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IRVINE

Temporal Patterns of Communication in the Workplace
DISSERTATION

submitted in partial satisfaction of the requirements
for the degree of

DOCTOR OF PHILOSOPHY
in Information and Computer Science

by

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2009
DEDICATION

To my mother,
Fusako Su (née Yoshimoto),
who sacrificed so much so that I could.
# TABLE OF CONTENTS

| LIST OF FIGURES | vii |
| LIST OF TABLES | viii |
| ACKNOWLEDGMENTS | ix |
| CURRICULUM VITAE | xii |
| ABSTRACT OF THE DISSERTATION | xvii |

## 1 Introduction
1.1 Background and Motivation .............................................. 1
1.2 Research Questions ....................................................... 4
1.3 Dissertation Outline ...................................................... 5
1.4 Summary of Contributions ............................................... 6
  1.4.1 Contributions from Analysis of Community Interactions ........ 6
  1.4.2 Contributions from Analysis of Chains of Communications ....... 7
  1.4.3 Contributions from Analysis of “Routineness” .................... 8
  1.4.4 Contributions from Analysis of Workday Patterns ................. 11
1.5 Recap of Dissertation Contributions ................................ 12
1.6 Understanding Media Appropriation through Temporal Structures .... 13

## 2 Related Work
2.1 Introduction .............................................................. 15
2.2 The Temporal Dimension of Work ........................................ 16
2.3 Routines ........................................................................... 18
  2.3.1 Ethnomethodology: Elevating Routines ............................ 19
  2.3.2 Cognitive Modeling with GOMS .................................... 28
  2.3.3 The Temporal Dimension of Routines ............................... 32
  2.3.4 Routines in Organizational Research ............................... 32
2.4 The Temporal Dimension of Computer-mediated Communication .... 35
  2.4.1 Email and Instant Messaging ....................................... 35
  2.4.2 Multitasking and Interruptions .................................... 37
  2.4.3 Rhythm Analysis ..................................................... 40
  2.4.4 Linguistic Analysis .................................................. 41
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5</td>
<td></td>
<td>Combining Two Perspectives: Routine uses of Media</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>2.5.1</td>
<td>Examining Media Relations</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>2.5.2</td>
<td>Addressing the Temporal Aspects of Media (and its combinations)</td>
<td>46</td>
</tr>
<tr>
<td>2.6</td>
<td></td>
<td>Conclusion</td>
<td>47</td>
</tr>
<tr>
<td>3</td>
<td>Field Site and Methods</td>
<td>49</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.1</td>
<td>Introduction</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>3.2</td>
<td>Shadowing</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.2.1 Coding Details</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.2.2 Survey Administration</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>3.3</td>
<td>The Field Sites</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.3.1 The Loquor Corporation</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.3.2 The Audite Corporation</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>3.4</td>
<td>Some Personal Reflections on Shadowing</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.4.1 Bias</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.4.2 Tools of the Trade</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.4.3 Prepping your Informant</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.4.4 Observing</td>
<td>66</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.4.5 Observing the Observer</td>
<td>68</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.4.6 Summary</td>
<td>68</td>
</tr>
<tr>
<td></td>
<td>3.5</td>
<td>Methodological Limitations</td>
<td>69</td>
</tr>
<tr>
<td></td>
<td>3.6</td>
<td>Conclusion</td>
<td>70</td>
</tr>
<tr>
<td>4</td>
<td>Interacting Across Groups of People</td>
<td>71</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.1</td>
<td>Introduction</td>
<td>71</td>
</tr>
<tr>
<td></td>
<td>4.2</td>
<td>Moving beyond communities of practice in the workplace</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>4.3</td>
<td>Shadowing Interactions</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>4.4</td>
<td>Coding Interactions</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.4.1 Criteria for Community Membership</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td>4.5</td>
<td>Results</td>
<td>79</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5.1 Connectors in the Workplace</td>
<td>79</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5.2 Switching Interactions in the Workplace</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>4.6</td>
<td>Discussion</td>
<td>89</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.6.1 Formal and Informal Connectors</td>
<td>89</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.6.2 Connectors as a Unit of Analysis</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>4.7</td>
<td>Conclusion</td>
<td>92</td>
</tr>
<tr>
<td>5</td>
<td>Interacting Rapid Fire: Communication Chains</td>
<td>94</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5.1</td>
<td>Introduction</td>
<td>94</td>
</tr>
<tr>
<td></td>
<td>5.2</td>
<td>Alignment in Multitasking</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>5.3</td>
<td>Research Settings &amp; Methods</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td>5.4</td>
<td>Data Coding</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.4.1 Communication Action Chains</td>
<td>99</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.4.2 Organizational Contexts</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>5.5</td>
<td>Descriptive Statistics</td>
<td>101</td>
</tr>
</tbody>
</table>
8 Understanding Media Appropriation in Terms of Temporal Structures 176
8.1 Introduction ........................................... 176
8.2 Multitasking Among People ............................ 177
  8.2.1 Theoretical Contributions ............................ 177
8.3 Chains: Rapid Fire Communication ..................... 178
  8.3.1 Theoretical Contributions ............................ 179
8.4 Routinized Patterns of Media Usage ..................... 179
  8.4.1 Theoretical Contributions ............................ 180
8.5 Workday Patterns: Looking at Lunchtime .............. 182
  8.5.1 Theoretical Contributions ............................ 182
8.6 Media Appropriation through Temporal Structuring .... 183

9 Conclusions 190
9.1 Introduction ........................................... 190
9.2 Standardizing the Shadowing Methodology ............. 191
9.3 Design Implications .................................... 193
  9.3.1 The Ostensive and the Performative ............... 196
9.4 Study Limitations ..................................... 198
9.5 Alternative Hypotheses ................................ 201
9.6 Ethical Implications of a Routineness Metric .......... 203
9.7 Concluding Remarks .................................. 205

