seller - Derek<br>Price - stevesOffer<br>Amount - 50              |
| Party - Derek<br>Stock - BATS<br>Amount - 100<br>BuyOrSell - SELL<br>Price - screenPrice<br>(BATS, BUY)                                                                                                                                                                                                                                                                                                                                                                                            | Party - John<br>Stock - BATS<br>Amount - 100<br>BuyOrSell - BUY<br>Price - screenPrice<br>(BATS, BUY)                                                                                                                                                                                                                                                                                                                                                                                                                 | Stock Name - BATS<br>Buyer - John<br>Seller - Derek<br>Price - screenPrice<br>(BATS, BUY)<br>Amount - 100 |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <i>((A short time later))</i>                                                                                                                                                                                                                                    |
| Steve:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <i>Which one are you booking John</i><br><i>(0.6)</i>                                                                                                                                                                                                            |
| John:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <i>Eh (1.5) I'll buy the hundred Bats</i><br><i>(0.3) ((Both start typing in their tickets))</i>                                                                                                                                                                 |
| Steve:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <i>All right. (0.5) I'll by the fifty Orange. (1.0) We're short of ( ) (.) hundred an (.) I know they're high but we're short of a hundred and fifty Vodafone. If we can use th these fifty (.) Orange to em bash down at some point doesn't matter does it.</i> |
| <p>However, John and Steve do not appear to have agreed between themselves who has done which deal in order to record them. Derek does not need to know which of the dealers actually books which stock, even though the information about who was trading was critical for the achievement of the deal.</p> <p>Even after the Deal? has been created with the buyer and seller deal trajectories, there is still scope for changing some of the details. In this case which parties will book the trade.</p> |                                                                                                                                                                                                                                                                  |

In modelling the activities of dealers we have focused on the core activity of dealing, the deal being an object. The exercise models particular features and components of a deal and how deals are initiated, agreed and finalised. We have attempted to model how different individuals participate in the deal and how various activities, such as initiating joining and exiting deals, are accomplished interactionally. We have also explored how a model could reflect some of the more tacit activities associated with the trading of shares in a financial dealing room, those that are not made explicit in their interactions. We produced a trajectory of movement in terms of what was transformed during the deal and when. The deal progressed from an initial statement, various components were added to it, and then it came to a completed deal. These were then broken apart again. Thus we have tried to model the movement from an initial utterance through to agreement and completion of a deal. To track these transformations we utilised a state-based model that was tied to the data moment-to-moment, and where every component was kept stable. The deal trajectories allowed us to track the participant's viewpoints of a deal; how each independent trajectory related to the participant's individual activities. In addition, many deal trajectories can exist at any one time in an effort to capture the dealer's individual relationships to multiple or groups of interleaved deals. Thus we are trying to capture how, despite collaborating over many deals, dealers can also trade separately. Although traders can engage in individual tasks and multiple interleaved activities, the distinctions between them and between these and 'collaborative' activities are produced in the ongoing interaction. Participants can delicately shift between an individual activity and a joint venture, and can even let which orientation they are engaged in remain open. It may be ambivalent as to whether participants are collaborating in a 'group' or are engaged in a collaborative activity, or even how they are at any moment in time discriminating their participation from that of their colleagues; even a participant's demarcation of an activity as his own can be

sensitively produced with regard to the concerns of others. The following points outline the critical issues that emerge when attempting to model such a complex, situated, and emergent collaborative activity.

### *1. Openness*

A deal is not a straightforward achievement. Some elements of the deal, particularly the amount to be traded and the price the stock will be traded at, may remain open as the deal progresses. We may need to model further aspects such as which particular items are left open, when they are left open, and in what ways they can be left open. For example, we might consider the extent to which a participant can move up or down on a price, or ways in which the amount to be traded may be left open and its relationship to price. We also need to consider the relationship between different stock, that is how deals may be coupled or grouped together in negotiation. We have represented some aspects of this openness, for example, that dealers can introduce possible deals just by mentioning the name of the stock without specifying whether they are interested in buying or selling. However, we have not captured that, by doing so, dealers may project some vagueness that can set up some negotiation and that this may be recognised as so by other dealers.

There is no model representing the starting point of a deal and how at each point the movements to progress the deal were made. We could build a more sophisticated representation of the magnitude of variance and the tendency towards a solution. However, more information would still be needed in terms of who the participants are, how current deals relate to previous deals, why the deal is being done, and whether dealers are long or short of stock. Thus, the model needs to show how participants are working towards different strategies that are continually contingent. This may be difficult to model as all the elements of openness need to be represented, including sudden shifts in the market in conjunction with the bank's overall strategy.

Similarly, whether a dealer is buying or selling may also be left open and is left open as part of the deal trajectory until it becomes fixed. Once again we must consider: who the deal is for, whether the dealer wants to buy or sell, and how asking for a spread does not commit to buying or selling. Thus, in the fragment the next move was an explicit request to find out what Derek wanted. Nevertheless, the strategy was accomplished through a set of interactional resources, such as repetitions, delays and reformulation of questions.

### *2. Collaboration*

Developing from this issue of openness we need to capture how participants, through their ongoing interaction, collaboratively produce a deal. As might be expected, one principal relationship that needs to be represented in a model is that between a buyer and a seller. However, this is not sufficient for describing the process by which deals

are made. During the production of the deal there may be more participants than the final buyer and seller involved; potential buyers may be approached; several dealers may collaboratively buy or sell; and, as mentioned above, whether a participant is a buyer or seller may emerge in the course of a deal. In addition, there may frequently be more than one deal going on simultaneously and these may be related in some way. Therefore, other dealers with varying degrees of participation in the ongoing deal(s) need to be included in the model. The notion of deal trajectory captures some of these features, for example, that an individual can participate in the production of a number of deals and how a point of convergence can be arrived at where agreement might be reached. However, the turn by turn model focuses Button's (1990) argument on the moral order of productions in interactions. Turns of talk are seen to achieve something; they are actions that are social in the sense that they are produced collaboratively in relation to others. But there is also a moral commitment in their production. For example, if a participant asks a question, an answer is not automatically produced. Rather, co-participants display an orientation to the social organisation of producing an answer where the details of the organisation of talk are an accomplishment between those participants. People can design their utterances in particular ways that 'allow participants to build into their talk the situated details of their contingent social circumstances' (Button, 1990, p. 89). In the dealing-room example, there is no rule that states that dealers must always trade and must give two-way prices. Rather, as Button states, "rules are oriented to features of action; they are contextual, situated practices of use" (p. 84). Thus, dealers may orient to a situation where there is an obligation on them to deal in such a way that the obligation is seen to be accomplished through skilled means of showing ambivalence or rejecting offers in particular ways. The model does not reflect the ways in which participants may use these rules as resources to make sense of their activities.

### *3. Completeness*

It seems reasonable to assume that, in a setting where deals are routinely being undertaken and these deals are about agreeing prices and amount, there must be some point in the interaction where the deal can be seen to be transformed from one which is open to one that is completed. In other words, where we might see that the dealers involved have specified and agreed prices and amounts. This would appear to be critical when considering the associated activity of deal recording which can itself only be undertaken when the deal has been accomplished. In our example, we have suggested the deal is complete if there is no explicit disagreement on components matched in the deal trajectories. However, modelling this kind of completeness is complex. For example, two dealers could treat a deal as being complete when they have agreed a price and amount on some stock. However, as stated previously, there is often no explicit agreement or disagreement and it may be unclear when the deal is

actually completed. In addition, we have not represented the continual possibility that elements may change, as in the fragment where Steve and John discuss who will book which deal. In building a more complex model we may need to represent different stages of completeness in order to capture other aspects, for example, various ways of completing a deal, when different participants orient to a deal having being completed, when the individuals involved disperse, and when elements of a deal are returned to or renegotiated.

#### *4. Commencing, joining and leaving an activity*

Locating the beginning of an activity, in this case when a deal commences, may also not be straightforward. There are many ways in which deal trajectories can emerge, for example, a deal may arise from responding to a question from a colleague, or another colleague looking at or pointing to a screen where the price of a particular stock is going up or down. Thus, it is not simply an explicit request to trade or the naming of a stock that may initiate a deal; a deal may also emerge with respect to some other remark, a glance or a bodily movement from another participant. Similarly, there are various ways of joining (or leaving) an ongoing dealing activity. Participants may utilise their body orientation or a shift of gaze in order to gradually move into or away from an activity. A complex model would have to represent the emergent and sequential ways in which activities are commenced, joined by other participants and gradually closed down.

#### *5. Information capture and projection*

Critical to the production of collaborative practices in the dealing room is the use of artefacts such as screens to make information relevant for different participants. These artefacts and the items presented on them are a key resource not only for the accomplishment of deals, but also for individuals to make sense of the activities of others with respect to the details of the current state of objects. Therefore, having access to the information display and a colleague's orientation to that source is critical to the achievement of collaborative practices. These objects may be brought into the interaction only momentarily, and their sense and relevance only understood with regard to the ongoing talk and to the emergent natural history of events. In the current model a simple operation represents prices displayed on the screen. This does not reflect the interpretative practices of participants in making sense of this information with respect to other prices and price movements.

Similarly, the transmission of information may not be straightforward. Not only does the model have to account for talk being overheard by participants and broadcasts to multiple unspecified co-participants, it has to account for particular communicative practices. For example, even the seemingly straightforward and ubiquitous talk about numbers is not straightforward. When dealers talk about price, they often refer to the 'small number' (the least significant part of the number), e.g.

‘three and a half’ may mean ‘573.5’. This assumes prior knowledge about the approximate price, usually by what is displayed on the screens, which they themselves can change in the course of a deal or an utterance. To model this requires an understanding of the ways in which numbers are utilised in the dealing room with respect to the current circumstances and the ways in which dealers transform particular items for the uses of others.

### *6 Multiple activities*

Apparently simple activities or utterances can be produced to be seen or heard in different ways, for different purpose by different participants. In such double duty activities (Turner, 1972), a shouted question about the price of stock, for example, may not only introduce a possible deal, it may also select a particular co-participant to the trade and make others aware of the ongoing deal. Our model reflects that various actions can accomplish more than one activity.

Similarly, dealers can be engaged in more than one activity with different co-participants. The form of their participation in each of these activities may be different and their footing (cf. Goffman, 1981a) to each may be marked in different ways for their colleagues. For example, dealers whilst doing a deal on the phone may break away from it to engage in a conversation with a colleague, marking this juncture not only for the caller but also for the co-present colleague. Thus, a model must capture how each participant may be involved in different events in parallel and at different stages.

### *7. Ordering of activities*

In deal production, there is no systematic ordering of the components of a deal; thus, capturing the ordering of particular activities in our model is not straightforward. For example, as the deal is a collaborative achievement, it is not possible to say that dealers always mention the name of the stock followed by the price and amount. Moreover, it may not even be possible to say that the name of the stock must always be mentioned as dealers sometimes use the price to identify the stock, and thus the name of the stock remains implicit in the talk. Although it is possible to represent particular (and partial) ordering relationships, what may be more important to convey is how the ordering is sensitive to the talk and activities of co-participants, and how the various activities of dealing, such as recording the deal, can shape the production of the interaction.

#### **6.5.4. Reflections on the model**

Overall, the model is driven by each turn in the transcript where a turn is seen to achieve some action. The consequences of these actions are captured in various states that may be continually transformed as the interaction progresses. In focusing the model on a turn-by-turn sequence of activities we are aiming to be sympathetic to the

notion of sequentiality in conversation analysis; that is, how each turn is produced in relation to the previous turn and sets up the context for the next. However, in the resulting model, each turn appears to perform some discrete activity that is almost separate from its context and, as such, seems to be more representative of Speech Act theory (e.g. Austin, 1962; Searle, 1969) that isolates utterances from their context and does not take into account the collaborative production of interactions. By concentrating on the change of state and showing various actions as new and distinct each time, we also lose the emergent nature of activities and the ways in which talk proceeds moment to moment. One illustration of this can be seen in the fragment of the deal between Steve, John and Derek. Derek asks for a half penny in one of the stocks, either Orange or BATS. This is followed in the next turn by John and Steve's overlap, where John's understanding of the previous utterance projects a rejection whereas Steve's projects agreement.

- 20      Derek: (Give) me a half penny in one of them  
 21                    (0.3)  
 22      John:    No (if ts )  
 23      Steve:        | I'll give you three and a half for the Orange ((To Derek))  
 24                    (0.4)

But there is also Steve's utterance in relation to John's; positioned just after John's display of disagreement. Through the turns of talk and their positioning, we can see how the social and collaborative nature of activities are produced moment by moment. By modelling the transcript almost turn by turn, the sequential links across turns appear to be broken apart. While this may be useful in exploring the nature of the phenomena, it may also have forced too rigid a boundary between turns. In the above example, we may break the relationship between John and Steve's utterances into state-based components that John does not agree and that Steve does. But in doing so, we lose the social nature of agreement and the ways that participants gently shift their participation in relation to others. We show in the model that activities such as initiating, participating and closing a deal occur, but not the actual work of doing these activities.

In examining the issues associated with developing a model of situated action, we have explored ways of capturing how activities are left open in this setting by defining not fully specified variables that could change moment-by-moment in the interactions. We have also reflected how multiple participants can be involved in different ways in a deal by developing an object and associated operations to represent deal trajectories. We have developed a framework with which we could consider how activities emerge, are transformed, and are completed. However, none of these solutions can be seen to be wholly adequate to deal with the complexity of situated action. In particular, the model fails to reflect the ways in which information is produced for others and recognised as relevant and, although the model uses a

temporary and not fully specified variable for some partial modelling of emergent and open aspects, it is insufficient to capture the ways in which activities emerge sequentially; how they are produced with respect to the contributions of others and may be interleaved with other actions and activities.

In this model we have had to introduce structure in the table to represent parallel activities. Typically, an algebraic model would comprise a collection of operators with a governing program. In the example above, it may be seen that the trace of the program executing the model is the transcript itself. Calculations of functions are described and the application is controlled tightly, but we have not considered the governing program that would produce such a model. Operators must be applied in a particular sequence that can relate back to the data. In order to add constraints of ordering to operators in this model, we would need to complicate this governing program adding rules and building in more complexity.

