

DISTRIBUTED COGNITION AND COMPUTER
SUPPORTED COLLABORATIVE DESIGN: THE
ORGANISATION OF WORK IN CONSTRUCTION
ENGINEERING

A Thesis submitted for the degree of Doctor of Philosophy

by

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Abstract

The intellectual contribution of this thesis lies within the area of computer supported co-operative work (CSCW), and more specifically, computer supported co-operative design (CSCD). CSCW is concerned with the development of information systems and technological support for multi-participant work activities. Research into CSCW seeks to understand how people and organisations interact with one another, and to integrate this understanding with the development of computer based tools to support real world settings.

Much of the technology developed to support the work of designers has been developed to aid individuals working alone, with tools like computer aided drafting (CAD), scheduling, and database software. The growth of interest in 'groupware' has led many technology developers to adapt these design tools for use in group situations. However, joint activities are different from those performed alone, and organisational structures can both interfere with, and supplement co-operative work practices in a way that the current technologies cannot provide support for. To develop effective group design tools, we need to understand more about collaborative processes in design.

This thesis draws from the theoretical underpinning of cognitive science and the methods of anthropology and sociology, in an interdisciplinary study of design performance in the construction industry. Fieldwork is used as a method of qualitative data collection and this is examined within the analytic framework of distributed cognition. The results of this analysis provide a useful and usable description of the work of design that technology developers can use to support collaborative design work. In line with the methods of distributed cognition, the activities observed in the workplace studies are examined in terms of their *processes* and *representations*. The resources that were available to the design participants are made explicit, as are their situation-specific work patterns.

Two case studies of design are examined. The first of these describes design work in a civil engineering project, which involves a number of different design activities. The second describes the work of consulting engineers in building design, focusing on a more limited design role, which is used to back up and supplement areas of the first study that were understood to be particularly relevant.

The findings of the study demonstrate how design processes operate simultaneously at personal, organisational and inter-organisational levels. The distinction between the formal, organisational procedures, and the informal, social processes that compliment them is examined to show how these are interrelated in the performance of the design task and their importance to the mechanisms used to co-ordinate actions. The findings of the study have implications for the development of novel technologies to augment the engineering design process, and have already been used in the development of assistive design technologies.

The thesis demonstrates that the framework of distributed cognition can be used in the analysis of cognition within a setting, involving multiple individuals, in concert with 'natural' and 'artificial' artefacts. The thesis makes clear a number of processes in design that can only be examined from a perspective which includes the social dimensions of work. The methods of study focus on the resources in collaborative activities, whilst the analysis, structured in terms of the representations and processes of collaborative activity, shows that the method can be used effectively in the development of CSCW and CSCD technologies.

Keywords: *Collaborative Design, CSCW, Distributed Cognition, Engineering, Construction.*