Bibliography 206

Appendices 221
A Appendix A: Interview Protocols ....................... 221
  A.1 Workplace Connectors Semi-structured Interview Protocols .. 221
  A.2 Routineness Semi-structured Pre-interview Protocol .......... 225
  A.3 Post-interview Protocol ................................ 227
B Appendix B: Survey Instruments ......................... 228
  B.1 Personality Scales ................................... 228
  B.2 Polychronicity Scale .................................. 229
  B.3 Job Content Questionnaire (JCQ) ....................... 230
  B.4 Daily Scales ........................................ 231
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Scene from <em>Kitchen Stories</em></td>
<td>58</td>
</tr>
<tr>
<td>3.2</td>
<td>Sample notes from shadowing.</td>
<td>62</td>
</tr>
<tr>
<td>4.1</td>
<td>Time spent in each connector.</td>
<td>80</td>
</tr>
<tr>
<td>4.2</td>
<td>Relation between connectors &amp; media type.</td>
<td>88</td>
</tr>
<tr>
<td>5.1</td>
<td>Detecting communication chains.</td>
<td>100</td>
</tr>
<tr>
<td>5.2</td>
<td>Communication usage of informants.</td>
<td>102</td>
</tr>
<tr>
<td>5.3</td>
<td>Descriptive statistics of communication chains.</td>
<td>103</td>
</tr>
<tr>
<td>5.4</td>
<td>Histogram of observed chain lengths per day.</td>
<td>104</td>
</tr>
<tr>
<td>5.5</td>
<td>Stress instrument averages.</td>
<td>110</td>
</tr>
<tr>
<td>5.6</td>
<td>Models of stress with communication chains.</td>
<td>111</td>
</tr>
<tr>
<td>6.1</td>
<td>T-Pattern detection example.</td>
<td>126</td>
</tr>
<tr>
<td>6.2</td>
<td>Routineness distribution.</td>
<td>128</td>
</tr>
<tr>
<td>6.3</td>
<td>Screeplot on routineness features.</td>
<td>137</td>
</tr>
<tr>
<td>6.4</td>
<td>Clusterings on routineness features.</td>
<td>139</td>
</tr>
<tr>
<td>6.5</td>
<td>Robert’s spreadsheet usage.</td>
<td>144</td>
</tr>
<tr>
<td>6.6</td>
<td>Robert’s metric working sphere.</td>
<td>145</td>
</tr>
<tr>
<td>6.7</td>
<td>Ada’s status report working sphere.</td>
<td>152</td>
</tr>
<tr>
<td>6.8</td>
<td>Barry’s wireless certificate working sphere.</td>
<td>156</td>
</tr>
<tr>
<td>7.1</td>
<td>Cluster dendrogram of day media usage.</td>
<td>166</td>
</tr>
<tr>
<td>7.2</td>
<td>Visualization of the left-hand cluster.</td>
<td>168</td>
</tr>
<tr>
<td>7.3</td>
<td>Visualization of the right-hand cluster.</td>
<td>168</td>
</tr>
<tr>
<td>7.4</td>
<td>Visualization of cluster 1, 2, and 3 (left-hand).</td>
<td>170</td>
</tr>
<tr>
<td>7.5</td>
<td>Visualization of cluster 4 and 5.</td>
<td>171</td>
</tr>
<tr>
<td>7.6</td>
<td>Visualization of JC’s 3rd day.</td>
<td>174</td>
</tr>
<tr>
<td>8.1</td>
<td>Appropriating media through temporal structures.</td>
<td>189</td>
</tr>
</tbody>
</table>
LIST OF TABLES

Page

2.1 KLM-GOMS example. ........................................... 30
3.1 Media event taxonomy. .......................................... 52
6.1 Psychometric summaries at Audite. .......................... 130
6.2 Regression on psychometrics for routines. .................... 131
6.3 Summary statistics for each cluster (mean and standard deviation). .. 140
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ABSTRACT OF THE DISSERTATION

Temporal Patterns of Communication in the Workplace

By

Norman Makoto Su

Doctor of Philosophy in Information and Computer Science

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Professor Gloria J. Mark, Chair

In this dissertation, we report on results of an in-depth observational study to understand the temporal dimension of communication in the workplace. By employing the shadowing method for in situ to-the-second data gathering of information workers’ behaviors, we gained a detailed snapshot of informants’ workdays, “warts and all.” Our ethnographic inquiry was conducted on 30 employees from two separate companies. Each informant was observed for a minimum of three whole workdays (e.g., 8AM~5PM). Time has long been ignored as a unit of analysis because of the lack of real, time-stamped data of information workers and the difficulty in carrying out data analysis of temporal data. This work is a first step to redressing this gap of socio-technical research in the workplace. Specifically, this dissertation seeks to understand how information workers draw on multiple forms of media through temporal structures to accomplish work. Three patterns of temporal structures reflecting media appropriation were discovered: 1) communication chains, varied media use one after another in rapid succession, 2) a working sphere’s (project) routineness, a continuous, rather than discrete scale of regularity in media use, and 3) day patterns about lunchtime, reflecting different strategies for multitasking media with the lunch “interruption.” In the course of our investigation, we developed the workplace connector construct to describe multitasking among different sets of people. Quantitative analysis with psychometric measures of stress, productivity, and personality are tied with qualitative methods
drawn from grounded theory to develop a rich story of how time structures much of our communicative and solitary work in modern organizations. We posit that these temporal structures encapsulate different approaches people have to appropriating media deftly; such differences can be tied to their reported mental state (e.g., stress). Our study of these micro-scaled temporal structures of media in work suggests that tools for multitasking might benefit by explicitly integrating a temporal lens.
Chapter 1

Introduction

1.1 Background and Motivation

Communication has long been a subject of intense investigation in the academic community. Linguistic (Pickering and Garrod, 2004) and social psychology theories (Sproull et al., 1996) have been developed to explain how it is that people artfully carry out dialogue. As new communicative technologies have been introduced in the office, the effects of such technologies in the workplace have been of prime concern among organizational, HCI, and CSCW researchers. Research has historically traced the arrival of “classic” technologies such as telegraph, copier, and the telephone (Yates and Orlikowski, 1992) to the office. The advent of “newer” technologies such as email (Venolia and Neustaedter, 2003; Sarbaugh-Thompson and Feldman, 1998; Feldman, 1987; Markus, 1994; Muller and Gruen, 2005), instant messaging (Herbsleb et al., 2002; Isaacs et al., 2002; Bradner and Mark, 2002; Nardi et al., 2000), and video conferencing (Fussell et al., 2000; Kraut et al., 2002, 2003, 1998) into the corporation has also been closely scrutinized.

While much of this research has focused on the novel usage patterns of individual technolo-
gies, there has been research framed around answering how and why people choose certain media types when communicating at work. This has given rise to media choice theory (Daft and Lengel, 1983), its later enhancements (Trevino et al., 1987; Short, 1974; Dennis and Valacich, 1999), and alternative theories (Fulk et al., 1990; Salancik and Pfeffer, 1978; Whittaker, 2003a; Nardi, 2005).