Therefore it may be worth considering a move away from a table of algebraic operators to a language, such as CSP, whose constructs seem to take on the force of the form of constructions embedded in the table. This notation seems to provide some of these constructs, that is, they do not need to be defined and thus may help to express various features more directly. We need a language where we can write more completely what the governing program would look like. The transition from our first model to CSP may be seen as an effort to capture what was written in words around the algebraic model, various subtleties regarding interactional resources that the participants use to produce and make sense of each other's actions. It is important to attempt to capture this information as it is these aspects that we argue are critical to informing system design appropriately. We suggest that in moving to a language that supports *implicitly* the form of the constructions built into our previous table, a better model may be produced that eventually might allow us to develop conclusions about interactional features and the requirements for technology in a work setting. This possibility is discussed in more detail in Chapter 8.

## 6.6 Modelling Sequential Activities

The modelling techniques described in the previous sections have the explicit aims of representing organisational, social or situated action using different notations. In this section we attempt to look at the original motivations underlying situated resources and investigate if there may be alternative ways of modelling the critical aspects of collaborative action, particularly the notion of openness and multiple activities. In this respect it may be interesting to consider a language that explicitly has motivations to represent non determinacy and concurrency.

### 6.6.1. Background to CSP

CSP (Communicating Sequential Processes) developed by Hoare (1985) is a notation for describing concurrent systems, that is, systems where more than process exists at a time. The notation allows the development of and reasoning about processes that interact with each other and the environment in specific ways. CSP also allows for various mathematical models and reasoning methods that provide analysts with resources to reason about possible states and the consequences of various combinations of states occurring. It takes as critical the notion of a process whose behaviour is described by a sequence of events it might 'use'. A process may be put in parallel or interleaved with other processes so that various combinations of events can occur. Thus, as in Conversation Analysis, CSP is concerned with notions of sequentiality, with parallel and interleaved activities, and it may be - given the previous discussion - that CSP could provide a way of elucidating particular aspects of situated social and organisational activities.

In this exercise we are not attempting to build up a complete model of the dealing-room activities in CSP. Rather, we wish to investigate the issues that emerge when considering the use of CSP to model the socio-interactional resources participants use in the dealing room. In order to do this, we use simple examples to illustrate ways in which the fundamental concepts in CSP such as interleaving and parallelism may be used to model collaborative situated action. We then reflect on various issues raised in the course of doing this exercise.

Historically, the development of CSP involved a movement away from considering computer processes as linear and distinct from the environment to systems where events can happen in parallel and interact with the environment itself. Thus, in a concurrent system, the various components are 'in (more or less) independent states (and) it is necessary to understand which combination of states can arise and the consequences of each' (Roscoe, 1998, p.2). This is perhaps most apparent when considering computer communication and distributed systems where various processes occur in separate places. In these cases it is important to model concurrent processes so that consistency between them and the potential communication breakdown can be reasoned about.<sup>15</sup>

As CSP allows reasoning about processes that interact with each other and their environment, the most fundamental object in CSP is a communication event. Communication in CSP has been defined as 'a transaction or synchronisation between two or more processes rather than as necessarily being the transmission of data one

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<sup>15</sup> Perhaps the most familiar example is when considering deadlock, where no particular component of a system can make progress because it is waiting for communication from other processes. Livelock is a complementary problem, where a process continues indefinitely because it cannot be interrupted by any external communication.

way' (Roscoe, 1998, p.8-9). Communication events are considered as events or actions that can describe patterns of behaviour regarding objects in the world. The set of events viewed as relevant in the description of an object is termed its alphabet. An object cannot engage in any event that is outside its alphabet. A process is viewed as the behaviour pattern of an object in the ways in which it can be described by the set of events selected in its alphabet. Processes can participate in events in sequence and may then be put together in parallel (denoted by the operator  $\parallel$ ). When two processes are brought together to run concurrently, events that are in both their alphabets require the simultaneous participation of both processes. However, each process also can evolve its own events independently.

Processes may be described as a single stream of behaviour. But they may also be influenced by their interactions with the environment in which they are placed. Thus CSP provides ways of describing processes that offer a choice of actions to their environment (denoted by the operator  $|$ ). For example, a price fluctuation could be described in terms of a simple choice of moving up then down, or down then up, and we could view the market as deciding between these two events. This may be defined as:

$$PRICEFLUCT = (up \rightarrow down \rightarrow STOP \mid down \rightarrow up \rightarrow STOP)$$

where the process can do the events *up* then *down* or *down* then *up* in either order.

There may also be situations where it is useful to join processes with the same alphabet to run concurrently but without interacting or synchronising with each other. CSP also offers the ability to provide parallel composition through interleaving (denoted by the operator  $\parallel\parallel$ ). Here, the processes run independently of each other. If one of the processes may not participate in the action, then it must have been the other one. But if both processes could have engaged in the same action then the choice between them is non-deterministic. A useful example from the fieldwork may be provided by fragment 4 in Chapter 4 from Deepdene's derivatives trading floor. Here, two requests for quotes and then two requests for clarification require different responses for different participants, and the requests for prices and for clarification overlap. (Sacks, 1992a; Schegloff, 1977). Questions and answers as well as requests for clarification could each be considered to be adjacency pairs of different types, where adjacency pairs can be inserted within other adjacency pairs. For question answer pairs we might have:

$$QAP = question \rightarrow answer \rightarrow QAP$$

A question-answer pair allows a question followed by an answer and, in order to show that further question-answer pairs could be inserted within it, we chain these events by using recursion to describe repetitive behaviour patterns in a concise way. We can define a request for a clarification and response pair in the same way:

$$CRP = requestForClarification \rightarrow response \rightarrow CRP$$

CSP also defines the term trace that provides a record of events, that is the sequence of events that occur: thus, we can keep a record of communications between the environment and the process. A trace may be finite where the observation was stopped or where the environment and the process could not agree on any event. It may be infinite where the observation continues forever and infinite amounts of events are transacted.<sup>16</sup> The QAP process defined above would generate a question followed by an answer, followed by a question and so on, and the CRP process would generate a request for clarification followed by a response followed by a request for clarification and so on. The traces might be represented as:

*<question, answer, question, answer.....>*

*<requestForClarification, response,.....>*

Thus an adjacency pair might be described by interleaving the clarification request response pair process and the question-answer pair process as follows:

$$QAP \parallel CRP$$

This might generate a sequence of *question answer requestsForClarification* and *response* where answers always follow a preceding question and responses always follow a preceding request for clarification. There are also always the same number of questions and answers and the same number of requests for clarification and responses. However, it would not be possible to have question-answer pairs inserted within question-answer pairs as in the recurrent case such as:

A: are you going to the cinema?

B: what time does it start?

A: eight o'clock

B: yes

We might model such an insertion sequence as follows: for question-answer pairs we might have:

$$QAP = question \rightarrow ((answer \rightarrow STOP) \parallel QAP)$$

So that every time a question occurs a new subprocess 'answer -> STOP' is created which is interleaved with the QAP process (i.e. another question and answer pair could be interleaved before the answer occurs). This process produces an answer for every question, but also allows any number of question-answer pairs to be 'inserted'

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<sup>16</sup> Traces can be recorded either by writing down the events as they occur in order, or they may be written down with the exact times that they occurred. This reflects two versions of CSP: 'untimed CSP' where only the order of events is important and 'timed CSP' that includes the time of each event in the traces.

before the answer is produced. A similar process could be defined for request for a clarification response pair.

$$CRP = requestForClarification \rightarrow ((response \rightarrow STOP) \parallel CRP)$$

These processes can produce infinite state processes. It could be possible to define processes using CSP which bound the number of inserted pairs.<sup>17</sup>

This might then generate a sequence of questions, answers, requests for clarification, and responses where answers always follow a preceding question and responses always follow a preceding request for clarification. There are also always the same number of questions and answers and the same number of requests for clarification and responses. A potential trace might be:

$$\langle requestForClarification, question, response, question, answer, answer \rangle.$$

Or, as in the case from Chapter 4:

$$\langle question_{R1}, question_{R2}, answer_{R1}, requestForClarification_{R1}, answer_{R2}, requestForClarification_{R2}, response_{R1}, response_{R2} \rangle.$$

### 6.6.2. Modelling examples from the dealing room

Having provided a few examples of the fundamental concepts and operators in CSP, we shall now offer some simple additional descriptions to the model described in the previous section. Once again we are not attempting to detail a full working model. We are utilising some of the concepts in CSP to investigate how a process language might be used to describe some of the interactional resources detailed previously. We go on to reflect on the exercise, providing some assessment of the notation for representing the issues selected.

The following defines a simple process that allows a dealer to agree a price on a deal, independently of agreeing the amount of stock on that deal as follows:

$$PRICE = agreePrice \rightarrow agreeDeal \rightarrow STOP$$

$$AMOUNT = agreeAmount \rightarrow agreeDeal \rightarrow STOP$$

Here *agreePrice* and *agreeDeal* are events in the alphabet of the PRICE process and *agreeAmount* and *agreeDeal* are events in the alphabet of the AMOUNT process.

If we now put PRICE and AMOUNT in parallel

$$PRICE \parallel AMOUNT$$

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<sup>17</sup> Though one would expect there are bounds to which insertion sequences can be embedded, it is unclear from current studies of conversation analysis what these would be or how they could be expressed. One could envisage extending the CSP description to take account of other adjacency pairs. Thus, CSP would nicely reflect the continual extendability of ordinary conversation.

we can see that the two processes are synchronised around *agreeDeal*. As these processes have been put in parallel, both processes must be ready to participate in *agreeDeal*. Thus, we cannot *agreeDeal* until we *agreePrice* and *agreeAmount*.

Relationships between the processes PRICE and AMOUNT might be further elaborated. We could put the two processes in parallel with other processes that may describe any dependencies that occur between agreeing the price and agreeing the amount.

We might also show the relationship between recording a deal and agreeing the deal. For example, the price process may be further elaborated,

$$\text{PRICE} = \text{agreePrice} \rightarrow (\text{recordPrice} \rightarrow \text{agreeDeal} \rightarrow \text{STOP} \\ | \text{agreeDeal} \rightarrow \text{recordPrice} \rightarrow \text{STOP})$$

Thus, a dealer might record the component price after the price has been agreed or after the deal itself has been agreed. This of course can be defined more fully to capture other possible permutations, but this illustrates how interleaved activities in social interaction may be described in CSP.

We might then define a DEAL process as

$$\text{DEAL} = \text{PRICE} \parallel \text{AMOUNT} \parallel \text{STOCK} \parallel \text{BUY} \parallel \text{SELL} \parallel \text{etc.}$$

where each of the processes PRICE AMOUNT STOCK BUY SELL are synchronised around *agreeDeal*. Each may also describe the relationship to recording in a similar fashion to the PRICE process.

We may also describe two (or more) deals happening at the same time using interleaving

$$\text{DEAL}_1 \parallel \text{DEAL}_2$$

where each of these deals is independent from the other and it is not specified which deal will be accomplished.

We can also describe possible ways in which buyers and sellers may be interrelated, for example, how in negotiating a deal they may move into agreement.

Thus, BUYER and SELLER processes may be defined as:

$$\begin{aligned} \text{BUYER} &= \text{initBuyOffer} \rightarrow \text{BUYERNEG} \\ \text{SELLER} &= \text{initSellOffer} \rightarrow \text{SELLERNEG} \\ \text{BUYERNEG} &= \text{up} \rightarrow \text{BUYERNEG} \\ &\quad | \text{agreePrice} \rightarrow \text{STOP} \\ \text{SELLERNEG} &= \text{down} \rightarrow \text{SELLERNEG} \\ &\quad | \text{agreePrice} \rightarrow \text{STOP} \end{aligned}$$

If they are put in parallel, BUYER  $\parallel$  SELLER, the only shared event between buyer and seller is *agreePrice*; thus, they must participate in that event

simultaneously. In the meantime, the buyer may be improving their offer with the *up* event and the seller may be reducing the amount they are willing to deal at with the *down* event. A trace of putting the two processes in parallel (with some illustrative examples) might be,

$\langle \text{initBuyOffer (6.25), initSellOffer, (6.29), up (6.26), down (6.27), up (6.27) agreePrice} \rangle$

PRICE and BUYER and SELLER are synchronised around *agreePrice*. In CSP we can introduce more detail, synchronising processes around less detailed events. We could also add more details showing the evolving negotiation to PRICE.

If we model the deals in BATS and Orange described in the fragment as interleaved processes, we see how Steve and John's uncertainty about who had made the deal may be reflected by the non-determinism that emerges from CSP interleaving. We first define a process to model the activities of a market maker in a particular stock;

$$\text{MM}_{\text{stock}} = \text{initiateDeal}_{\text{stock}} \rightarrow \text{agreeAmount}_{\text{stock}} \rightarrow \text{agreePrice}_{\text{stock}} \rightarrow \\ \text{agreeDeal}_{\text{stock}} \rightarrow \text{recordDeal}_{\text{stock}, \text{dealer}} \rightarrow \text{STOP}$$

In our example when making a deal with the salesman Derek, the market makers John and Steve and the salesman share all the above events except that they record their deals independently. It is necessary that the recording is seen as two independent activities as this provides for some cross checking about what was agreed in the deal. Thus, the activities of a salesman process would be

$$\text{SM}_{\text{stock}} = \text{initiateDeal}_{\text{stock}} \rightarrow \text{agreeAmount}_{\text{stock}} \rightarrow \text{agreePrice}_{\text{stock}} \rightarrow \\ \text{agreeDeal}_{\text{stock}} \rightarrow \text{recordSale}_{\text{stock}} \rightarrow \text{STOP}$$

We can model the collaboration between the market maker and the salesman by putting the two processes together in parallel

$$\text{MM}_{\text{stock}} \parallel \text{SM}_{\text{stock}}$$

Note that the only difference between these two processes is that in each process there is a private event to record the deal (i.e. not in the alphabet of the other process). This suggests a way of characterising the difference between public and private activities, a recurrent issue in workplace studies.