Table of Contents

| | |
|---|-----------|
| CHAPTER 1 | |
| INTRODUCTION - THE ROAD AHEAD | 1 |
| 1.1 SETTING THE SCENE..... | 1 |
| 1.2 RESEARCH AIM AND OBJECTIVES..... | 9 |
| 1.3 SCOPE OF THE THESIS..... | 10 |
| 1.4 RELATED WORK | 10 |
| 1.5 STRUCTURE OF THE THESIS | 12 |
| | |
| CHAPTER 2 | |
| COMMUNICATION, CO-ORDINATION, AND COLLABORATION IN DESIGN | 14 |
| 2.1 FOUR ELEMENTS AND A THEME | 14 |
| 2.2 COLLABORATIVE DESIGN | 16 |
| 2.2.1 <i>The character of generic and engineering design</i> | 16 |
| 2.2.2 <i>Collaborating for design and designing for collaboration</i> | 18 |
| 2.2.3 <i>Collaborative design as a communication issue</i> | 21 |
| 2.2.4 <i>Mechanisms of collaboration - the 'objects of co-ordination'</i> | 22 |
| 2.2.5 <i>CSCW - collaboration and technology</i> | 24 |
| 2.3 COGNITION IN DESIGN..... | 26 |
| 2.3.1 <i>Design in the wild</i> | 26 |
| 2.3.2 <i>Moving out of the lab: the systems approach to task analysis</i> | 26 |
| 2.3.3 <i>Ecological, contextual and situated approaches to systems analysis</i> | 28 |
| 2.4 EXTENDING THE BOUNDARIES OF COGNITION | 30 |
| 2.4.1 <i>Theoretical approaches</i> | 30 |
| 2.4.2 <i>Activity theory</i> | 31 |
| 2.4.3 <i>Cognitive sociology and the ethnomethodological approach</i> | 32 |
| 2.4.4 <i>Situated cognition and distributed representations</i> | 34 |
| 2.5 COMPUTER SUPPORT FOR COLLABORATIVE DESIGN..... | 36 |
| 2.5.1 <i>Context, HCI and CSCW</i> | 36 |
| 2.5.2 <i>Designing artefacts for collaboration</i> | 37 |
| 2.5.3 <i>Collaboration, technology and theories of design</i> | 38 |
| 2.6 SUMMARY..... | 39 |
| | |
| CHAPTER 3 | |
| DISTRIBUTED COGNITION IN COLLABORATIVE SYSTEMS..... | 40 |
| 3.1 OVERVIEW | 40 |
| 3.2 COGNITION IN THE WORLD | 40 |
| 3.3 COGNITION AS A SOCIAL PHENOMENON..... | 42 |
| 3.3.1 <i>Definitions of cognition</i> | 42 |
| 3.3.2 <i>Cognition, representation and communication</i> | 43 |
| 3.4 DISTRIBUTING COGNITION | 45 |
| 3.4.1 <i>Rationale and aims of distributed cognition</i> | 45 |
| 3.4.2 <i>Division of labour</i> | 46 |
| 3.4.3 <i>Inside the cognitive system</i> | 48 |
| 3.4.4 <i>The unit of analysis</i> | 51 |
| 3.4.5 <i>The role of representations</i> | 52 |
| 3.5 RESEARCH METHODOLOGY | 54 |
| 3.5.1 <i>Methodological issues</i> | 54 |
| 3.5.2 <i>Research methodologies and cognitive science</i> | 54 |
| 3.5.3 <i>Developing a research methodology for distributed cognition</i> | 55 |
| 3.5.4 <i>Levels of description in information processing activity</i> | 56 |
| 3.5.5 <i>Data collection and distributed cognition</i> | 56 |
| 3.6 AN INTRODUCTION TO WORKPLACE STUDIES | 58 |
| 3.6.1 <i>Workplace studies and distributed cognition</i> | 58 |
| 3.6.2 <i>Ethnography - 'making work visible'</i> | 59 |
| 3.6.3 <i>The ecological basis of the ethnographic method</i> | 61 |
| 3.6.4 <i>Analysis of the cognitive ethnographic data</i> | 62 |
| 3.7 CONCLUSION..... | 63 |