However, both lenses into communication at the workplace typically ignore the temporal dimension (Ancona et al., 2001; Orlikowski and Yates, 2003). That is, such research typically focuses in on brief snapshots or events. Survey-based or experimental approaches have been criticized as unable to realistically gauge how people use technology in the everyday course of their workdays (Kiesler and Sproull, 1986; Mintzberg, 1970). Naturalistic studies on attempting to gain a better perspective of the flow of an information worker’s day highlight office work’s frenetic and ephemeral makeup (Perlow, 1999; Mintzberg, 1973).

Indeed, part of the challenge in doing temporal studies is that it is simply difficult to do. How data is collected may largely dictate what insights may be gleaned from it. For example, it may be difficult to draw generalizations of socio-technical behavior on data based on only a few hours of work from informants. Or, if one deploys computerized sensors to automate data capture of computer usage at a high fidelity, this necessarily leaves out other non-computer-mediated communication use such as telephones or face-to-face interactions. Certainly, approaches such as surveys and diary studies can be quicker, easier, and cheaper to deploy, but our goal is to gain a fine-grained, detailed analysis of people’s days, and, to that end, we believe in situ studies are best at capturing how people perform communicative patterns and how people perform communicative acts throughout the course of the workday.

Following the rise of information technologies in companies, the character of multitasking has become of interest (Czerwinski et al., 2004; González and Mark, 2004; Mark et al., 2005; Iqbal and Horvitz, 2007b; Mark et al., 2008). While these analyses of multitasking
have underscored the breakneck speed people multitask between projects in their office environments, most research has ignored the *sequential and temporal aspects of work*. Indeed, while the temporal aspects are sometimes mentioned in passing in the HCI/CSCW literature (Bellotti et al., 2004; Nardi et al., 2000), it is rarely taken up as the focal point of research (exceptions include work by Reder and Schwab (1990, 1998); Begole et al. (2002); Reddy and Dourish (2002); Reddy et al. (2006)). Research on routines have, however, focused on patterns of activity (Feldman and Pentland, 2003; Pentland and Feldman, 2007) in work (though without necessarily a focus on communication media).

Our research seeks to add to the relatively small literature on the temporal aspects of work by specifically looking at how communication is accomplished throughout the day. We are interested in how communication mediums interspersed with solitary work is used in a temporal sense throughout the day. Stated succinctly, this dissertation seeks to to *unpack what are the temporal patterns of media usage within the workday period and their psychological effects on the information worker*. The contributions of this thesis are in describing how time plays an important role in the social phenomena that is work.

More concretely, this temporal lens will shed light on how we *appropriate multiple forms of media throughout the workday*. We argue that the way we appropriate such multiple forms is through *temporal structures* (Yates and Orlikowski, 1992). That is, these temporal structures (e.g., *grammars of action* (Pentland and Rueter, 1994) or ostensive routines (Feldman and Pentland, 2003)) necessarily include a variety of both computer-mediated and traditional forms of media to accomplish work deftly. The act of *temporal structuring* is the process by which workers can (re)produce and change temporal structures to orient their ongoing work (Yates and Orlikowski, 1992). We draw from temporal structures that we have “enacted previously to organize...ongoing practices” (Ibid., 1992). In other words, actors cognizantly reflect on and act upon their lived-in practices by calling upon, implicitly or explicitly, their “arsenal” (a metaphor we will occasionally utilize) of tempo-
ral structures. This arsenal of well-honed media patterns allows us to intelligently combine different artifacts within a temporal landscape.

We posit that our own psychological states such as stress and personality traits are reflected in the unique temporal structures that occur in the day. While these temporal patterns of action can be efficiently culled upon to accomplish work, they are also significantly related to our mental state. Thus, following Orlikowski and Robey (1991), temporal structures are continually shaped by us and, in turn, shape us.

1.2 Research Questions

With this temporal structuring vantage point, we ask, *how can we understand media through temporal structures*:

- How do we appropriate multiple forms of media in temporal structures?
- How do we shape such phenomena to accomplish work?
- What tools can we utilize to discover temporal structures?
- How are temporal phenomena related to our mental states (e.g., stress, personality, productivity)?

This chapter will outline the plan of attack we take to revisit media appropriation through temporal structures, summarize the contributions of this thesis, and the research questions it seeks to answer.
1.3 Dissertation Outline

We first outline the dissertation content before summarizing our key contributions. Chapter 2 will summarize related work on the temporal approach to studying work behavior. We will go over research on “routines” from an ethnomethodological, cognitive, and organizational approach. This is followed by a literature review of research on the temporal aspects of computer-mediated communication. Chapter 3 will describe the two field sites (Loquor and Audite Corporation) from which informants were observed, as well as the kind of intense observation we employed, shadowing.

Chapter 4 begins with unpacking what sorts of groups of people information workers regularly interact with from a temporal viewpoint. Chapter 5 then moves onto analyzing a particular phenomena of interaction we observed: chains of interactions that occur one after another in quick succession. Chapter 6 re-examines what it means to interact and work “routinely” and argues for the advantages of viewing routineness on a continuous scale, not discrete, scale. Chapter 7 takes a more macro-scaled view of work, and examines what the temporal patterns of multitasking in communication and solitary work across multiple people’s workdays.

The end of our work starts with Chapter 6 recapping our findings, and summarizing how media appropriation conducted through temporal structures reflect stress, control, and personality traits when conducting multitasking. Chapter 7 concludes this dissertation by discussing the design implications of our findings for systems that wish to take temporal structuring into account.
1.4 Summary of Contributions

We draw from our research insights conducted primarily through the ethnographic shadowing of informants in two organizations. The first is a non-profit institute, dedicated to providing expert advice to government agencies (Su et al., 2007; Su and Mark, 2008). The second is a for-profit research company in the high-tech sector (study in progress). In total, we have 20 people shadowed, each for 3.5 workdays, at the first site for about one and a half years, and 10 people shadowed, each for 3 workdays, at the second site for three months. Informants were deemed to be information workers, people whose main task is to deal with the production, transfer, and maintenance of information in the corporation. All told, our data set contains more than 30 informants’ worth of data, each with at least 3 days of data. This is over 720 hours of recorded data.