There are only two possible traces of  $\text{MM}_{\text{stock}} \parallel \text{SM}_{\text{stock}}$

$$\langle \text{initiateDeal}_{\text{stock}}, \text{agreeAmount}_{\text{stock}}, \text{agreePrice}_{\text{stock}}, \text{agreeDeal}_{\text{stock}}, \\ \text{recordSale}_{\text{stock}}, \text{recordDeal}_{\text{stock}, \text{dealer}} \rangle$$

$$\langle \text{initiateDeal}_{\text{stock}}, \text{agreeAmount}_{\text{stock}}, \text{agreePrice}_{\text{stock}}, \text{agreeDeal}_{\text{stock}}, \\ \text{recordDeal}_{\text{stock}, \text{dealer}}, \text{recordSale}_{\text{stock}} \rangle$$

In our example, we see the simultaneous dealing in Orange and BATS. These two deals may be viewed as independent in the same way that, for example, agreeing the price of BATS is independent of agreeing the amount of BATS. The salesman Derek now sees  $MM_{\text{Orange}}$  interleaved with  $MM_{\text{BATS}}$  in CSP terms,

$$MM_{\text{BATS}} \parallel MM_{\text{Orange}}$$

An example of a trace of events from this interleaving that the salesman has also participated in

*< initiateDealBATS, agreeAmountBATS, initiateDealOrange, agreeAmountOrange, agreePriceOrange, agreePriceBATS, agreeDealBATS, agreeDealOrange ... >*

The salesman Derek knows he has been dealing with two market makers, but he may not be able to tell and does not care which of the following four possible sequences of events will end the trace. These are:

*< recordDealBATS, John, recordDealOrange, John >*  
*< recordDealBATS, John, recordDealOrange, Steve >*  
*< recordDealBATS, Steve, recordDealOrange, Steve >*  
*< recordDealBATS, Steve, recordDealOrange, John >*

The reason this is not important to Derek is that he records the counterparty number which, in this case, is his home institution. But, in fact, from the fragment we can see that it does not appear clear to the market makers which way to resolve the private activity of recording the deals. This ambivalence can be reflected in the non-determinism arising from CSP's conception of interleaving.

Note that actually it is more complicated than described in this example. There are in fact four processes, John dealing in BATS, John dealing in Orange, Steve dealing in BATS and Steve dealing in Orange. In addition, we have not defined an event to show that John actually never agrees a price in Orange and it is only John who agrees to deal in BATS explicitly.

We might also consider the case where an action follows the characteristics of double-duty activities described in Section 6.5.1.2. In our fragment illustrating the deal between Derek, John and Steve, Derek closes the interaction as follows:

31                    Derek:     Thank you Steve and John

This utterance not only closes the interaction, but also agrees to the deal. In trying to capture the notion that an action may do more than one thing in talk, we might envisage this closing as a shared event between various processes that might evolve in different ways; thus an interaction process may participate in an event *closing* (representing the closing of the interaction) and a deal process may participate in the same event and may then evolve from this point into a deal agreement. Thus all

processes that participate in an event can evolve in different ways. In the case of double-duty activities, a process might evolve in the way of agreeing a deal or it may also be part of closing an interaction through a medium like a telephone where it is the last turn. In this way we might show how an activity like ‘thank you’ both completes the interaction and agrees the deal.

Similarly, a deal process may participate in a *twoWayPriceRequest* event such as the one in our fragment ‘What are BATS’, and the deal may evolve in particular ways from there on as the event requesting a two-way price has occurred. At the same time, a participation process may also participate in this event and evolve in particular ways, having elicited engagement through the *twoWayPriceRequest* event.

The ability for processes to evolve in different ways would allow us to distinguish interactionally between the participation status of John and Steve in the fragment described in our exercise. Following Goffman’s (1981b) work on participation frameworks, we can differentiate their participation by providing events to describe, for example, *addRatifiedParticipant* (John) *addSecondaryParticipant* (Steve). We might then be able to generalise this to situations in the dealing room where outlouds occur, for example, in Chapter 4 fragment 8 where Annie shouts out ‘Shearson on the bid’. In this fragment, the outloud is taken up by John, but the outloud may be potentially interesting for all the dealers within hearing range. In CSP, dealers can evolve in relation to another colleague’s deals. The ability for dealer processes to evolve in particular ways provides opportunities for other dealer processes to engage with them. If there is an outloud, then all dealer processes can evolve; all have the opportunity to recognise the relevance of the outloud to them. In such a way we have the mechanism to consider what information we and others in the local setting can explicitly see about a process. Processes can be made public through parallel composition and, thus, can also be observers of other processes. This provides a mechanism to look at the public nature of activities in the workplace. Events in common to the alphabets of more than one process can be shared and thus made public. Where processes do not share events, those events can be hidden from other processes and be therefore private. More importantly, the different ways in which activities are made public can be reflected in the ways in which different processes evolve. The distinction between the public and private nature of activities in the workplace rests more in terms of how activities are produced for others, how they are recognised by others and how they may produce different trajectories of actions for other people. CSP provides the mechanisms to describe collaboration and the coordination that allows us to consider not just that an activity has occurred, but that it has been seen to be made relevant by other participants who may then undertake possibly different next activities.

There is, therefore, a possibility of distinguishing how activities are made public in collaborative settings and the different ways that those activities engender actions by

co-participants. Hence, with respect to issues associated with ‘awareness’ considered earlier in this chapter, it could be possible to reflect on the ways in which participants configure awareness for others and how those activities are rendered sequentially relevant by other co-participants.

### **6.6.3. Reflections on the CSP model**

In our discussion we have started to consider how parallel activities occurring in the dealing room may be described using CSP. Parallel composition in CSP allows us to set up some relationship between producing a deal and recording it. We have the potential to model the components used for recording a deal and the ways in which they emerge in the deal talk. Further, we might show when each component is recorded, i.e. after the component emerges, after the deal is completed, in groups with other deals, or interleaved with other deals.

We can also consider double-duty activities through the ability in CSP for different processes to evolve independently. Thus, we start to see how openness of certain activities may be modelled. If we have a state where openness is in both processes, we have the ability for deals to move forward for both processes. Similarly, both processes can recognise that things are incomplete. We, therefore, have some way of representing the notion of public and private activities using this model. This aspect of collaborative work has also been described in other workplace studies, particularly those that have drawn on conversation analysis where there is a focus on social actions being publicly witnessable. Modelling in CSP has the potential to provide a way of representing where activities are produced for and recognised by others. In CSP, the communication, if only in terms of multiple traces and actions, allows us to show aspects of openness and flexibility. This should not suggest behavioural aspects in the sense that one event brings about one response as reflected in the previous model. Rather, aspects of nondeterminacy allow us to consider a variety of courses of action, even though some may be preferred.

In our previous model we needed to build in structures to deal with various issues. CSP allows for more general connections such as non-determinism and parallelism that free the data structures to carry the information. Thus, in the previous model we had to build in structure to deal with the ordering of events. In CSP, we do not have to build in this structure, and sequences of events seem more an emergent property. Critical issues arise when we start looking at activities in the domain regarding their ordering, decomposition and segmentation. These issues include: how activities are ordered and made available to others, what others may be orienting to, and how explicit the coordination of activities may be. We may still be concerned with the same components, but processes may now be non-deterministic. The model may also be more generative in that we can actually see how not only this fragment emerges, but how other aspects of dealing activity may be represented. Thus, with respect to

the Deepdene dealing room we have the potential to show the explicit work in terms of how the participants get around the problem in the adjacency pair modelling, where the talk around buy and sell in the transcript almost provides the resources through which processes evolve. Similarly, we have the potential to model the ways in which participants move into securing agreement in the BATS and Orange deal. Derek asks for a half penny more in either stock. This is followed by John and Steve's overlap, where John projects rejection and Steve projects agreement. Thus, we have two points where non-determinism seems relevant and it is also interesting to note that this is also a pivotal place in the interaction for participants themselves.

A curious issue that seems to emerge from modelling naturalistic activities in CSP is that, where two activities are described as being interleaved in conversation analysis, in CSP interleaving processes describes a situation where two processes evolve independently. In conversation analysis parallel activities tend to refer to independent actions, whereas in CSP they refer to processes where the evolution of one process is dependent on the evolution of another.

In terms of modelling the subtleties of interactions, a certain openness remains that is still not conveyed. Vagueness such as 'around 50' may be related to the local circumstances and as yet it remains unclear how to model this. In a similar fashion, it is also debatable how strongly we might want to say that "What are BATS" actually initiates a deal. The utterance provides the resources for participants to move gently into dealing or not. It is also unclear how this might be captured.

As in the previous model, we may find that we separate the interactional and dealing activities in terms of different consequences of what we are attempting to convey. Thus, there is a tension in the model when we try to say one activity may achieve two things, but we want to keep them interrelated. Parallel processes are dependent on each other to occur, being synchronised around an event. If one process cannot participate in an event, neither can the other. It is not clear that the ways in which activities are related in ethnomethodological terms should be viewed as strongly as this.

In conversation analysis, the orientation to sequentiality looks at the current activity in terms of its understanding of the prior and the ways in which it sets up the next activity. Thus, as stated previously, activities are social in the sense that they are produced collaboratively in relation to others. However, there is also a moral commitment in their production. People can design their activities in ways that build in the situated details of their contingent social circumstances. As these appear to be produced in specific ways at particular times and depend on the contingencies of this particular occasion, it remains unclear how such information might be modelled.

Though the examples provided in this section are brief and merely illustrate some characteristics of CSP, they do suggest that the notation provides resources for

reflecting how the ordering of activities undertaken by individuals can be left open and flexible whilst, at times, they can be coordinated with the actions of others. CSP's consideration of parallel and interleaved processes, private and public events, and the potential for outcomes to be non-deterministic provide critical resources for reflecting the contingent, situated, and sequential nature of collaborative activities.

## 6.7 Discussion

When considering recent efforts to model social and organisational activities, it seems that the notations adopted may not have been the most appropriate for modelling the contingent nature of workplace conduct. The notations appear best suited for focusing on activities undertaken by individuals, certain aspects of which remain stable and are clearly delineated from others. This seems in marked contrast to the workplace activities that these notations may be trying to convey and revealed by social scientific studies. These suggest how activities emerge and are transformed throughout their course and where certain features may be left ambivalent for practical purposes. It is important to convey these flexible, open, contingent and situated practices to designers if the technologies they are to develop are to be sensitive to the settings in which they are deployed. The ways in which these practices inform the requirements for particular technologies is discussed in detail in Chapter 7.

The notations adopted may indeed obscure the very aspects they are intending to convey. Attempting to model communicative action in terms of single channels or relationships between co-participants, as between 'speaker' and 'hearer' or 'writer' and 'reader' for example, may hide from view the interactive and collaborative production of the interaction. Considering 'awareness' as a simple property, a relationship, or as a simple activity between individuals and objects glosses the very practices, complex and heterogeneous, through which participants collaborate and interact.

With its concern with concurrent activities, CSP does appear to offer resources for conveying critical features of collaborative and interactional workplace activities. Of course, this is not to say that it is not possible to convey these features in other notations. But it is important to consider the motivations behind the modelling exercise in the first place. If the modelling exercise is only intended to convey information to system developers it is unclear why a formal (or semi-formal) notation is necessary, particularly as natural language is quite an effective way of revealing the complex and rich nature of everyday conduct. A re-examination of the objectives of modelling may allow us to reflect on certain aspects of the process in the light of the difficulties encountered.

To consider the aims attributed to modelling within system development, with particular emphasis on the modelling of social and organisational activities, we can view the various objectives of modelling social action in terms of:

- a) communicating a sensitivity to the domain to system developers;
- b) assisting in the activities of requirements analysis;
- c) supporting design activities.

a) *Communicating a sensitivity to the domain to system developers*

Modelling has been seen as a valuable tool for communicating a sensitivity of work practices, developed through ethnographic analyses, to designers. However, the modelling exercise can do more than communicate features of a setting. Through the activity of developing a model, various details of complex issues may need to be clarified. Consequently, a dialogue may begin between ethnographers and designers where issues of clarification may result in more fieldwork, analysis and presentation of results in an iterative process. The modelling process itself may raise questions about how an object as simple as a form is used, along with the detailed practices through which it is completed and used in the accomplishment of various organisational activities. Though it may be valuable to explore the implications of modelling naturalistic material in formal languages, there is an issue regarding the appropriateness of doing so. Formal languages in their raw state are not readily accessible to the diverse range of people recognised to be involved in the design process. However, some argue (Viller and Sommerville, 1999) that for those who are skilled in these languages, this is the type of activity that computer scientists do, and thus we need to be more sensitive to the practices of software designers and consider their languages and discourses. As we have been attempting to communicate issues regarding sequentiality, we have focused on an area in computer science that has been concerned with sequential processes. It is not *a priori* the case that the two notions of sequentiality are incommensurate. Ultimately, social scientists are attempting to consider system design, and it is obvious that developers are. Various ways of bridging the gap between the social and technical in practice is part of an ongoing debate (Bowker, et al., 1997; Floyd, et al., forthcoming; Goguen, 1992). In this chapter we have described one way of attempting to reconcile these practices whilst attempting to preserve the sensitivities of each.

b) *Assisting in the activities of requirements analysis*

In support of some of the activities of requirements capture, modelling may assist in breaking apart aspects of the problem or concentrating analysis on particular issues. The requirements engineer needs to consider the existing social organisation of the workplace with respect to how it could be transformed by technology. In this case, the requirements analyst is providing a context for the next stage of development, that of specification and design. Thus modelling may assist in making statements about what

technology should exist in the domain, in terms of its placing certain resources into the environment to support certain types of activity. The requirements exercise may focus on what resources to put into the environment and what to inhibit or degrade. An assessment of the ways implementations may be embedded into the setting becomes critical, and the descriptions of how these resources are required must be general enough to permit several different implementations and kinds of technologies.

Modelling of various aspects of the problem may seem useful in describing transformations to the workplace. From a social scientific perspective, modelling helps to break apart some of the issues of concern, for example, notions of ambiguity, a turn of talk, sequence, and participation. There may be ways of presenting the nature of these issues in practice, for example, communicating the organisationally relevant ways in which things may be left open, that are pertinent both to social science and system design. In the case of the dealing room, the modelling exercise can break apart the activities of deal capture into the production and recording of the deal. It may then be possible to consider, in terms of the coordination of these activities, what might happen if they are conducted in parallel, sequentially or interleaved.

If conducted at the same time, the model might suggest the types of support that such a technology would need in the setting in order to succeed. The model should show what resources would be required for the system to work, in this case potentially a complete understanding of the context of deals. If dealing and recording the deals are done one after another, the modelling might show the relationship between deals and deal capture in terms of what the system must support. The model might show how various items of the deal are preserved over time for different purposes and, in considering the timing of deals, how a form of technological support may be best designed for deal capture by other people (not dealers). In contrast, support for interleaved deal and deal-capture activities overlapping might show how the resources of talk and writing may need to be preserved, and how these are interleaved in the doing of not just one deal but several at different stages with different participants.