| | |
|--|------------|
| CHAPTER 4 | |
| APPLYING DISTRIBUTED COGNITION TO DESIGN | 64 |
| 4.1 OVERVIEW | 64 |
| 4.2 DESIGN IN CONTEXT..... | 65 |
| 4.3 THE ORGANISATION OF DESIGN IN CONSTRUCTION..... | 66 |
| 4.3.1 <i>Navigation and construction</i> | 66 |
| 4.3.2 <i>The engineering process</i> | 69 |
| 4.3.3 <i>Participants in the design process</i> | 70 |
| 4.3.4 <i>A novel perspective on engineering design</i> | 71 |
| 4.3.5 <i>A cognitive architecture for engineering design systems</i> | 72 |
| 4.3.6 <i>The role and organisation of organisations</i> | 76 |
| 4.4 DATA, THEORY AND SYSTEMS DEVELOPMENT..... | 77 |
| 4.4.1 <i>Bridging the gap</i> | 77 |
| 4.4.2 <i>The role of theory in research</i> | 77 |
| 4.4.3 <i>Technology transfer and the function of the analyst</i> | 78 |
| 4.4.4 <i>From fieldwork to technology development</i> | 80 |
| 4.5 THE FRAMEWORK FOR ANALYSIS..... | 80 |
| 4.5.1 <i>Data collection in DC - methods and application</i> | 80 |
| 4.5.2 <i>Elements of analysis in engineering design</i> | 82 |
| 4.5.3 <i>An integrated framework for analysis</i> | 83 |
| 4.5.4 <i>The format of the field studies</i> | 85 |
| 4.6 CONCLUSION..... | 86 |
| | |
| CHAPTER 5 | |
| DATA COLLECTION - COLLABORATION IN CONSTRUCTION..... | 88 |
| 5.1 OVERVIEW | 88 |
| 5.2 STUDYING THE CO-ORDINATION OF DESIGN WORK | 88 |
| 5.2.1 <i>Background to the field studies</i> | 88 |
| 5.2.2 <i>Data collection</i> | 89 |
| 5.3 THE TASK - CONSTRUCTION WORK..... | 91 |
| 5.3.1 <i>Goals</i> | 91 |
| 5.3.2 <i>Resources</i> | 91 |
| 5.3.3 <i>Relationships</i> | 92 |
| 5.4 ORGANISATIONAL STRUCTURES..... | 96 |
| 5.4.1 <i>Phases of design</i> | 96 |
| 5.4.2 <i>Roles and responsibilities</i> | 97 |
| 5.5 TRANSFORMATIONAL WORK IN DESIGN..... | 99 |
| 5.5.1 <i>Inputs, outputs and transformational activity</i> | 99 |
| 5.5.2 <i>Computation and re-representation</i> | 100 |
| 5.5.3 <i>Bi-directional movement of representations</i> | 104 |
| 5.6 COLLABORATIVE WORK IN DESIGN | 105 |
| 5.6.1 <i>Communication and co-ordination</i> | 105 |
| 5.6.2 <i>Context and planning</i> | 108 |
| 5.6.3 <i>The allocation of tasks</i> | 111 |
| 5.7 SUMMARY..... | 113 |
| | |
| CHAPTER 6 | |
| SYNTHESIS - DISTRIBUTED COGNITION, DESIGN | |
| AND THE DEVELOPMENT OF TECHNOLOGY | 115 |
| 6.1 OVERVIEW | 115 |
| 6.2 ACTIVITIES INVOLVED IN ENGINEERING DESIGN..... | 116 |
| 6.2.1 <i>Design through and around artefacts</i> | 116 |
| 6.2.2 <i>Mechanisms of co-ordination</i> | 118 |
| 6.2.3 <i>Synopsis of engineering design activities</i> | 121 |
| 6.3 A DISTRIBUTED COGNITION OF ENGINEERING DESIGN..... | 122 |
| 6.3.1 <i>Communication, co-ordination and collaboration</i> | 122 |
| 6.3.2 <i>Distributed computation and collaboration</i> | 123 |
| 6.3.3 <i>The structure of informational resources</i> | 124 |
| 6.3.4 <i>The division of labour</i> | 125 |
| 6.3.5 <i>The role of context in organising behaviour</i> | 127 |
| 6.3.6 <i>A review of distributed cognition in engineering design</i> | 128 |
| 6.4 DEVELOPING COLLABORATIVE TECHNOLOGY FOR DESIGN..... | 132 |
| 6.4.1 <i>Technologies to support collaborative systems</i> | 132 |
| 6.4.2 <i>Supporting organisational and social processes</i> | 132 |

| | |
|--|-----|
| 6.4.3 Supporting organisational and inter-organisational activity..... | 134 |
| 6.4.4 Supporting the flow of design..... | 136 |
| 6.4.5 Developing a technical memory..... | 139 |
| 6.4.6 Co-ordinating spatially distributed collaboration..... | 140 |
| 6.4.7 Meetings support..... | 142 |
| 6.5 CONCLUSION..... | 143 |

CHAPTER 7

| | |
|---|------------|
| CONCLUSIONS AND ISSUES FOR FURTHER RESEARCH..... | 145 |
| 7.1 SUMMARY OF THE RESEARCH..... | 145 |
| 7.1.1 Contribution to knowledge..... | 145 |
| 7.1.2 Domain sensitive research findings..... | 146 |
| 7.1.3 An evaluation of the study..... | 149 |
| 7.2 ISSUES IN COLLABORATIVE DESIGN..... | 150 |
| 7.2.1 Expanding classical conceptions of design..... | 150 |
| 7.2.2 The media of design: representations and artefacts..... | 151 |
| 7.3 ISSUES ARISING FROM THE RESEARCH..... | 153 |
| 7.4 CONCLUSIONS DRAWN FROM THE RESEARCH..... | 154 |
| 7.5 FUTURE DIRECTIONS FOR RESEARCH..... | 156 |
| 7.6 ENDNOTE..... | 157 |