Throughout this dissertation, we will refer to fieldsite 1 as Loquor (Latin for “listen”) corporation and fieldsite 2 as Audite (Latin for “hear”). Both are pseudonyms. We will now outline our contributions.

1.4.1 Contributions from Analysis of Community Interactions

Due to the intrinsically quick nature of task switching, we were motivated to see if people similarly switch between groups of people rapidly. Just as people switch briskly between working spheres (Mark and Poltrock, 2004), or projects, do people switch briskly between communities, or groups of people?

In this research, informed by a grounded theory approach (Strauss and Corbin, 1998), we derived categorical labels for the interactions from our shadowing data into organizational, formal, and informal boundaries. Calling them workplace connectors, these categories of interactions that people share fell into one of seven categories: work home (one’s own busi-
ness unit), company (the entire organization), common workrole (coworkers in the same job position), formal (company sanctioned communities), professional (networks formed to develop professional skills), social (clubs, hobbies), and private (family and friends outside of work) connectors.

**Contribution #1:** *Switching among workplace connectors, just like switching between applications when multitasking, is also characterized as ephemeral and rapid, across all connectors.* On average, connector interactions last only 3 minutes.

**Contribution #2:** *People use communicative technologies to effectively manage their multiple workplace connectors.* Our observations indicated that certain connectors were associated with certain media patterns. For example, IM proved a useful way to interact with private communities without interrupting the employee’s main workflow.

**Contribution #3:** *The time spent in a connector does not necessarily indicate its importance to the interactor.* For example, even though one manager had little time to spend interacting outside his home work context, interviews revealed that he valued what little communication he did have with other managers (common workrole) because it gave him a global idea of how the company was doing.

### 1.4.2 Contributions from Analysis of Chains of Communications

In this study, we examined the phenomenon of *communication chains*, interactions (IM, email, face-to-face, and phone) that happen one after another in quick succession. Using Pickering and Garrod’s (2004) notion of alignment to achieve effortless communication as a framework, we analyzed different aspects of how alignment might be revealed. We examined media-switching (the number of times people switch media in a communication chain) and organizational switching (the number of times people switch workplace connec-
tors (Su et al., 2007) in a communication chain. For example, F2F→F2F→Phone→F2F has two media switches. We also examined what kinds of chains are stressful.

Contribution #1: Chains of communication are a real phenomenon in the workplace. People on average experience 27.36 chains per day, each with an average duration of about five minutes per day and with an average chain length of 2.51 per day. Most chains have very few organizational and media switches (< 1.0) per chain per day.

Contribution #2: Chains of communication that have long duration and have many links seem indicative of stress. Chain duration was found to be predictive of job demands, while link duration is predictive of overall job strain. This suggests chains spanning a lengthy time period are stressful, leaving less time for solitary work; additionally, longer individual communication acts in a chain also lead to stress.

Contribution #3: Chains of communication which exhibit a high rate of organizational switching seem indicative of stress. The most predictive factor for job strain is organizational stress. This is mostly due to decision latitude, indicating that organizational switching beyond boundaries may be related to a loss of control in decisions and less influence with people outside the work home.

Contribution #4: Chains of communication which exhibit a high rate of media switching seem indicative of less stress. People who experience a high rate of media switching had less job strain, perhaps indicating that people are choosing the appropriate media to fit their multitasking practices.

1.4.3 Contributions from Analysis of “Routineness”

When looking at so-called routine work, ethnomethodologists have often pointed out that such work is actually highly situational and requires a great deal of exception handling
(Suchman, 1987; Whalen, 1995; Salvador and Anderson, 2003; Tolmie et al., 2002). However, if you were to inquire about routines, most people can readily identify them (Sche- gloff, 1986; Whalen et al., 2002). So, there is some sense that certain tasks are routine, yet their “routineness” differs when performing the routine again in everyday worklife. Feld- man and Pentland (2003) argue that routines have both *ostensive* and *performative* aspects. The ostensive aspect is the standard, laid out schematic of a routine, while the performa- tive is the actual situated actions taken when accomplishing a routine. To put it in other words, we are seeking a middle ground between what cognitive scientists have labeled and analyzed as “ideal” routine (ostensive) tasks (Olson and Olson, 1990; Gray et al., 1993), and what ethnomethodologists see as the performative, improvisatory nature of routines (performative). This is the *duality* of routines. On the one hand, routines can never be performed exactly the same each time. On the other hand, routines can often be unproblematically labeled as such when asked to identify them.

In ongoing research conducted at the second field site, we focused on routine work. We asked informants to identify tasks that were done on a routine basis, but not entirely routine to accomplish. We shadowed each informant carrying out at least one same routine task for three days. We used a technique called T-pattern analysis (Magnusson, 2000) to derive the “routineness” of a working sphere (Mark and Poltrock, 2004).

**Contribution #1:** *T-pattern analysis can determine whether temporal patterns of media usage are statistically significant.* T-pattern analysis allows us to find what repetitive patterns are statistically significant. For example, T-pattern analysis revealed a pattern of F2F following email after 20-45 seconds. Most important, it says that this pattern is statistically significant and gives a *temporal* specification that says that 20-45 seconds between F2F and email is a real pattern. The T-pattern algorithm identifies sequences of events that are repetitive and characterized by a specific duration in time. For a series of events to be classified as a T-pattern, the time gaps between
events need to be very constant and with a sufficient number of repetitive occurrences. Thus, T-pattern analysis provides a distinct advantage of sequential analysis (e.g., Markov analysis) because it allows a time gap between events.

**Contribution #2:** *T-pattern analysis allows us to derive a sense of “routineness”*. The T-pattern detection algorithm identifies a number of T-patterns that are significant \( (N_T) \) per working sphere. For each detected significant T-pattern \( T_i (N_T \geq i \geq 1) \), the algorithm outputs the number of significant occurrences \( (n_{sig_i}) \) which may be a subset of the total number of occurrences \( (n_{total_i}) \) of this pattern. In addition, the significant minimal and maximal temporal length \( (d_{1i} \text{ and } d_{2i}) \) of the T-pattern is reported, that is, if A is an earlier and B a later component of the same recurring T-pattern, then, after an occurrence of A at \( t \), there is an interval \([t + d_{1i}, t + d_{2i}] \) \( (d_{2i} \geq d_{1i} \geq 0) \) that contains at least one occurrence of B.