### *c) Supporting design activities*

Requirements engineers might wish to model the potential solution in order to test out aspects of the design of a system; however, there is a danger when modelling social interactions for design purposes that this may get confused with other objectives of modelling. They need to be able to reconstruct the relationship between the physical properties of the system, the social organisation and potential transformations. For example, when designing a distributed shared system, designers might consider what interactional resources may need to be reconstructed to provide reference and then if the resource is still used in the same way. They might also consider the likely impacts of different forms of providing reference in a domain and assess the impacts of the transformation on the social setting. When presenting an ethnographic analysis it is

possible to draw on the everyday understandings of the audience to make sense of certain features; for example, when people shout outloud in a setting this is produced for others who are within earshot. For the purposes of design some of these understandings need to be made explicit.

In modelling areas of complex social interaction such as awareness, designers may get drawn into modelling the concepts themselves rather than what it is they are trying to support. For example, if trying to support the collaborative activities surrounding the use of documents, a design activity could become focused on the resources necessary to make the documents peripherally accessible rather than supporting how various aspects of the document are made relevant and appropriate to others at certain critical times. Modelling complex concepts like awareness may lose much of the detail of how awareness is achieved in practice, whilst also possibly leading designers to considering capabilities of systems that may not be appropriate. Modelling is used as a resource to help to clarify and communicate issues for design and specification of technical systems. However, as complex social activities are open, ambiguous, tacit and interactional, perhaps it is inevitable that they are difficult to model. Moreover, models of social action may become problematic when the frameworks are too rigid and inflexible to account for the emergent and situated nature of social and organisational conduct.

But it is hoped that modelling provides more than simply a communication device, for example, that it provides some resources for considering the consequences of a particular set of features for the technology in a domain. We discuss this in more detail in Chapter 8.

## 6.8 Summary

This chapter initially explored three different kinds of modelling exercises in relation to considering the representation and communication of social, collaborative and organisational practices for system design. These exercises have different foci, for example, bureaucratic communication through forms, communication through awareness of activities at work, and the situated production of activities. Each exercise uses different modelling techniques: the modelling of forms through entity-relationship diagrams; awareness of work through a UML notation; and situated action through abstract data types. Moreover, each exercise draws upon a different analytic orientation with respect to the organisation of social activities. The first exercise examines critical artefacts in organisational communication. The second attempts to model the tacit practices around the use of documents, and the final exercise looks at the interactional production of collaborative activities. In each, problems emerge in accounting for the tacit and interactional practices in models

utilising (semi-) formal notations. In part at least, this may be due to attempts to model practices that are inherently open, emergent, and ambiguous and are designed by participants to be so, in what claims to be an unambiguous way. Not capturing the socio-interactional resources through which individuals accomplish their work may have consequences for realising opportunities to improve system design.

We continued with our own investigation into modelling the tacit and interactional resources people rely on to get their work done. We began by modelling certain aspects using a simple notation, and progressed from this to explore aspects of sequentiality using a more sophisticated technique - CSP. We have discussed the potential uses of modelling both to the social sciences and to system design, in terms of providing the potential to increase our understanding of the practical and organisationally relevant ways in which concepts such as ambiguity, participation, turns of talk and sequence are utilised. The exercises have generated issues that, for example, may be related to requirements for technological design in the following chapter.

# Chapter 7

## Implications for System Development

### 7.1 Introduction

The modelling exercise in the previous chapter suggested that there may be alternative ways of clarifying, communicating and presenting the critical features of social scientific analyses for requirements and design. A set of sensitivities drawn from the analyses of Chapter 4 and 5 and other related workplace studies have been identified that have informed a range of studies of work and interaction in the social sciences, most particularly those studies of an ethnomethodological orientation. If it is possible to make these sensitivities more explicit, there may be a way of focusing analyses on specific issues that are relevant to system design. This chapter will investigate this issue with respect to two technological case studies and will discuss the appropriateness and relevance of these sensitivities to the software development process.

As mentioned in Chapter 2, various researchers have attempted to draw on naturalistic analyses to inform system design. In these studies there is an attempt to move from a description of the domain to a description of a technology to work in that domain. When a technology is deployed, often the work practices in the domain are transformed. A key issue in moving from a description of a setting to a specification of technology lies in circumscribing particular objects and activities of interest and communicating these to system designers. No doubt such practices are iterative and interactive in nature so that any problems that emerge can be refined throughout the process; however, there seem to be more general issues that emerge from the body of work known as workplace studies referred to in Chapter 2, that can enable designers to target various critical aspects of work practice more effectively.

In the previous chapter we have looked at modelling collaborative activities in detail and considered the ways in which these practices may be communicated to

system designers. In this chapter we consider these collaborative practices in terms of requirements and design for technology in general. The exercises in modelling in Chapter 6 pointed to the need to communicate the openness and flexibility of workplace activities; how individuals may be engaged in a set of apparently unrelated activities simultaneously and, in addition, can design their activities in relation to colleagues' actions in the local setting. We have discussed how the modelling of these activities can assist requirements analysis by breaking apart aspects of the practice. The requirements engineer can further consider requirements in terms of the transformation of the existing social organisation of a workplace. The modelling of these types of tacit and interactional practices can allow the requirements engineer to consider statements about the types of resources that should exist through the technology to support different kinds of activities. Thus, even early on in the requirements process, the shaping of the analyses of socio-interactional practices in a setting may be geared towards the practices of requirements engineers. This chapter examines how to focus such an analysis for the concerns of requirements engineers. We consider how the issues raised in the modelling exercise could be relevant further into the design process. We do this through a basic breakdown into critical sensitivities that have been drawn upon in the workplace analysis, in order to provide alternative ways of communicating these tacit and interactional practices to designers. This may be achieved either through producing models, or asking others to produce models, or simply to reflect on the critical analysis, models and observations. It is not our intention to suggest that the sensitivities should be seen as guidelines or as a part of a framework for design. Instead, we are attempting to provide a means for designers to have access to detailed work practices and domains difficult to make available through text or fieldwork.

The key feature of this approach draws on ethnomethodological studies of the workplace in considering transformations brought about through new technology, and attempts to preserve the analytic orientation by providing designers with various sensitivities to workplace practices. These sensitivities are derived from the analysis done in this thesis and from a set of other related workplace studies (Button and Sharrock, 1994; Goodwin and Goodwin, 1996; Harper and Hughes, 1993; Heath et al., 1993; Heath and Luff, 1992a; Luff et al., 2000b; Randall et al., 1994; Suchman, 2000). The approach attempts to show designers how these sensitivities are derived from the analytic orientation and how they can be pertinent to proposed technologies. In such a way, these sensitivities are not mutually exclusive but can focus requirements engineers on particular aspects of the work context to investigate further. This may be seen as the same order as Hughes and his colleagues' (Hughes et al., 1997; Hughes et al., 1995) attempts to structure ethnographic findings in order to make them accessible for design. As mentioned in Chapter 6, the framework described is for social scientists, and attempts to structure naturalistic analyses into

the general areas of: ‘distributed coordination’ to describe how people coordinate their activities in the workplace; the ‘plans and procedures’ through which people practically coordinate their activities both co-present and distributed; and ‘awareness of work’ for how certain activities may be made visible or intelligible to others in the workplace. However, there may be some danger in utilising such a framework - by focusing on such notions as ‘roles’, ‘plans’ and ‘spaces’ and not on how the activities are produced, the research may lose the ethnomethodological orientations. This may be even more problematic when such a framework is adopted by designers to structure their analyses.

In order to illustrate the sensitivities, we draw on the analyses of the dealing room described in the previous chapters incorporating a focus on the interactional production of activities in the workplace. We consider these sensitivities in the light of two case studies that illustrate the possible transformations to the social organisation of work practices through technological intervention and their relevance for requirements.

## 7.2 Description of Case Studies

Requirements engineers may consider the existing social organisation of the workplace with a view to its possible transformation through technology. Jirotko and Wallen (Heath and Luff, 1992a) have suggested this transformation could be characterised as a hypothesising of a social organisation, where the requirements engineer attempts to project a technology-based understanding of social organisation into a technology-based description of a hypothetical social organisation. A major consideration for requirements analysis is how relevant ethnomethodological analyses of the workplace may be for assisting them in producing this technology-based description of a particular hypothetical social setting and, hence, ultimately to considerations of how a technology might transform a work setting and the practices of its participants. These problems are not unique to ethnomethodological analyses; when considering various techniques for eliciting requirements such as questionnaires or interviews, or various analytic orientations whether they be psychological or computational, there is a need to transpose what the implications of the analyses are for requirements (cf. Barnard, 1991b). Thus there is a need to move from the original data to an analysis that makes prescriptions about the future technology and social organisation. In this respect, it seems quite appropriate to understand the context of people’s work in order to transform their work through technological innovation. However, it remains unclear how designers can utilise sociological analyses that are fundamentally descriptive in nature to assist in their work that is of necessity prescriptive. This problem is also common to other areas in the social, between conventional sociological studies and social policy sciences for example.

In the light of these issues, we now discuss how critical sensitivities drawn from the ethnomethodological orientation might be useful for producing this technology-based description of a particular hypothetical social setting in relation to two actual technology transformations in financial dealing rooms. As mentioned in Chapter 3, the dealing room was considered an appropriate setting for analysis because within the organisation, managers and traders in dealing rooms also have a range of technologies they wish to explore and augment. In addition, new technologies are constantly being developed for trading in the commercial world and, consequently, the roles of participants are often being re-characterised and altered.

The two cases of technological intervention described have quite different motivations. The first was intended to transform the dealers' work practices quite radically. The second would only effect their roles and some of their activities. The first case to be considered is of technology design and development; the second case is concerned with the deployment of a technology. Both have relevance and implications for requirements over a range of aspects including: how work and the roles and responsibilities of individuals may be transformed; what kinds of resources need to be put back into the environment to allow current work practices to proceed through the new technology; how to deploy a technology in the workplace; and what designers should be sensitive to in deployment.

Case 1 considers the introduction of Voice Recognition Systems fitted to the telephone lines connecting dealers with other trading rooms. The system was intended to increase the speed and efficiency of the deal-capture process which was perceived as slow and inaccurate with as much as a ten percent error rate. Errors occur when trade input staff do not type the information correctly into the database. Thus they wished to make the process of capturing and recording the details of the deal more accurate. The process was also potentially quite slow. Consequently, actual trading might be affected as dealers wait for their positions to be updated; thus, there was a motivation to speed up the process. Most importantly, the trading room has no real-time position (the amount and value of all the stocks traded) until trading on particular markets closes for the day. Thus there is a lack of moment-to-moment real time overall position keeping whilst dealing. As the voice recognition system is processing the details of the deal from the phone, both parties to the deal could automatically get a record of the deal. The aim of the new technology would be, therefore, to change work practice radically, cutting out the overhead of bureaucratic recording and eliminating the need for trade-input staff. The existing paper system mediated by trade-input staff was viewed by many in this setting, traders and system analysts alike, as an archaic and slow practice.

Case 2 also examined a proposal for technology to speed up this process. However, the suggestion proposed a more modest change. Rather than using a paper ticket to write out the details of the deal and passing this to trade-input staff, dealers would

type the information directly into the trade-input system themselves. The system required dealers to type in the details of the deal in a fixed order (starting from the left field and progressing to the right), filling in such information as whether the trade was a buy or sell, the amount traded, the price, the name of the stock, the counterparty, and the time of the deal. Such a system would transform the roles and responsibilities of both trade-input staff, who would now be redundant in the process, and dealers who had acquired an extra part of the activity to perform. Not only would they need to recover the details of the deal, they would also need to enter these components into the trade-input system.

In Case 1, the voice recognition system was being developed by an external company who were in the business of designing financial trading systems. The analysis of the interactional work of dealers in both producing and recording deals influenced the overall requirements of the system the company intended to develop. Case 2, on the other hand, was concerned with an in-house deployment of an existing system to be used by a new group of people, i.e. traders. The system to support traders to do their own deal capture was not a success, and the analysis may in part explain why users found the technology intrusive and inefficient.

In the following section we consider the key sensitivities that have been utilised in developing the analyses of the dealing room and deal capture and other related studies (Luff and Jirotko, 1998). First, we outline each sensitivity and discuss its relevance to the design of technologies in general. We then relate each sensitivity to the two types of systems described above and discuss their implications for requirements for these systems in particular.

## 7.3 Critical Sensitivities

### *Talk and the sequential ordering of activities*

Critical to Conversation Analysis and Interaction Analysis is the analysis of participants' talk and bodily conduct, an orientation that is reflected more generally in ethnomethodology's concern with conduct in interaction. In Chapters 4 and 5, we revealed through a sequential analysis of the dealers' talk, the ways in which the production of a deal is a collaborative activity. We also described how the recording of a deal is produced through interactions with others and is tied into the deal talk in a sequential and temporal manner. As mentioned in Chapter 2, the notion of sequence here draws from the analysis developed by Sacks, Schegloff and Jefferson (Sacks, et al., 1974) and others, and investigates the way one activity is tied into the previous activity and in turn shapes the next activity. Participants can be sensitive to various aspects of talk, such as the timing and pacing of talk or pauses in its delivery, and can be aware of shifts in glances towards artefacts and changes in bodily orientation.

From such resources participants can make sense of and draw inferences from a speaker's conduct. Such features in talk, positioned at relevant moments, can for example demand a response, select next speakers, or bring others into focused interaction around an artefact.

Considering this sensitivity with respect to requirements would necessitate, where relevant, taking account of how talk and body movement are related and how the deployment of a technology may affect this. This is relevant, for example, when explicitly designing to support gesture and talk, particularly in distributed systems where consideration must also be given to remote participants. Technologies to support such distributed interaction (Gaver, 1992; Kuzuoka et al., 1994) might inadvertently break apart these sequential resources. When more conventional technologies are being considered for interactive domains (e.g. call taking or medical consultations), care must be given such that systems designed should not interfere with the sequential conduct of participants (Greatbatch, et al., 1993). For example, one must be sensitive to the sequential relationships between the telephone talk and the demands of the ordering of activities through the computer system.