| | |
|-------------------------|------------|
| REFERENCES | 158 |
|-------------------------|------------|

APPENDIX A

| | |
|---|------------|
| FIELDWORK: DESIGN ACTIVITY IN THE WORKPLACE..... | 172 |
| A.1 ARRIVAL STORY: A NARRATIVE..... | 172 |
| A.2 TEMPORARY WORKS DESIGN..... | 173 |
| A.2.1 Entering the field..... | 173 |
| A.2.2 Background to the study..... | 174 |
| A.2.3 The construction site..... | 175 |
| A.2.4 Temporary works co-ordination..... | 179 |
| A.2.5 The temporary works design team..... | 180 |
| A.2.6 Other stakeholders to the process..... | 181 |
| A.3 PHASES OF ACTIVITY IN TEMPORARY WORKS DESIGN | 182 |
| A.3.1 Information gathering..... | 183 |
| A.3.2 Information collation..... | 187 |
| A.3.3 Generation of Structural Designs..... | 193 |
| A.3.4 Organisation of Site Activities | 199 |
| A.3.5 Construction..... | 203 |
| A.3.6 Reporting..... | 204 |
| A.4 FEATURES OF THE DESIGN PROCESS..... | 207 |
| A.4.1 Intra and inter-organisational activity | 207 |
| A.4.2 Bi-directional movement of representations | 209 |
| A.4.3 Patterns of communication | 210 |
| A.4.4 Artefacts in the design process..... | 211 |
| A.4.5 The allocation of tasks..... | 211 |
| A.5 SUMMARY OF FIELDWORK..... | 213 |

APPENDIX B

| | |
|---|------------|
| FIELD STUDY 2 - CONSULTING ENGINEERS | 215 |
| B.1 NARRATIVE | 215 |
| B.2 FIELD STUDY OF CONSULTING ENGINEERS..... | 216 |
| B.2.1 The engineering unit at ACEO..... | 217 |
| B.2.2 Organisation of resources in ACEO and BEG..... | 219 |
| B.2.3 Quality assurance at ACEO: rationale, process and practice..... | 219 |
| B.2.4 Design work at ACEO..... | 220 |
| B.2.5 Organisation of resources | 220 |
| B.3 DESIGN ACTIVITY IN BUILDING ENGINEERING | 222 |
| B.4 FEATURES OF DESIGN IN BUILDING ENGINEERING..... | 227 |
| B.4.1 Inter-organisational activity..... | 227 |
| B.4.2 Patterns of communication | 227 |
| B.4.3 Artefacts in the design process..... | 228 |

Figures and Tables

LIST OF FIGURES

| | | |
|------|---|-----|
| 1.1a | Representations and processes in individual cognition | 6 |
| 1.1b | Representations and processes in socially distributed cognitive unit | 6 |
| 2.1 | Mediation of technology in Activity Theory | 32 |
| 3.1 | Functional representation of a cognitive system | 50 |
| 4.1 | Relationship between analytic theory, domain theory and fieldwork. | 78 |
| 4.2 | The cycle of design | 84 |
| 5.1 | Interrelationships between the analytic elements of the field studies | 90 |
| 5.2 | Hierarchy of seniority in the construction team | 93 |
| 5.3 | Layout of construction team office | 94 |
| 5.4 | Sketch of road gradient | 101 |
| 5.5 | Inter-Group interactions in and around ConsCo | 107 |

Appendices

| | | |
|------|--|-----|
| A.1 | Bridge surface prior to concrete pour. | 175 |
| A.2 | Hierarchy of seniority in the construction team | 176 |
| A.3 | Layout of construction team office | 177 |
| A.4 | Sketch of road gradient. | 186 |
| A.5 | Photograph of construction team office. | 189 |
| A.6 | Photograph of drawings pinned to senior engineer's wall. | 191 |
| A.7 | Photograph of whiteboard in construction team office. | 200 |
| A.8 | Inter and intra-ORGANISATIONAL interactions | 208 |
| B.1. | Layout of BEG office area. | 218 |

LIST OF TABLES

| | | |
|-----|--|-----|
| 1.1 | Thesis objectives | 10 |
| 2.1 | Approaches for examining collaborative systems. | 36 |
| 3.1 | Marr's three levels of information processing activity | 56 |
| 4.1 | A comparison of navigation and engineering design | 67 |
| 6.1 | A comparison of primary and mediating artefacts | 121 |

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