1. \( N_T \) = number of T-patterns per working sphere, which refers to the number of T-pattern classes that have been identified to be significant.
2. \( \text{MinDist}_T = \frac{\sum_{i=1}^{N_T \text{-patterns}} d_{1i}}{N_T \text{-patterns}} \) = average minimum temporal length of the T-patterns per working sphere.
3. \( \#\text{Sig}_T = \frac{\sum_{i=1}^{N_T \text{-patterns}} n_{sig_i}}{N_T \text{-patterns}} \) = average number of significant occurrences of the T-patterns per working sphere.
4. \( \text{SigRatio}_T = \frac{\sum_{i=1}^{N_T \text{-patterns}} (n_{sig_i}/n_{total_i})}{N_T \text{-patterns}} \) = average ratio of significant occurrences of the T-patterns (with respect to the total number of occurrences of each T-pattern) per working sphere.

In this research, we derived three measures of routineness:

1. Number of T-patterns per working sphere: gives a sense of how many (statistically significant) repetitive patterns of media use are in the working sphere.
2. Average temporal length of the T-patterns: gives a sense of how “long” these significant patterns of media use are.

3. Average number of significant occurrences of T-patterns per working sphere: gives a sense of the average number of occurrences of the T-pattern.

4. Average ratio of significant T-patterns to the total number of occurrences of each T-pattern: gives a sense of the proportion of T-patterns that are significant. This measure normalizes by doing a ratio again the total number of T-patterns that were not significant.

**Contribution #3:** The facets of routineness (measured above) effect stress and productivity differently. For example, patterns that are more spread out temporally over the day lead to an increased workload, and a decreased autonomy.

### 1.4.4 Contributions from Analysis of Workday Patterns

In this set of analyses, we expand on research on rhythms (Reddy et al., 2006; Begole et al., 2002) to examine the daily temporal patterns of F2F/Phone, computer-mediated communication (Email/IM), and solitary work (e.g., productivity software). What sort of days do people who profess a preference and belief in multitasking as an optimal strategy to conducting work have?

**Contribution #1:** *We establish a methodology to parse and cluster time series data.* Each day is split into 5% slots, with each slot containing the % of F2F/Phone, mediated, and solitary work, and this resultant time series is clustered with the divide hierarchical clustering method.

**Contribution #2:** *Two large patterns of workdays are centered about how people treat and react to lunchtime.* We establish two distinct patterns of days, one in which
lunchtime and the periods immediately before and after causes a large reduction in solitary work, and another in which lunchtime does not create a discernible reduction in solitary work, and instead is “shifted” to the first or later half of the day.

**Contribution #3:** One cluster of workday patterns is significantly related to people’s days who reported a greater preference for polychronicity and less overall job strain. People who reported greater polychronicity in fact are the ones who have days with a more pronounced dip of solitary work during lunchtime.

**Contribution #4:** Despite a dip in lunchtime, there is no significant difference in the overall amount of work (F2F/Phone, computer-mediated, and solitary work) accomplished between the two clusters. On the other hand, those who were not affected by lunch (perhaps by skipping it altogether), experienced individually longer solitary work and CMC events. Thus, each individual event was less fragmented; this perhaps suggests that working through lunch allows greater concentration and more workload to be accomplished (without multitasking to interrupt solitary work).

### 1.5 Recap of Dissertation Contributions

Our research’s contributions thus far can be summed as follows:

1. People communicate in a variety of *workplace connectors* (or equivalently, organizational contexts) to accomplish work. Just like multitasking, people switch among these different connectors at a quick pace, and only rarely stay in one single context for a long period of time.

2. The nature of communication is often characterized by its unpredictability (e.g., interruptions) and variety, but it is also heavily influenced by the *organizational con-*
straints impeded upon it. Organizations can make communication difficult (especially for those on the “fringes” like nomadic workers), leading to alternative tactics when communicating.

3. Communication chains encapsulate the notion that people encounter chains of interactions. Switching between different connectors is costly, but the strategic use of media can lessen this stress.

4. Routineness can be measured by T-pattern analysis and reveals different facets of how we perceive routineness (e.g., repetition, versus temporal distance).

5. Workday patterns related to polychronicity revolve about how one “handles” the lunchtime disruption.

1.6 Understanding Media Appropriation through Temporal Structures

Our approach here is to understand how information workers gather and use multiple forms of media to accomplish work through temporal structures. Three patterns of temporal structures reflecting media appropriation were discovered: communication chains, routineness, and day patterns about lunch. Four key contributions can be gleaned from these structures:

1. The diversity of media has implications for multitasking and control over one’s work-life.

2. The patterns of media action we enact from our “grab bag” of patterns to accomplish projects reflect different ways of moving forward to accomplishing a working sphere’s goal.
3. Conversely, media appropriation itself is shaped by temporal structures such as lunchtime, the initial link of a chain, or a working sphere’s goal.

4. Temporal structures are related to particular psychometric attributes: stress, control, extraversion, and polychronicity.

Having gone over the main contributions of this dissertation, we now turn to reviewing the related literature.
Chapter 2

Related Work

2.1 Introduction

The workforce of today has weaved a vast array of information technologies into the everyday lives of employees. As a result, much of knowledge work is computer-mediated. Whether it be solitary work on productivity software, or communication through email or instant messaging, people are expected to be competent with the use of multiple computers throughout their workday (Dearman and Pierce, 2008). Of interest is how workers’ competency, expertise, or deftness in using a multitude of technologies at-hand is properly demonstrated. Moreover, it is of interest in how the apparently mundane nature of computers usage is achieved. However, this achievement of the seemingly nonchalant integration of technology in everyday work is not accomplished merely through single points in time isolated from other events, but rather throughout the day, or temporally. People use these technologies in the flow of time that governs us all. This brings us to the central concern of this chapter: the temporal pattern of media usage in the workplace.
This chapter will survey on how time has been examined in the workplace in two particular research domains:

1. Studies on temporal patterns and “routines” in the workplace.

2. HCI/CSCW studies on temporal patterns in computer-mediated communication in the workplace.

To necessarily scope this chapter, I have not included literature that purely focuses on a non-work environment (e.g., domestic, underrepresented populations, etc.). From this survey we hope to derive strategies for approach the problem of analyzing why and how people use multiple media in the day. Throughout the paper, I will restrict the definition of media to primarily be methods or artifacts through which communication is achieved.