#### *Local environment of the other*

Interaction analysis (e.g. Goodwin, 1981; Heath, 1986) has demonstrated how participants are sensitive to both their own and the other's local environment. Activities may be tailored for others with respect to the local environment in which they work. Participants may therefore design utterances or activities in relation to the artefacts and information they know is available to colleagues. For example, in various fragments from the dealing room we have revealed how dealers can produce prices for a colleague with the assumption that they have access to computer screens displaying this information. Thus utterances like 'I can do them both on the prices' is produced in the light of assuming the local environment of the other.

Systems that require what was co-present work to be achieved in a distributed setting, may remove not only what is relevant and what needs to be available to the other, but also the resources through which that feature may be made visible to the other, particularly in relation to conduct. In the case of media-spaces technology, multiple cameras provide access to the other's domain by splitting the resources, to make sense of what individual did in the local environment for the other. It became problematic for individuals to integrate the different views provided by the various cameras of the environment of the other.

#### *Engagement in multiple activities*

Participants may be engaged in more than one activity with various co-participants and may participate in these activities in different ways. For example, the extent of their participation may vary from being a fully 'ratified' participant (Goffman, 1981b) to perhaps being an overhearer ('ratified' or 'non-ratified'). Participants may

seemingly be engaged in an individual activity, whilst at the same time overhearing or overseeing others. Thus individuals may be peripherally involved in a multitude of activities and organise their work accordingly. In situations where individuals may be overhearing an utterance, the analysis could reveal how one activity is produced in relation to another; how participants design their utterance to be overheard and engender action in others. Similarly for hearers, such an analysis could reveal what types of things they are orienting to and how they design and organise their activities in relation to the overhearing.

System designs may transform a participant's ability to engage in various activities in different ways. Designers may 'individualise' particular activities, thereby undermining the ways in which public resources such as displays are utilised by participants to achieve their work. For example, in the London Underground Study (Heath and Luff, 1992a), designers wished to eliminate the public display of the train network in order to reproduce 'private' versions on individuals' screens. The researchers in this setting revealed how participants rely on overseeing other colleagues' monitoring of this display in order to coordinate their work. On the other hand, systems that attempt to provide 'awareness' of others may make public what was once private. These technologies remove the resources that enable professionals to design when activities should be made public and when they are private, and delicately to move between the two.

#### *Openness and completeness of activities*

As we have described in Chapter 6, participants may design their activities to be left open or incomplete in various ways. Leaving part of an activity open may be a way of bringing about other activities and can be recognised as such by others. Often various aspects of an activity may be left open or ambivalent by individuals and this may allow colleagues to move into interaction; for example, either through making a contribution or offering a suggestion, thereby moving into focused collaboration.

A consideration of what components may be left open in interactions can suggest to requirements analysts to consider the professional competencies of others in the setting and to attempt to interpret and understand those components. If various items are designed to be left open, the system may then allow for variability in understanding to assess various actions and trajectories of action. When systems are designed in such a way that each full component must be entered in particular ways, they reduce the opportunities for individuals, when using the system, to make use of these competencies for others.

#### *Double-duty activities*

Seemingly simple, mundane activities may be produced simultaneously for various participants (Turner, 1972). A shouted comment such as Annie's outloud 'Shearson

on the bid' in Chapter 4, might not only select a particular participant in the setting, but can also make others in the domain aware of the ongoing activity. In a similar fashion, a reply can self-select a respondent and display to others in the local setting that the matter is being dealt with. Thus, outlouds may be both a sensitive way of providing information to others in the local domain that does not demand a response from others and may engender next actions by others.

In the case where one action may accomplish two or more activities, technology can either break these up into distinct achievements, thereby losing the nature of the work, or neglect one activity altogether. For example, forcing an explicit completion operation in the technological design, or neglecting the social and collaborative features of seemingly individual tasks.

These reflect some of the basic sensitivities that we drew upon in the analyses of the dealing room and, indeed, of other settings (Luff and Jirotko, 1998). Utilising the two case studies of technological intervention in the workplace, we now illustrate how these sensitivities may be relevant with respect to two technologies; Case 1 the design of a Voice Recognition Systems and Case 2 the deployment of a Dealer Trade Input System.

#### *Talk and the sequential ordering of activities*

*Case 1.* Understanding of an utterance is revealed through its sequential position within the talk. The sequential position of an utterance provides resources to display the understanding of the prior utterance and produces the context for the next. Consequently, the voice recognition system should have an understanding of what happened in the prior talk. As we see in the fragments given, the relevant items of the deal that need to be captured are distributed through the talk. In addition, what individuals do through talk is produced and recognised as social action; for example, a rejection may be marked in very subtle ways, maybe through a slightly elongated pause, perturbations in speech, or through some explicit marker. Thus, recognition of the sequential ordering of talk, and the fact that utterances are performing social actions, should also be built into the design of the system if it is not to transform the practices of dealers. An alternative would be to completely rule out notions of the sequential, and possibly change dealers' work practice by requiring them to repeat or make explicit various actions that are performed in previous talk and to produce in final form all the components of the deal. However, the original motivations of such systems were to design a non-intrusive technology that speeded up the work of dealing. Moreover, if the technology is supposed to be non-intrusive, this should apply not just to individual dealers but also to others at the end of the phone.

*Case 2.* A sensitivity to this feature in the design of the more conventional system would necessitate taking into account the nature of deal talk on the phone. This may then have implications for requirements for interface components (e.g. which items

appear with others), the type of interaction that is undertaken, and even the choice of input devices and displays.

#### *Local environment of the other*

In Chapters 5 and 6 we discussed the ways in which prices are produced and understood by others in the setting. In the dealers' interactions we see how current prices of stock are produced in the light of what they expect of the space around the co-participant in the deal; most particularly, what is assumed to be visible on the other's screen. Relying on this as a resource for a colleague to make sense of what is being said, a dealer may omit various details or elide certain others, relying on a competent member being able to recover such information from the screen in front of them. Dealers not only reconstruct the full numbers from the numbers given in talk in the light of what is on the screen, but also produce these numbers in terms of what is assumed to be on the other's screen.

*Case 1.* This sensitivity seems relevant to voice recognition technology where there may be an attempt to automate the process of deal capture. A consequence for such a system is that an understanding of utterances is not only tied into talk and prior utterances of participants, but is also tied into what is displayed on the screen regarding the state of the market and what is assumed to be on the recipient's screen also. Thus, any competent reader of a screen can identify stock just from a number within the ongoing talk and, in addition, can be expected to do so. The voice recognition system, therefore, may need to understand the real-time state of the market if it is not to transform dealers' work practices.

*Case 2.* The proposed recording technology had no relationship to other systems in the dealers' environment and consequently was not related to other real-time activities. There may be simple ways of integrating aspects of separate systems. The system could draw upon resources from the state of the market; for example, there may be a way of providing on-screen only the resources that are required at that time in the interaction, rather than all the information at the same time (e.g. bringing up the present price in relation to the stock name). In addition, the information that is provided should be easily manipulated, allowing for small alterations (as in price) to occur.

#### *Engagement in multiple activities*

*Case 1.* The voice recognition system must recognise deal talk and determine what is relevant to record from the surrounding talk. As described in Chapter 4, deals may be done through various technologies such as telephones and stentafons and may also be achieved through outlouds or in face-to-face interactions. If dealers are to get this system to work, and as they may be engaged in various other activities at the same time as trading, dealers must mark out that the system is just recording one particular

deal and mark off interference from other activities. Suggestions have also been put forward for dealers to wear headphones with this technology in order to provide constant access to the phone without being encumbered by the receivers. However, headphones tend to 'individualise' activities, in that it becomes problematic for others in the setting to see when a colleague is on the phone and consequently undermines their ability to initiate interaction.

*Case 2.* The conventional trade input system separates the two activities of dealing and recording. It is also designed on the assumption that deal recording follows the deal talk. As mentioned in Chapter 5, recording is done in a real-time setting; the ordering of components, what gets done, when and how, is tied into the interaction. It may be problematic for dealers to interleave deal talk on the phone with typing in the components of the ongoing deal as they emerge. In addition, problems may appear when dealers are typing in the information from one deal and a call comes in requiring them to deal again. They may have to abandon the recording of the previous deal in order to do the current deal. This may suggest that the technology to input such information should be flexible enough to allow dealers to be engaged in various dealing practices without constraining their engagement in the critical activities (e.g. using hand-held mobile devices for inputting the information).

#### *Openness and completeness of activities*

Some items of the deal, particularly the amount to be traded and the price the stock will be traded at, can remain open for negotiation as the deal progresses. Dealers might introduce potential deals by mentioning the name of the stock, without specifying whether they are interested in buying or selling. Leaving the status open in this way is one way in which dealers can begin negotiations, and is recognised as such by others. Similarly, when a deal is treated as complete, for example when the phone is put down, is not straightforward as seen in Chapter 6. A deal may be treated as complete by participants when the phone call is over or through a 'thank you'.

*Case 1.* If the voice recognition system is not to transform what dealers do in these interactions, it must recognise where dealers have left items open and where and when these items are completed. It must also recognise agreement and what has been agreed. In order to do this, the system - once the telephone has been hung up - may need to work backwards through the deal to recover what the agreed components of the deal were.

*Case 2.* Recording a deal on a paper ticket can be done whilst deals are being agreed and can easily be altered or transformed. Items are often left open in deal talk and this is reflected in the recording of deals; when and how components are filled in may be tied into the interaction. These aspects need to be reflected in the requirements for what should be displayed and manipulated on the screen. The system should provide easy ways of moving prices or amounts up or down. This is not only helpful for

bringing in other aspects of the environment but also easily able to adapt what is there. In addition, there should be flexibility of ordering, allowing dealers to record components as they emerge in the interaction, leaving open items that are yet to be agreed.

### *Double-duty activities*

In terms of dealing, it may be that single utterances can perform multiple actions - a 'thank you' may complete the deal and at the same time display agreement. An enquiry about the price of stocks such as 'What are BATS' may also be initiating a deal. More mundane activities within the dealing room, such as ripping out a ticket from the book, may perform the function of the individual task, but also marks for others that the activity has been completed. The ripping out of a ticket from the book can make it relevant for other dealers and staff that the deal is complete.

*Case 1.* Incorporating such features into a voice recognition system is not straightforward. Matching utterances to a single consequence, for example an utterance that only starts or completes a deal, may transform the dealers' practices. Thus requirements must consider that utterances have multiple consequences. This would focus attention particularly on how activities are initiated and completed.

*Case 2.* A sensitivity to double-duty activities may require re-introducing one of the activities an action accomplishes in the more conventional trade input system. As mentioned previously, ripping out the ticket is a resource for other dealers to know that a deal has been done. When typing information in at the interface, this resource may be lost. However, it may be possible to associate a sound in combination with an already existing action on the keyboard to make relevant to others that a deal has been completed. Thus when a dealer presses a key an amplified sound marker to accompany the trade completion key event may be designed to be heard by others in the local domain. Such a requirement also has implications for a gestural type of system, such as a mobile hand-held device. Dealers could enter details of the deal onto this system and, in an attempt to be sensitive to the local environment, designers could build in a sweeping gesture to despatch the deal to the necessary databases. Including such a visible gesture for other dealers attempts to be sensitive to issues around recipient design. There would be further advantages of such a system over a keyboard; for example, dealers might be more readily able to monitor screens and engage in other activities, interleaving these actions with entering components on the device.

We have investigated the sensitivities in relation to two different types of technologies to support the work of traders, and considered the problems of ignoring particularly the local context through which their activities are produced and recognised. Most specifically, we have discussed these issues with an orientation that focuses on activities-in-interaction, concentrating on the sequential production and

recognition of activities – how one activity may display an understanding of the prior and furthers the context for the next activity. In Case 1, the voice recognition system, designers should consider that talk performs actions rather than just providing meanings. These are social and collaborative actions and even the most mundane features of talk, how it is abbreviated or paced, may have relevance for voice recognition technology. Case 2 is an example of an entirely different system, but its use is still related to an interactional context to other activities. The use of the system is tied into the production of other activities; in particular, talk and actions on a computer system may be both related and relevant to others in the domain.

We have discussed some critical sensitivities drawn from an ethnomethodological orientation with a view to making them available to system designers. These sensitivities have been derived from both the investigations carried out in this thesis, but also from sets of other related workplace studies. There is a large body of work in the ethnomethodological tradition that provides further sensitivities that may be pertinent to design, particularly in terms of reasoning about the impact of new system designs on work practice. The following is a brief description of further analytic resources drawn upon in the investigations of detailed work practices that may be developed as sensitivities for design.

#### *Gestures, Reference and Body Orientation*

These may be designed quite subtly for others to distinguish critical features and aspects in a collaboration. However, their production must be understood in relation to the ongoing talk. Thus, the initiation and shaping of a gesture may be tied both to the talk and to the participation of the recipient. Gestures are produced and recognised with respect to body orientation. Participants are able to produce and make sense of subtle changes in body orientation, shifts of gaze, and delicate movements into particular domains. It is possible that a person can remain oriented to an artefact whilst glancing at a colleague or another artefact. Others in the local setting can use these movements in the production of next activities.

#### *Participation Frameworks*

In collaborative settings, participants quite frequently adopt orientations that facilitate the monitoring, overseeing and, sometimes, overhearing of colleagues' activities. Even when engaged in seemingly individual tasks, participants can be sensitive to the activities of colleagues and design their activities with respect to their colleagues' conduct.

More generally, Goffman's (1981b) analysis of social encounters decomposes the notion of 'hearer' and 'speaker' by examining the status of participants in a social encounter. Official or ratified participants may be addressed or unaddressed. Unofficial participants may still be listening to an interaction either as overhearers or eavesdroppers. On an individual level, the relation of each member to the speaker's

utterance is that member's *participation status*. At the level of a gathering, the relation of all the members to the speaker's utterance is the *participation framework*.

#### *Recipient Design and Membership Categorisation Devices*

The ways in which activities by participants are produced or designed display an orientation and sensitivity to their co-participants. Thus, utterances in conversation are directed toward specific others, and the analyses reveal the ways in which these utterances are constructed specifically to be understood by a particular recipient.

More specifically, these are used by members to group together collections of 'similar' identities of categories. Many kinds of activities are associated with certain kinds of membership categories. Sacks (1992a) suggests a 'hearing rule' that structures how members hear a description. Thus when two or more categories are used to describe two or more members, and it is possible to hear the categories as belonging to the same collection, we hear them that way.

#### *Use of artefacts*

Artefacts and certain features of artefacts are a major resource in collaborative activity. Ongoing talk and visual conduct may only be understood with respect to the current state of the objects. Therefore, having access to the artefact and a colleague's orientation to that artefact is critical to collaboration. Though these artefacts may be brought into the interaction just for a moment or two, their relevance may only be understood with regard to the ongoing talk and the emergent natural history of events.

The analysis of the dealing room activities, drawing on the sensitivities described above, had specific effects in both case studies. From the presentation of video fragments and the analyses, designers of the voice recognition system became aware of the complexity of capturing the information required from the deal talk on the telephone. Thus, they modified their original requirements and suggested that the system should optionally identify callers and counterparties that could be automatically recorded. Dealers would then signal the conclusion of the deal through the interface. The system would then print out a ticket with this information completed, and dealers would be required to fill in the missing information. However, designers were not sure that the level of automation provided by these alterations would be enough to justify its cost. Given this and the extra demands on the user, it was unclear that the project would progress.

The system to support traders doing deal capture was abandoned after initial trials. The analysis suggests, in part, why this system was found to be intrusive by traders. Critically, it slowed the trading activity down, as dealers were required to enter information onto the screen; laboriously filling in the components of the ticket, moving from left to right in fixed order. Dealers found it was very difficult to carry out the parallel activities of trading on the telephone and entering information onto screens.

These sensitivities may not only be relevant in the dealing-room setting, but also in the consideration of technologies for various other domains. For example, they have been drawn upon in the investigation of distributed electronic meeting systems where detailed analysis of co-present meetings revealed some key interactional resources that participants draw upon to achieve their work. Orienting to a sensitivity to turns of talk in this setting reveals the delicate ways in which participants transition from one activity to another; a sensitivity to body conduct and gaze raises the importance of visual conduct for the chair's control of the meeting, that is, in terms of coordinating the activities of the meeting; or locating the many ways participants use artefacts to display engagement in, or movement out of, various activities; the use of body orientation and pointing to mark out critical aspects for others in the local setting or to engage others in collaboration (Jirotko and Wallen, 1999).

Such interactional resources can form the basis for a consideration of what may be transformed when co-present meetings are distributed and conducted electronically in terms of the risks involved. For example, we might consider that the provision of synchronous audio support, at the very least, is critical in order to place some of the resources in the electronic setting that are key in face-to-face meetings. An absence of robust and multi-party video communications may rule out video links or media spaces in distributed meetings. Thus, some risks may include: a reduced sensitivity to a colleague's current activities, and reduced awareness of the other's activities in relation to their local environment; greater difficulties making contributions; greater difficulties establishing common references (colleague's orientations to new documents, for example); sequentialising activities (for example, the movement in and out of activities may need to be much more explicit, rather than a stepwise progression as in face-to-face reviewing, and therefore greater overheads should be placed on the chair in terms of time spent co-ordinating the discussions).

Alternatively, we might consider the use of real time distributed and co-present systems to promote what has been termed 'situational awareness'. This has been defined as "having to perceive all the relevant elements of a complex, dynamic situation, building up an accurate and up-to-date understanding or 'picture' of it, predicting how the situation will change in the future, and the applying all this knowledge to making the right decisions and performing the right actions" (McGuinness, 1995 p.15). An analysis of how people are interacting through such systems, with an orientation to the sensitivities described, may reveal how participants might attempt to produce outlouds that are designed to be heard by others and engender some action (double-duty activities), but where the current system reduces the impact of the utterance for the distributed others. Other aspects include the problems in shifting between private and public displays and the ways in which participants attempt to rely on the use of gestures and pointing to provide reference, but where the gesture or point loses its interactional relevance and must be built back

into the talk. The aim of such an approach is to investigate what key sensitivities exist in the domain and to understand how they apply. Breaking these key sensitivities apart may then provide some foundation for considering which resources need to be preserved, in order to get the work in the setting done through the proposed technology. Considering such features, as what may be happening on the periphery of an activity or how participants are made aware of the activities of others, may help inform the body of work that is attempting to design technologies to support situational awareness.

Such sensitivities may also be relevant in the consideration of other technologies within CSCW; for example, where an understanding of the impact of distributing work that was co-present or similarly systems that allow the bringing together of once disparate groups of people is critical. The resources that people use to interact with each other and artefacts in the respective settings may provide critical information for the design of how turns of talk may be interleaved with typing, for example, or how different forms of participation in interactions may be supported technologically. Thus, by examining both the remote and co-present talk between personnel, detailing what is made explicit in their talk and what remains implicit in the current system can provide system designers with the information necessary to either preserve certain features where necessary or build them back into the proposed technology.

A sensitivity to the features described above can provide a resource for designers in the consideration of other types of technologies, such as mobile and augmented technologies. Within CSCW there is an understanding that we are not simply attempting to support groups of people coming together to collaborate, but to support people doing the work they naturally do. This has led to issues of how to support the coordination of activities over documents, artefacts and with other colleagues, often when also engaged in other activities. Critical to this issue is how people use talk and visual conduct to make sense of and draw inferences about activities in their local environment. Documents and artefacts are a key resource and talk and visual conduct may only be made sense of with respect to the present state of those objects. Everyday objects themselves have become a focus for research in terms of augmenting tools, spaces and artefacts with computational power (Weiser, 1991). Such technologies offer a rich source of support for everyday activities. However, it may be difficult to locate what exactly to augment and how to augment it. Interesting work is currently being carried out in areas of mobility and how objects can have computational resources to support both co-present and distributed collaboration that allow people to draw on their existing interactional resources and practices in use. An orientation in design to the key sensitivities described may help to identify not only which objects are a focus for collaboration in various settings, but also how they are; how they work as a resource for focused collaboration. This may in turn allow designers to locate what objects to infuse with computational power, but also in what ways.

## 7.4 Discussion

In our consideration of sensitivities to inform requirements analysis, we are also attempting to preserve a particular analytic orientation to the collaborative and interactional nature of work. As mentioned in Chapter 6, we are not simply interested in practices such as awareness, but the resources through which people achieve these activities. These resources are interactional and provide a foundation for analysts to consider in system design. We do not wish to suggest, however, that these sensitivities should be regarded too rigidly, or be seen as guidelines to follow. Such an approach may only serve to reproduce the problems of methods discussed in Chapter 3, such as task analysis where analysts seek to understand a setting utilising certain *a priori* categories. These problems may also be reflected in Hughes et al.'s (Hughes et al., 1997; Hughes et al., 1995) approach where the framework for structuring ethnographic findings may lead to analysts looking for these features in a domain.

An alternative way of reaching these sensitivities is through a case-study approach, providing requirements engineers with a set of illustrative case studies where the richness of the analysis may be communicated in various ways. The sensitivities discussed previously are simply a gloss for the details of practices. In order to communicate these in a more powerful way for design, they might be supplemented with resources and analyses of the original materials including video materials. Case studies supported by the analysis of video provide designers with an access into work practices and domains difficult to make available merely through texts or extracts from field notes.

In general, requirements engineers' exposure to the workplace is very limited. Though observation of particular activities may be recommended in various requirements methods, and an understanding of organisational issues is viewed as important for requirements analysis, engineers are more often encouraged to rely on (un)structured interviews, questionnaires, verbal protocols and personal experience in order to elicit the necessary information. Such techniques are currently employed in a context where requirements specifications are produced with little or no access to the domain in which the system will eventually be placed. In contrast, the video and analysis of work practice allow designers to see actions as they are produced and how they are relevant for others. It is important to stress that these video fragments are not just illustrations and examples. Rather, the fragments are selected in terms of the ongoing analysis and analytic framework. The video and analysis can show some aspects of the constituent properties of the activities; how actions are produced for others in the very work that is being done. The video data illustrates from the analysis how work is coordinated, how work is interrelated with talk, and how people shape their gestures and bodily conduct in relation to the activities of others. How these

gestures are designed and understood by participants in the setting, when seen on video, is quite different to a transcript. The video fragments can help communicate aspects about the domain such as the configuration of artefacts, how people move around the setting, and where particular tools and technologies are placed. It seems unnecessary in these cases to provide copious amounts of fieldwork notes to communicate these aspects.

Moreover, video and interaction analysis may have a role to play in various phases of the system design process. In requirements, such analyses would be relevant in the generation of scenarios, or providing instances that engineers can reflect upon. Video fragments and the accompanying analyses may also be used in other processes. They may provide background information and a context to participants' local activities that may be drawn upon in broader design methods such as IBM's Joint Application Design (JAD) and Soft Systems Methodology (SSM) (Checkland, 1981). Requirements engineers needing to make trade offs between various requirements and provide justifications for their choices can draw upon video data to assist in and support their choice. In the design phase, there may be further choices regarding, for example, the layout and ordering of components on a screen. The analyses and video materials can provide resources for designers to draw upon in this respect also. There may be occasions within the design phase where it may be relevant to ascertain if a particular feature has a potential impact on work practice. Re-scrutinising video fragments and the corresponding analysis may assist designers with this information. Utilising video can assist in revealing and understanding the sensitivities of work practice. But it may also be that the sensitivities may help requirements engineers by providing a starting point for their analysis of the work domain, allowing them to configure that data and view the video fragments in certain ways as the analysis progresses. There may be a systematic process that designers can go through, starting from the initial analysis - possibly supported by modelling as discussed in Chapter 6 - to reason about possible consequences of the current designs of systems for future work practice. Such an approach is considered in Chapter 8.

## 7.5 Summary

We have considered ways in which the issues that emerged from the previous modelling exercise can be used in the requirements and design process. These issues that were drawn upon in the workplace analysis have been grouped into certain key sensitivities. These sensitivities are designed to provide an alternative means of communicating tacit and interactional practices to requirements engineers, either through the modelling process or in reflecting on the critical analysis and observations. By adopting such an approach we are attempting to preserve the analytic orientation through which these observations were derived. It is a sensitivity

to particular aspects that we argue is critical for informing system design appropriately and, thus, we attempt to provide access to the orientation as well as to the particular features to designers.

We illustrate through the use of two case studies of the design and deployment of technology, how these critical sensitivities may be of relevance to requirements analysis. These case studies provide the means to consider the potential transformations to work practice through technological intervention, and we illustrate how these sensitivities may be used in practice with respect to two technologies to support the work of traders. We have also considered the consequences of failing to take account of the local context through which activities are produced and recognised.

Further analytic resources have been outlined that have been utilised in other related workplace studies, and we have considered how these may be relevant in the analyses of various other domains and in the design of other kinds of technologies. We do not wish to suggest that these sensitivities should be seen as guidelines or a part of a framework for design. Rather we wish to provide a means for designers to have access to detailed work practices and domains difficult to make available through text or fieldwork. Utilising video fragments with the accompanying analyses provides a means for designers to see the ways in which actions are produced and made relevant for others in a setting, and how they are recognised and acted upon by others. The video fragments and accompanying analyses can be re-scrutinised at any point in the system development process, particularly at the design phase where certain design decisions may be assessed in the light of their potential impact on work practices.

We conclude with the suggestion that these sensitivities potentially provide a means for designers to draw upon when reasoning about the consequences of different technological designs on future work practice. This possibility is discussed further in Chapter 8.

# Chapter 8

## Future Research issues

### 8.1 Introduction

A major concern for both system design and workplace studies research has been how to move from an ethnographic study, that is essentially descriptive in nature, to making prescriptions about technological innovation and intervention in organisational settings. In general, workplace studies produce descriptions of the rich interrelationships between work and technology. These descriptions, and the techniques utilised in their production, are potentially usable by the requirements engineer to understand existing domains through their technological and organisational elements. The requirements engineer's analysis of technological structure is paramount to the requirements specification and, consequently, many techniques are currently available to support the engineer in this activity. However, workplace studies do not lay emphasis on describing technological structure.

Consequently, current research is focused on how to present and communicate the results of ethnographic studies to software engineers in order to inform the design process. Of course, to thoroughly address the question of how these studies can inform system design requires a study of the practices of system designers which is beyond the scope of this thesis. Nevertheless, there are various ways in which researchers have gone about 'bridging the gap' between social sciences' analyses and the design of computer systems. In Chapter 2 the discussion was of research that described the interaction between ethnographers and software designers in terms of 'a questions and answers approach', attempting in the process to locate the boundaries of the ethnographer's activities and concerns (Randall et al., 1994). The presentation of ethnographic material has also been considered in terms of viewpoints such as the context of the setting, views of work and work flow, and has been incorporated in a general tool for designers (Hughes, et al., 2000). Participatory design techniques attempt to bring users into the process of design, providing a framework to develop

aspects of technology themselves through visualisation tools. More recently, Pycock et al. (1998) consider current work practice and the envisionment of future work practices through the use of virtual reality technologies.

The bridge between naturalistic studies and system design has been perceived as a relationship between two distinct disciplines; two areas of research with different skills and quite different concerns, motivations and perspectives. A questions and answers approach, for example, characterises one view of such a relationship, where social scientists may go back into a domain to investigate issues further that arise from system analysts' questioning of the analyses of the setting. However, there are certain difficulties with such a view of this relationship. The process through which the relationship converges on particular issues may be long and drawn out. For example, initial fieldwork in a domain could take at least three months, whereupon a set of preliminary issues are developed for requirements analysts. These issues may then be reflected back to the social scientists for further investigation in the domain. Such a process may be viewed as too long in terms of the time constraints under which many systems are developed.

A further view of the bridge between the two disciplines of social and computer science lies with respect to their different skills and tends to rely on perhaps participants from only one discipline conducting the field study and analysis. Adopting this view from the outset, social scientists could be provided with a set of technological issues on which to focus that would drive their fieldwork and analyses. Conversely, a method from the social sciences could be developed for system designers to assist in analysing the domain during the requirements phase.

However, ethnography is often characterised as something of a 'black box', it being unclear what skills and practices social scientists utilise in order to develop an analysis. For system designers, the process of arriving at requirements from naturalistic analyses can be equally vague – involving what appears to be intuitive or creative work. The view of the relationship between system designers and ethnographers may then be characterised as one of 'communication'; the analysis passes between the two disciplines and each does their own work on it. Certainly, designers may not necessarily have an appropriate analytic framework from which to scrutinise the analyses they receive from social scientists.