2.2 The Temporal Dimension of Work

Ancona et al. (2001) advocate using time as a new research lens, instead of focusing on the three traditional lenses in organizational literature (culture, politics, and strategic design): “the temporal lens puts time and timing front and center.” A temporal lens allows us to examine the pace, cycles, rhythms, flow, temporal orientation, and symbolic meanings of time. The authors note that there is a general dearth of literature focusing on an organization’s temporal characteristics. They note that 1) fieldwork often does not allow capture of timed events over a prolonged period of time, 2) experimental work is biased towards short-term tasks, and 3) temporal work is simply difficult to do. The later point has to do in part with the proficiencies of the researchers themselves: “although we are skilled at detecting linear patterns and even quadratic forms, we are not yet able to readily detect spirals that increase and decrease over time...we are not experienced enough to know
how to choose temporal variables.” Of particular relevance is a seminal work (Roy, 1959) called “Banana Time,” in which machine operators have an extreme set of ritualized time breaks: coffee time, peach time, banana time, window time, lunch time, pick-up time, fish time, and Coke time. The colorful titles indicate the activity occurring during the breaks. Ancona et al. (2001) refer to these as “timing norms.” The workers expect these breaks to occur everyday. This event timeline is an established norm, shared, and constructed by all the workers. The authors ask what are the effects of such timing norms. For example, an organization’s original timing norms may be a bad fit for the new pace introduced with computer-mediated communications. Furthermore, changes to timing norms can be disruptive and cause productivity to suffer.

In a follow up work by Orlikowski and Yates (2003), the authors draw from structuration theory (Giddens, 1979) to explain that “temporal structures are created and used by people to give rhythm and form to their everyday work practices. In doing so, people establish and reinforce (implicitly or explicitly) those temporal structures as legitimate and useful organizing structures for their community.” They propose an alternative to viewing organizational research in time as a distinction between the objective and subjective. The former presupposes time as a clock, quantitatively measurable and continuous, unaffected by agency. The later presupposes that time is dependent on people’s viewpoints, and the cultural practices that surround the individual. Orlikowski and Yates (2003) instead emphasize a “practical perspective” into temporal structuring in organizations. Namely, people change, create and modify temporal structures, and temporal structure similarly can modify and shape people’s behaviors and thoughts. In particular, the researchers argue that the focus on temporal structuring emphasizes that when people are faced with multiple decisions regarding temporal structures, they can and do choose to adapt and shape the temporal structures to fit their needs in the situation at hand. Temporal structuring has important implications:
The concept of temporal structuring also sheds a different light on the idea of “time management,” which suggests that individuals are capable of so ordering their temporal schedules and rhythms that they can “take charge” of their busy lives.

Temporal structures are also a social process in that other people’s rhythms similarly effect one’s own rhythms. While Orlikowski and Yates do not focus on information technologies, they do note that with “zero time” (characterizing the break neck speed of working in an IT/web dominated world), temporal structuring explains the fleeting nature of work not by the technology itself, but “the decisions people have made about how they wish to structure their activities, both on or off the Internet.” This duality in time will be touched upon in the next section about routines.

### 2.3 Routines

We now review the literature on routines. This poses a challenge in that there is no standard definition of what routines are. Our inquiry focuses primarily on literature that explicitly mention the notion of “routines.” We believe five spheres of research on routines merits investigation: 1) the ethnomethodological tradition stemming from Garfinkel; 2) early HCI work based on cognitive modeling (GOMS); 3) CSCW literature on the subtleties of collaborative work; 4) reflective works in ubiquitous computing focusing on tractability of attaining an environment permeated with invisible computer; and 5) later work on the temporal dimension of routines.
2.3.1 Ethnomethodology: Elevating Routines

In explaining ethnomethodology’s agenda, Garfinkel recast Durkheim’s aphorism, “the objective reality of social facts is sociology’s fundamental principle,” by noting that the achievement of this objectivity by people should be the very object of inquiry in sociology. This achievement is a phenomenon, not a principle, that is continually maintained, and then publicly viewable at large by one’s fellow members in society (Garfinkel et al., 2002) (cf. Dourish (2001) for an overview of the philosophical underpinnings of Garfinkel). In other words, when people speak of their own everyday actions as “uninteresting,” they are taking for granted that their actions are seen as being rational to others members (those who recognize it as such) (Garfinkel, 1967):

They treat as the most passing matter of fact that members’ accounts, of every sort, in all their logical modes, with all their uses, and for every method for their assembly are constituent features of the settings they make observable. Members know, require, count on, and make use of this reflexivity to produce, accomplish, recognize, or demonstrate rational-adequacy-for-all-practical-purposes of their procedures and findings.

Garfinkel’s 1964 essay, *Studies of the Routine Grounds of Everyday Activities*, outlines why routines deserve to be looked into. In a series of experiments, Garfinkel (in)famously asked his students to act as a “stranger to the ‘life as usual’ character of everyday scenes.” For example, when students briefly acted as if they were guests at their own homes, family members acted with “astonishment, bewilderment, shock, anxiety, embarrassment, and anger.” Garfinkel argued these *in situ* experiments reveal that routine activities are the very activities by which “persons discover, create, and sustain this standardization.” By acting out of character, the students were able to make the accomplishment of routines a topic of
sociological study (what Garfinkel [1964, pg. 9] called treating the rationality of routines as “anthropologically strange”).

Garfinkel admonished the prevailing viewpoint that a person is a “cultural dope.” A cultural dope posits that people unwaveringly and blindingly follow predetermined, agreed rules without taking the current context into account (Garfinkel, 1967) (pg. 245). By taking the most base of activities, routines, Garfinkel showed the cultural dope assumption to be an oversimplification of how people accomplish work. If we were to examine critically each repeated instance of a routine as “another first time” [1964, pg.9], we can see the work that goes to make routines routine.