It may indeed be possible to map aspects of the fieldwork into a structured framework or model, but the consequences of these types of mapping for actually producing requirements is still problematic. In this respect, it may be useful to consider if there is a more symmetrical relationship between the two disciplines; one that involves being able to examine the consequences of particular social scientific analyses and their relationship to various choices to be made regarding what a potential technology is to do, and how it might transform the practices of participants

in that setting. Rather than concentrating on the particular skills of these two disciplines, it may be that attention should be placed on the activities that have to be performed in order to reach a technologically relevant set of requirements from naturalistic analysis (Shapiro, 1994). Thus, consideration may be given to the activities that need to be undertaken, the ways in which these activities could be organised and how they may be made relevant for others in the process. It is this approach that we discuss in Section 8.3 of this chapter.

Other research conceives of the relationship between system design and naturalistic analyses in different ways. For example, some researchers doing a case-by-case approach attempt to inform the conceptions underpinning system design; conceptions such as ‘task’, ‘interaction’ and ‘group’. In these studies the conception of ‘activity’ is significant and forms the foundations for analyses. For this research, it is important to infuse the process of system requirements and design with the analytic orientation on which the naturalistic analysis is based. The consequence of this being to point to issues regarding the training of individuals involved in system design to be sensitive to these concerns.

A very different and radical approach to the way the relationship between system and social science is conceived is concerned with providing computer scientists with tools where the infrastructure allows for extremely collaborative and flexible systems. This research is being developed by Dourish and Button (Dourish and Button, 1998) and is characterised by them as Technomethodology. Such an approach calls for a fundamental re-thinking about the software infrastructures necessary for developing computer systems and is discussed in detail in Section 8.2. We briefly suggest and explore an alternative way in which naturalistic analysis could be related to system design activities in Section 8.3, based on our investigation into modelling. We discuss how issues raised in Chapter 6, modelling interactional resources, and Chapter 7, sensitivities for system design, may be used together to inform the requirements phase and how they may be developed to ‘fit’ more generally into the process of system design as part of future research work.

## 8.2 Technomethodology

Technomethodology (Dourish and Button, 1998) provides a radical alternative to previous efforts of characterising the relationship between naturalistic studies and system design. Rather than viewing the relationship in terms of communication or looking at implications for requirements through a case-by-case approach, technomethodology attempts to be more foundational by focusing on the technological infrastructure underlying the applications developed for users. Using a file copying scenario to illustrate their work, Dourish and Button discuss various ways

of copying files using an infrastructure that allows for different ways of achieving similar actions. When a user copies a file to a folder, there is no distinction at the interface level between copying to a local or a remote folder; whichever is being attempted looks the same to the user. This has certain consequences. Normally, the user receives some feedback regarding the progress of the copying as it happens, for example, a ‘percentage-done bar’ that indicates how much of the copying has been done. However, if the user is copying to a folder on a remote system, and the copying fails perhaps because the network breaks down, as there is no relationship between what is represented to the user at the interface and the system’s behaviour, there are few resources available to the user to make sense of what is happening and what course of action to take. These resources: the differences between local and remote folders; the difference between local and remote copy operations; and the consequences of these differences – all these are inaccessible. Instead, the system offers an abstraction of these resources in the form of a folder.

Dourish and Button argue that by opening up such system abstractions that are normal practice within system design, and revealing some of the mechanisms that lie behind the system, ‘more translucent’ interfaces could provide a means for the user to understand the system’s behaviour in the context in which the system’s behaviour is interacting with the user. This might contrast with typical situations, where users resort to manuals, that Dourish and Button say lie outside the circumstances of the system’s activity. Therefore, they argue for a model of this interaction that could provide an account that gives users a way to understand what copying means as it is actually happening on specific copying occasions. The account then should not be seen as an explanation, but a resource for users to make sense of what is happening at the interface. This is important from an ethnomethodological point of view, in that individuals find within the circumstances of an action the means to render that action intelligible. Thus, in conceiving of the relationship between social science and system design, Dourish and Button draw upon a major issue of ethnomethodology, namely, accountability. That is to say, that the ways in which social conduct is organised provides resources for others to recognise and render that conduct intelligible. This is achieved within the production of the conduct itself (reflexivity) rather than within any framework of ‘social meanings’.

So, the organisation of action, within specific (and innumerable) circumstances of its production, furnishes to others the means to recognise, observe and report on it.

(Dourish and Button, 1998, p. 401)

This research certainly relates one aspect of ethnomethodology, accountability, to system design in a way that seems useful in this scenario. However, although the system in this case is providing an account to users in the course of the ongoing activity, it is unclear how far this fully captures the characterisation of accountability in ethnomethodology, despite its claim. Nor is it clear how generic such an approach

might be in terms of reflecting the other tenets of ethnomethodology, even if it were possible to build in other properties like indexicality into the system infrastructure. Though it is important that a system is able to support such features and designers may need to be sensitive to these tenets, it is not yet clear which features may be required, how they are related, or indeed that they are even needed at the infrastructure level.

Nonetheless, this is a radical view of the ways in which the relationship between the social sciences and system design may be conceived, one which borrows largely from reflective programming as described by Cantwell Smith (Cantwell Smith, 1998), and raises some interesting issues for future research.

Though the tools and approaches described earlier may be useful for presenting ethnographic observations, a critical issue for research lies in describing technologically relevant requirements that reflect and are empirically supported by naturalistic analyses. Thus we might consider ways in which investigations into modelling socio-interactional resources described in Chapter 6 may be extended.

## 8.3 Further Investigations into Modelling

The proposal for research put forward in this section describes an approach that attempts to improve the ways in which social ethnographic studies can inform system design. By increasing the possibilities for designers to gain access to and deliberately attend to issues raised from ethnographic analyses, we hope to realise the opportunities afforded by these analyses to produce more sensitive designs for supporting collaborative work, thereby improving the results of the system design process. Thus, we attempt to map out a programme of research by describing a proposal for further investigations into modelling ethnographic analyses for the purposes of system design.

In Chapter 6, we discussed various studies that have investigated the possibility of using modelling techniques to communicate social and organisational activities to system designers. In this section, we determine what tasks might be required to relate modelling practices to an ethnographically informed design process. It is not our intention to outline a new design method; rather do we wish to give some sense of what the practices of modelling - particularly those related to CSP - can offer to the design process, most specifically through the opportunities provided for reasoning about the impact of technological choices on organisational activities. Throughout the process of system design, various business concerns need to be addressed, such as the feasibility of particular technological solutions and the envisaged impact on work practices. We outline four main tasks to be accomplished that seem to make the best use of the modelling approach for addressing those concerns. In order to provide a

better sense of what is involved in these tasks, we draw not only from the work in the thesis, but also make use of a motivating example to illustrate the approach. The process has been divided into tasks in order to be clear about the distinctive activities that would be necessary. However, in practice, we expect these tasks to be interrelated, and highly iterative, yet broadly developmental.

In order to reason about a model, it is necessary to allow designers to manipulate what has been defined in the model, to explore the consequences of these definitions. As described in Chapter 6, CSP not only appears to provide an appropriate structure for reflecting concurrent and collaborative activities, but also a means of reasoning about them. As it is primarily concerned with the representation of concurrent activities, there are a range of resources embedded within CSP for describing coordinated action. Moreover, the traces inherent in CSP are not merely records of the process, but resources for reasoning about the processes defined. The traces of a CSP model allow for the exploration of the consequences of different combinations of processes.

In the light of the issues discussed above, we consider in this section the analytic procedures and processes that may need to be undertaken to allow requirements analysts to reason about the consequences of particular technological choices, and to reflect back to analyses of the domain early on in the process of system design. We suggest four main tasks that analysts might need to carry out: 1) conducting an ethnomethodological analysis of the activity where the focus of the analysis is motivated by technological or business concerns; 2) rendering aspects of this analysis in notational form where the consideration of what constitutes 'relevant' is driven by the needs of design in an iterative process. Thus, in the process of modelling certain features of social conduct, designers become aware of additional information that is needed from the analysis that then guides further investigation of the setting; 3) building models of social conduct and proposed technology, where analysts begin to reason about future socio-interactional and technological resources in a hypothetical setting and build models of the social activities and proposed technologies; 4) manipulating the model to reach particular formal consequences and discussing these consequences in relation to the video material and analysis.

We emphasise again that these tasks should be viewed as activities that, in practice, would be carried out in an iterative manner. In addition, at any point in such a process, various contingencies could occur that would suggest the technology or business case under consideration to be either not worth developing or that a new direction might be more fruitful to pursue.

Previous attempts to incorporate ethnographic analyses into the development process, drawing upon the particular skills of each discipline, have tended to assume that ethnographers provide analyses of social settings that are then passed onto system

designers to do the system development work. However, this may not necessarily be the case. Many of the tasks in this process should be achieved collaboratively between ethnographers and system designers.

In the following sections we describe these activities in more detail, providing examples to illustrate the types of practices that analysts would need to carry out.

### **8.3.1. Ethnomethodological analysis of activity**

Throughout this thesis, we have attempted to point to the potential value of ethnographic analyses utilising an ethnomethodological orientation for informing system design. The first activity is to carry out such an analysis. The orientation is concerned with: investigating routine activities in the setting; analysing the tacit practices the individuals rely upon to achieve such mundane practices; and revealing the interpretative and organisational competencies of members in producing and recognising particular activities. The analysis does not attempt to capture everything about the setting under investigation, but rather is motivated by technological and business concerns from the outset that provide a particular focus for the study of the social setting.

As outlined in Chapter 3, most likely the analysis will proceed inductively, with an initial exploration of the video data, where analysts collect ‘candidate’ fragments of what might seem to be related phenomena. Some more detailed analyses of vocal, visual and bodily conduct may also be undertaken on those fragments. Analysts can then produce a description of how an activity is organised that provides for the ways in which it is systematically achieved by members at particular times. The critical problem of what is relevant for analysis is addressed in this approach through analyses that examine the ways in which members produce and display their understanding of each other’s conduct in their subsequent activities. The aim of using such an approach is to remain sensitive to the orientations of members themselves.

Within the social sciences, an ethnomethodological study aims to develop a thorough analysis of particular phenomena in social settings. However, for the purposes of system design, a more iterative approach seems necessary in order to raise concerns related to technology early on in this task. Our concern here is to raise issues of potential relevance for design, rather than develop thorough analyses of phenomena. Where relevant, this may occur later in the process. The initial sets of issues could be related to a range of technological concerns in an organisation. For example, issues may relate to the design of specific technologies to support activities in the dealing room, like voice recognition systems. To support deal capture, such systems would extract the components of the deal from dealers’ telephone interactions and generate a computerised record of the deal. Alternatively, these issues may be related to the feasibility of using particular technologies to address a perceived problem in a domain for instance ‘noise’, where there may be concerns that

information of importance is being missed by the relevant participants. And finally, the initial set of issues might be concerned with specific technologies to transform the activity - for example, distributing the work of dealing and combining the work on one trading floor with other 'remote' dealing rooms.

We shall focus on the last of these technological concerns to distinguish the set of issues from those considered earlier in this thesis related to voice recognition systems. In addition, the scenario is also typical of developments in CSCW and in business in general, where consideration is given to how best to link different geographical spaces. The distributed trading room is intended to provide an illustration of why modelling may be relevant to the process.

With this example in mind, this task should produce a set of issues that are relevant where designers are considering distributing the broadcasts that occur in dealing rooms, such that a dealer communicating information in London may be heard in New York. So, for example, an ethnomethodological analysis focused on issues related to broadcasts in the co-present environment would suggest that:

- Outlouds are coordinated with the activities of those who receive them. They are produced in relation to the activities of others in the dealing room, not just broadcast irrespective of what is happening in the setting;
- Recipients are sensitive to particular outlouds and not to others;
- Dealers are seen to be able to relate their conduct to the conduct of others, so the relationship between one trader's activity to an outloud can be inferred by other members of the dealing room;
- In their production, outlouds are coordinated with and related to other outlouds.

There are various reasons why such issues are interesting and consequential for later tasks. First, they point to interactional practices that may be transformed if a technology is introduced to distribute co-present activities. This is discussed further in later sections. The issues also make explicit certain tacit activities that may later form the focus of a design study to note the impact on such practices with the introduction of the new technology. The ways in which activities are coordinated in the setting are suggested by these issues, and they also point to certain publicly available features. Finally, the video fragments and corresponding analyses act as illustrations of the phenomena and describe how they may be relevant for design.

### **8.3.2.        Render aspects in notational form laying out structure of activities**

In the next part of the process, aspects of social conduct are selected from the analysis of the organisational setting, and are then modelled in CSP notation. As we do not expect to capture all possible conduct and information about the setting for the analysis, neither do we expect to produce a complete model of the work of the setting under investigation. The selection of what is relevant is driven by the needs of design in an iterative process, whereby aspects of participants' conduct is modelled and, in so

doing, reveals additional areas of analytic concern to be investigated. This iterative approach guides further analysis of the setting. In this respect, the ethnographic analysis is not simply passed onto designers in this approach, nor discussed after the analysis has been achieved. Rather, from the outset, the initial analysis raises a set of issues that may then be modelled through collaboration between ethnographers and designers, and areas for further ethnographic investigation revealed.

The model produced here may be quite simple, but is achieved in order to check the understanding of both designers and ethnographers of the phenomena - in this case, outlouds. Thus, designers may model what has been analysed and observed in the video fragments as a set of CSP processes in parallel. For example, at the top level,

$$P = \text{MARKETMAKER} \parallel \text{DEAL} \parallel \text{OUTLOUD} \parallel \text{SALESMAN}$$

Some of these processes represent what people do in the setting, e.g. market maker and salesman, or they represent objects in the domain, e.g. deal. Other processes represent the socio-interactional resources, e.g. outlouds. This provides a model of outlouds without technological assistance. A goal of the model designer might be to ensure that each of the scenarios in the video fragments can be represented by a trace of the CSP processes.

Modelling in this way would raise further issues of concern such as, which aspects of the dealers' activities are made public and which are kept private, what the components of an outloud are and when made, whether they are acknowledged by others and, if so, how and in what ways they are designed for others.

These issues provide a focus for further ethnographic investigation into the ways in which activities are coordinated and how they are sequentially produced. Here it may be necessary to consider doing a more detailed sequential analysis to reveal how the features of outlouds are coordinated. Analysts may draw upon resources from conversation and interaction analysis, particularly the notion of sequentiality, to inform the model. This issue of sequentiality can then be tied into a model of concurrent processes, not in an effort to model conversation *per se*, but to increase understanding of what is of relevance to participants in interactions. From examining a few scenarios where one action seems to produce another, possibly emerging from more than one individual, analysts may endeavour to establish in what ways an action is tied to previous ones and how to represent these in a model of concurrent processes.

It may not be necessary to model all possible features of outlouds. Designers only need to produce a model that is good enough to work for a certain set of scenarios in the video fragments. Thus, although the model is flawed, it works in some cases and thereby provides some features to begin to reason with. In addition, events need to be defined clearly and it is important that those involved agree on what these events

mean. The video fragments may act as a resource for designers to test their understanding of the definition of events.

Even at this early stage, the modelling may suggest issues of concern for designers that have not been raised by the initial ethnographic observations. For example, it is possible that, on analysing traces, various orderings may be suggested that have not been considered or more unusual sequences of events may arise that need further investigation.

### **8.3.3. Build models of social conduct and proposed technology**

The focus of analysis shifts from looking at the domain in question to consideration of the various technological concerns of the organisation or business. Through discussions with organisational members, designers may arrive at a set of technological options to provide support for some of the key issues of social conduct identified in previous tasks. Further analysis of these aspects of social conduct may be required in the light of viewing them in relation to the different technological options. The level of granularity for analysis should resonate with the proposed technology. It may be the case that designers are just given one technology to consider in relation to the workplace activities; alternatively, they may have a range of technological choices. Returning to our motivating example for supporting remote traders, the technological features proposed may be intended to support distributed outlouds in such a way that colleagues in remote offices could both produce them for others and hear them from others. Different technological solutions might suggest alternative ways in which broadcasts could be achieved. By interrogating the sequential analysis and model, it may be possible to consider different technological solutions in relation to aspects of producing and recognising outlouds and how these might be accomplished.

Drawing on the details of how outlouds are achieved in the current setting, designers can consider how an individual could coordinate the production of the outloud with activities in the remote setting. Outlouds in New York would need to be sensitive to the setting, activities, and sounds in London. For instance, the broadcasting comes from another setting, and it may be decided that the announcement is to be made public to the relevant participants through an automated announcement system. The information contained in the outloud might be provided in audio, video, textual or graphical form, or some mixture of these, and could be automatically produced or initiated by others in a remote domain. When deliberating the technological features needed to support these broadcasts, designers may have to consider what may be needed at the recipient's end to make the outloud relevant and apparent. Furthermore, they may need to determine what other features are necessary and relevant if the outloud is achieved through audio, and how these features need to be supported. Thus, drawing upon the models produced in the previous task, designers

may consider what aspects of this outloud are permanent or transitory, and what other items the outloud might coordinate or overlap with - for example, noise or talk in the dealing room or other visual items on a screen. In this case it would be important to consider the different ways in which the outloud may be made public and how it may be produced in parallel with other activities.

Keeping the focus on the motivating example, designers could envisage the refinement of the models of outlouds in relation to three different technologies; for example, a restrictive technology that imposes constraints on when a dealer can make a broadcast in a remote domain, a coordinating technology that provides access to dealers in the remote setting of the other domain so they can coordinate their own activities, and an automated technology that allows dealers to make outlouds but then automatically sequences the broadcast in the other domain. Designers may have various resources from which to ascertain the possible behaviour of technologies in relation to the way they may be used in the hypothetical setting. For example, in the restrictive setting, it may be that a dealer presses a button in order to make a broadcast, but can only do so when the button is lit. When the button is not lit, other dealers are making broadcasts and therefore this outloud cannot be made until they have stopped.

Features of the technological options may be modelled where designers consider what the CSP processes and corresponding traces might be. In our remote trading example, when combining models of technological features with social conduct, designers may consider, for instance, what might happen when a remote trader is trying to operate a particular system so that a reasonable set of activities occur. Designers might examine the different ways information from outlouds can be made publicly accessible, and the different sets of resources that should be present. To do this, they might consider the model of outlouds as they are achieved at present, in relation to dealing and other activities in the dealing room. At this point, designers may need to reflect upon what components, if any, of outlouds are necessary to support, what their granularity is, and how they are voiced and parsed. In CSP this is done in relation to modelling the processes of different types of technological support and different media.

Continuing with our motivating example, designers might now build different models of the various technological features to support distributed outlouds. A new CSP process may be defined that models the technologically assisted outloud. For example,

#### DISTRIBUTEDOUTLOUD

Where the process has an event `pushButton` in its alphabet, representing the pushing of a button that enables a dealer to distribute their outloud as suggested in the case of the restrictive technology referred to earlier.

#### 8.3.4. Manipulate model and discuss consequences in relation to video analysis

This final task brings together models of technological features built previously and user activities, in order to reason about the consequences of different combinations of processes. From combining the processes and examining the traces, the designer should be able to evaluate what the consequences of different technological features might be for social conduct.

A process may have many traces. Given that the approach has modelled aspects of the current environment, the sets of video observations, as representative clips, should have a corresponding representation in the traces. It will be those traces that may be used to plot a path through the new model.

Returning to our example, we have modelled the system we originally observed through the video fragments as

$$P = \text{MARKETMAKER} \parallel \text{DEAL} \parallel \text{OUTLOUD} \parallel \text{SALESMAN}$$

We now replace the existing outloud process with the new process for distributed outlouds

$$Q = \text{MARKETMAKER} \parallel \text{DEAL} \parallel \text{DISTRIBUTEDOUTLOUD} \parallel \text{SALESMAN}$$

If  $T_1$  is a trace of  $P$ , then it should be straightforward to check whether  $T_1$  is also a trace of  $Q$ . If it is, and the relevant events have been modelled, then it would appear that the technology to distribute outlouds would have little impact on the scenario represented by  $T_1$ . However, it may be necessary to modify the other processes in order to allow the processes to evolve in a way that may not be identical to  $T_1$  but is similar. Thus, in our example of the restrictive automated technology for distributing outlouds, if the `DISTRIBUTEDOUTLOUD` process has an event `pushButton` in its alphabet, the designer could follow the trace of the process up to the point at which the process could not evolve in the desired direction without the button on the system being pressed. At least one of the processes modelling a dealer will also need to participate in that `pushButton` event. The designer will need to modify the behaviour of the dealer process to get the trace to achieve the same goal. Thus, it would seem that the technological features proposed for distributing outlouds in this case may have a specific impact on the domain. Dealers may be required to do at least one extra activity, pressing a button, in order to do an outloud.

The traces that are produced when manipulating a CSP model allow for exploration of the consequences of the different combinations of processes. The analysis in the above example just looks at one evolution path of the process. But there are also opportunities to analyse processes for deadlock that would indicate a problem with design that might also be resolved by modifying other processes. In addition, other traces may be produced that have not been drawn from the observed

setting and may be interesting for analysis. Designers assessing these traces may decide that the set of events produced do not make sense and therefore the process model may be incorrect. Alternatively, a set of events may never have been seen before, but nonetheless invoke an interest for design and therefore need to be considered.

The approach described above provides a novel way for designers to consider the details of work practices, manipulate models, and reason about the consequences of the manipulations in terms of their impact on the work setting.

### **8.3.5. Discussion**

We have outlined an approach for incorporating modelling of ethnographic analyses into the design process. The approach does not consist of a set of discrete phases, rather is it one in which we have described the types of tasks that would need to be achieved. Modelling and ethnographic analysis are interweaved, the modelling suggesting areas for further analysis and the analysis refining the process models. This iteration continues up to the point at which designers in conjunction with analysts and organisational members discuss different technological options, model features of these and then reason about the consequences. There is an attempt to match a gloss of a model with a gloss of analyses of social conduct. Though an analysis could go into very fine detail, this may not be necessary. Similarly, designers may be able to model quite complex features of social interaction, but this may also not be necessary for considering the consequences of different technological choices. For certain cases more detailed analysis may be needed, where there is an interest in examining the sequencing of activities or how one activity relates to another. The talk that is produced by individuals acts as a powerful resource for analysis of such activities. But in other cases, such as visual or bodily conduct, a strong warrant of the sequential nature of the activity may not be possible. In the case of analysing talk, though it may not be necessary to go into such detail, there may not be a straightforward classification of talk into turns and turn components. Such features of social conduct may be difficult to model.

In general, social resources rely upon common sense practices that may not be delineated. The modelling of such common sense practices in detail may yet prove to be intractable and, if this is the case, avenues such as improving the sensitivities of requirements engineers as discussed in Chapter 7 may be the best way to proceed. However, it is interesting to note that in the approach described in this section, the sensitivities have informed the development of both the ethnomethodological analysis and the progress of the models. However, just as a sequential analysis may be limited when trying to understand visual conduct, the modelling of common sense resources may be problematic. At the very least, the attempt to model such resources, may

increase our understanding of the ways in which they are intractable, rather than accepting that they are as a set of *a priori* statements.

Overall, the prospects of utilising modelling languages are interesting enough to warrant investigation. The approach described in this section provides a way of reasoning about the move from a socio-interactional resource to a technological one. If the social resources can be modelled in such a way that allows manipulation, then designers have a way of formally comparing what happens when a technological resource replaces the social one. The approach may provide a more systematic way for designers to reason about interactional resources and, thus, they may be able to assess whether one type of technological configuration will require certain interactional configurations. The value of such an approach lies in providing designers with some resources to support certain judgements about design decisions. Even in cases where carrying out parts of the process may be difficult, the approach may still yield resources to allow designers to make statements about technological interventions.

## 8.4 Conclusion

An ethnomethodological orientation to analysing social and collaborative conduct provides access to requirements analysts to the details of work practices in organisations. It is a valuable way of providing some awareness of work practices from the participants' own understanding. However, naturalistic studies of this kind tend to be rich and detailed and descriptive in nature. A critical problem, therefore, has emerged regarding how to move from the details of work practice to the consequences for requirements and, ultimately, the design of the system to support or transform these work practices. In an attempt to support this activity in a more systematic or analytic manner, we have made tentative proposals that suggest modelling as a way forward. If a modelling technique could facilitate the consideration of particular aspects of the setting, then it may be that the modelling exercise would not only be a resource for communication to others in the development process or for providing a conduit to an eventual design. Modelling sensitivities that are revealed from the video data and interaction analysis could be a way to explore the consequences of an emerging requirements analysis so that, through it, particular aspects could be considered in more detail in the fieldwork. A preliminary analysis of the collaborative conduct of participants, how they are aware of each other's activities, how a particular tool or artefact figures in an activity or how an activity is left open or closed, as examples, could provide the resources for an initial model which when analysed could raise issues for further investigation and analysis. This approach is both sensitive to the ethnomethodological orientation and reflects the practical concerns of system development.

Future research might then focus on collaborative exercises between social and computer scientists, where sensitivities derived from an ethnomethodological analysis of a setting could be rendered in CSP notation, laying out the organisation of the work and conduct of participants. So, a preliminary analysis of the collaborative conduct of participants in a setting, how they are aware of each other's activities, or how an activity is initiated, left open or closed, may provide the resources for an initial model. When this model is scrutinised by researchers, it may then raise issues for further fieldwork or analysis. The model acts as a potential framework for the interrogation of data, allowing researchers to reach into the materials and analysis for details regarding the way particular activities in the setting under investigation are achieved.

The emerging schematic model of work may then be mapped onto a model of technological features that have either been detailed in a requirements specification or are possible choices being proposed as the model is being developed. Manipulating the model may allow analysts to detect any inconsistencies or to reason about different combinations of activities. These may be discussed in relation to the video material and analysis, and may allow analysts to come to certain formal conclusions regarding either particular features of a proposed system or transformations to work practice. Though the modelling of socio-interactional conduct may prove intractable, the opportunities afforded by such an approach are worthy of investigation – to provide a more systematic way for designers to reason about interactional resources and thus, to be able to assess whether one type of technological arrangement will require certain interactional configurations.

# Appendix

## Transcription Notation for Talk and Visual Conduct

The conventions used to show such features in transcripts as loud or soft speech, pauses, synchronisation of speech by different people, and so on, are described below, followed by examples of transcriptions to illustrate how they are used in practice (notation developed by Gail Jefferson and taken from Atkinson and Heritage 1984).

### 1. Simultaneous utterances

When two speakers start talking at the same time, a left square bracket '[' is used to denote synchronisation:

J: I thought he said "Green is best"  
(0.9)

J: [or was it just "Green is good"?

G: [He didn't say that.

### 2. Overlapping utterances

When two speakers do not start talking simultaneously, the point at which an ongoing utterance is joined by another is marked with a single left-hand bracket, linking an ongoing with an overlapping utterance at the point where overlap begins:

T: I used to smoke [a lot

B: [He thinks he's real tough

### 3. Contiguous utterances

When there is no interval between adjacent utterances, the second being latched immediately to the first (without overlapping it), the utterances are linked together with equal signs:

J: I used to smoke a lot =  
B: =He thinks he's real tough

### 4. Intervals between utterances

When intervals in a stream of talk appear, they are timed in tenths of a second and inserted within parentheses, either within an utterance:

When I was (0.6) oh nine or ten

or between utterances

H: Step right up  
(1.3)  
H: I said step right up  
(0.8)  
J: Are you talking to me

### 5. Characteristics of speech delivery

Punctuation may be used to capture characteristics of speech delivery. For example, extensions of sounds or syllables are indicated by placing a colon (:) after the relevant letter:

R: What ha:ppened to you

More colons prolong the stretch:

T: I'm so::: sorry re:::ally I am.

Other punctuation marks are used as follows:

- . A period indicates a stopping fall in tone, not necessarily the end of a sentence.
- , A comma indicates a continuing intonation.
- ? A question mark indicates a rising inflection.
- ! An exclamation mark indicates an animated tone.
- A single dash indicates a halting cut-off

Marked rising or falling shifts in intonation are indicated by upward and downward pointing arrows immediately prior to the rise or fall:

T: I am however (0.2) very ↑fortunate (0.4) in having (0.6) a  
↑mar:vlous dep↓uty

Emphasis is indicated by underlining:

A: It happens to be mine



The gaze of the speaker is marked above the utterance; that of the recipient(s) is marked below it.

A line indicates that the party so marked is gazing toward the other.

The absence of a line shows that the party is not gazing toward the other.

A dot or series of dots marks the movement that brings gaze to another.

A capital X connected to a specific point in the talk with a bracket shows the place where gaze reaches the other.

Commas mark a movement withdrawing gaze.

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