Schegloff (1986), in The routine as achievement, expanded on Garfinkel’s theories by analyzing what “may initially appear unworthy of sustained scrutiny,” the openings of telephone conversations. Schegloff indeed acknowledges that, upon first glance, many conversations display a remarkable sense of similarity and almost seem automated. For example, openings often contain the exact phrase “Hello” and “How are you?” However, Schegloff [1986, pg. 114] argues that routines themselves are an achievement “out of structured sets of alternative courses or directions which the talk and the interaction can take.” For instance, phone openings can become more efficient through varying degrees of preemption by the receiver or caller. The normative case might be an exchange of serial howareyous between the caller and receiver, but the caller may compress the call by not returning a howareyou and instead jump straight to introducing the topic of the call. In a more extreme example, the caller may utilize a non-canonical opening such as “Are you awake?” not as a pre-apology but to demonstrate that the caller must have something urgent to speak about because he or she was willing to take the risk of rudely calling someone early in the day. In such a case, howareyous may be completely dispensed with. Schegloff notes that this pattern appears in the majority of caller preemptions cases, and that another pattern also

\[1\]Sacks (1984) described the remarkable lengths with which we go to to initially ascribe even the most calamitous situations (e.g., airplane hijackings) as “being ordinary.”
dominates the majority of receiver preemptions (the receiver wishes to apologize for not returning or answering a call).

Thus, Schegloff does not discount routines; indeed, he notes that there are many patterns of conversations that are nearly identical (one must be careful, however, to not interpret ethnomethodology as asserting that people converse mechanically by strict rule sets (Have, 1999)). Yet these routines are often utilized “in the moment” and display the skillful selection from a repertoire of possible talking styles. Such subtle variations in telephone openers illustrate how people utilize a wide range of (similar) strategies to make something come off as effortless, routine.

It should be emphasized that Schegloff’s emphasis is not on the entire phone conversation. More precisely, it does not seek to dissect the patterns evident in the task or project of carrying out a phone conversation for a particular motivation (e.g., setting up a meeting, asking a favor). Indeed, it could be argued that such “routines” in conversation fragments may not be equivalent to an individual’s work practices (such as in GOMS where phone operators tasks are entirely mapped out). Rather, the particular scope of the analysis is fine-grained and limited. Nonetheless, we might suggest that Schegloff’s motivation is to show that even “routine parts of routines” are themselves a product of human accomplishment.

**Applied Ethnomethodology: Workplace Studies**

In parallel to Garfinkel’s opposition to the cultural dope, ethnomethodologists studying technology sought to bring about an alternative to the prevalent cognitive modeling, artificial intelligence (AI) model of human behavior. While not dismissing the goals-oriented aspect of activities, ethnomethodologists rallied against the dominant AI paradigm that people solve and execute their plans methodically and sequentially. Dourish (2001, pg. 72) explains that “the planning model sees features of the world (and of our interaction with
it) as stable, objective phenomena; this enables the relatively unproblematic execution of a plan formed around these objective phenomena.”

In her magnum opus, *Plans and situated actions*, Suchman (1987) describes the problem of miscommunication between the copy machine and human. The copy machine has been designed to proceed in a stepwise manner, according to its plan. At each step, user input is interpreted by the copy machine. Hence, the interplay between human and machine depends on a harmonious choreography such that the goal can be successfully reached. Suchman found, however, that users often misinterpreted the copier’s “reactions” to their input (called the *false alarm*), and misunderstood what portion of the machine’s plan they were actually at (called the *garden path*). For instance, the false alarm occurs when the user encounters an subsequently identical feedback: “ambiguity arises between interpreting the repetition as a straightforward directive to repeat the action, or a directive for repair” (pg. 170). The garden path occurs when users ignore instructions, assuming (incorrectly) that the copier at-hand will behave as previous copiers have. The “bad” input given by the user is not recognized by the machine, for the machine merely assumes that the input is the next step towards completion of its plan: “Interactionally, her statements provides an occasion for the discovery of the misunderstanding. She even looks to the display for a response. The information provided there is efficient enough, however—it simply says, ‘The copies have been made’—to support her assertion, rather than challenge it” (pg. 167). The point is that when people normally communicate with each other, they operate in “terms of situated action, locally improvised guesses at what might have to be done next and what the machine displays and activities could ‘mean’” (Have, 1999); in contrast, designers follow the AI paradigm, drawing from an inherently paltry communicative repertoire, leading to miscommunication. This “asymmetry” in communication capabilities is described by Suchman as the problem of human-machine interaction.

From Suchman, we have a number of workplace studies that take an ethnomethodological
approach in parsing out the problems of human-machine interaction. Here we give two examples. Work on air traffic systems (Heath and Luff, 1992) highlighted the extremely choreographed nature of communication between air traffic controllers facilitated through subtle, skillful use of brittle artifacts (e.g., paper strips). This suggested that any system that sought to “improve” on existing systems would need to also facilitate the effortless interplay between controllers through traditional mediums like paper. Whalen (1995) demonstrated how expert systems that automatically recommended “optimal” routing commands for emergency vehicles failed to facilitate competent dispatching. By not illustrating how recommendations were reached, the dispatchers were unable to trust the system as well as integrate their own personal knowledge of recent activity of various emergency units (it might be more prudent to divert an ambulance en route to its station) and local geography.

In a later work, Whalen et al. (2002) examine specifically what it means for computer work to be seen as “routine.” Their ethnography focuses on the routine telephone conversations with customers of sales representatives in a call center. Whalen et al. (2002) explain that despite the popular notion of call center work as the epitome of routine (“a new type of sweatshop”), their work might be more accurately called “improvisational choreography.” Importantly, the sales representative is tasked with providing a “hearably competent” call, one that is quick and efficient, to their customers and managers. Thus the call center provides a particularly useful demonstration of ethnomethodology’s principles, in that some of the work to do the work is hidden via physical constraints from those who receive its benefits. In particular, Whalen et al. (2002) give four prime characteristics of improvisational choreography:

1. The sales rep’s workstation is strategically organized to allow flexible physical manipulation of artifacts to expedite phone calls, e.g., the placement of paper cheat sheets and the position of the mouse of the left-hand side of the keyboard (despite the user being right-handed) for touch-typing the numpad.
2. Improvisational choreography allows the rep to “compensate for the software’s insensitivity to the social organization of talk-in-interaction.” Customer’s often state their name at the beginning of the phone call, but the system’s stepwise method does not allow the name to be recorded unless the customer account number is *first* entered. To avoid the hassle of having the customer repeat her name, the rep uses a notepad strategically placed on the right of the hand to record the name where it will be undoubtedly useful in a few minutes later.

3. Having experienced innumerable calls, reps are good at anticipating events. They carefully control their speech patterns to not only allow the customer to record the information, but to also give themselves time to look up information via the computer to be ready for the next step, thus avoiding any awkward pauses that may signal a less than competent call.

4. Reps are adroit in “managing multiple means of action with multiple tools.” In the transcript given by Whalen et al., they note how the rep physically places a finger on his notes and then, with the finger still at place (a pseudo-bookmark), goes to reference his cheatsheet to smoothly move from one product to another product’s order information.

Drawing from Schegloff, Whalen et al. make the important point that these characteristics of improvisational choreography imply a need to reexamine what we mean by routineness:

The conventional (and reconizably vernacular) division in our discipline between ‘routine’ work and other, presumably more demanding and cognitively challenging kinds of work needs to be respecified...We recognize then, that ‘routineness’ can be (and often is) a perceptible feature of work activity, but propose that his phenomenon should be further respecified to take account of
its contingently produced nature; that is, how it could come to be perceptible, and a ‘social fact,’ in the first place.

While Whalen et al. qualify their statements by noting that, indeed, some tasks become so constrained to leave little room for improvisation, one can never completely dismiss the context in which the technology with which we do work with is situated:

We recognize that for at least some teleservice settings, the work may include significant assembly-line features...where the management objective in every respect is thus to enforce...a ‘workmanship of certainty. Still to make the key point once again, even though these technologies may be designed to increase certainty, they have to be used during singular encounters that are locally organized and thus necessarily contingent.

**Applied Ethnomethodology: Ubiquitous Computing**

We have just discussed studies emphasizing the primacy of routines in the workplace. One rhetorical strain in the ubiquitous computing corpus underlines the challenge of pervasive technologies by contrasting the hidden, but important, work that goes into achieving everyday routines with the inherent limitations of the machines that are tasked to unobtrusively assist in those very routines.

Tolmie et al. (2002) note that “a focus upon supporting work with resources rather than automating representations of routines has now become a distinctive characteristic of CSCW in recognition of ‘routineness’ as an accomplishment produced through practised exercise of complex skills.” The authors studied scenes of domestic life, video taping five households over a course of a year. They argue that routines are a central part of domestic life: “Routines mean that people can get out the door, feed themselves, put the children to bed,
and so on, without having to eternally take pause and invent sequences of action anew or open up their every facet for inspection or challenge or to constantly have to account for what they are doing with explanations or rationales.”

In one example, two mothers who live next door to each other are about to go out to pick up their children, a routine task. As one mother prepares to go out, she hears a knock on the door. Her response is not, “Hold on a minute.” Rather, she simply opens the door ajar without any visible or auditory reaction, and resumes her preparations. The door is a message to indicate both an imminent departure, and current involvement in preparations. Similarly, the knock from the other mother is also a message that she is about to leave for school. Importantly, Tolmie et al. (2002) describe each of these activities as “just enough” to convey a message: “the routine has become honed and well understood mutual accountabilities.” Indeed, to the outsider, the visible actions of people do not give any outward markers that a routine is happening—to do so would label the routine as significant and special.

In a subsequent example, Tolmie et al. (2002) observe someone trying to reach an associate by phone. He is not there but notes that it is close to ten o’clock. So, he decides to visit the coffee shop knowing that his associate is usually there at that time. This example illustrates that people can be cognizant of others’ routines, but, crucially, the explicit knowledge and description of routine is an occasioned activity. And the aspects of the routine that are significant to the describer as intimately tied with the occasion at-hand. In conclusion, Tolmie et al. (2002) suggest we move away from the perceptual (visual) notion of invisible computers and instead towards the notion that computers might become invisible in use, embedded into routines. Moreover, one must be careful to not design domestic technologies that destroy the mundane nature of routines. The very requirement that one explicate his or her routines to a system for it to do a routine might be jarring. There must be a “clear conceptual understanding of the difference between involved in giving a description or account of a routine and being involved in doing the routine.”
On a more micro-level, Salvador & Anderson’s 2003 examined how ubiquitous computing might support an Alzheimer patient’s daily routines. They shadowed “Bob” over two days from breakfast until dinner, taking photos and videos; in-depth interviews were also conducted with Bob and his wife. The paper scrutinized a single activity, responding to a greeting card. Each step of this routine was critically interrogated by asking how a context-aware system might have assisted Bob.

For example, Bob has a todo-list that tells him he needs to respond to the card from Marsha. When he looks at the list, he decides to call the sender, but he first wants to have another look at the card; Salvador & Anderson note the fluidity involved in switching contexts:

A proactive system could provide Marsha’s phone number. That much is obvious. However, Bob doesn’t want to call her just yet. He doesn’t remember the letter, and to make the call means responding to the letter, which he evidently wanted to read again...Even if the system had indeed inferred correctly that Bob wanted to call Marsha, how could it have known that Bob also wanted to read the card?

The crux of the matter is that if we are to create systems that utilize “context” to assist routine tasks (responding to a letter), then they must deal with the fact that at different, fragmented times, the same contextual event may mean different things. We can say something is routine in that you have done it many times before, but that doesn’t mean that that thing has to be done again, every time, and that it has to be done in a particular time, in a particular set of circumstances, and in a particular way.

We have just summarized how routines are seen from an ethnomethological viewpoint. In the next section, we move to discuss an influential, yet very different take on routines.
2.3.2 Cognitive Modeling with GOMS

No review of routines would be complete without mention of the task modeling framework called GOMS (Goals, Operators, Methods, and Selection rules) (Card et al., 1983). GOMS stems from cognitive modeling, a theory based on psychological principles and empirical studies of how people perform tasks and solve problems based on psychological/empirical studies. This theory is centered about the notion of the Human Processor Model. Analogous to a computer, the human can be thought to contain both long-term and working, or short term, memory. Carrying the analogy further, the human “computer” has three processors: perceptual, cognitive and motor. Explicit in this model is a fixed, sequential order among these components for handling external inputs (the external world). For example, in the case of a customer service representative, the operator receives auditory input from the telephone, this audio is handled by the perceptual processor, sent to working memory, then transferred from working memory to be processed by the cognitive processor, and finally to the motor processor which directs the worker to start typing, and the loop begins anew. Thus, GOMS assumes that routine cognitive skills can be decomposed into a serial sequence of cognitive operations and motor actions.

Olson and Olson (1990) provide a good overview of GOMS and its variants, but we now briefly summarize here the GOMS framework. GOMS provides a formal representation of routine cognitive skills. User behavior is modeled in terms of Goals (what the user wants to do), Operators (specific steps a user is able to take, and their respective execution time), Methods (well-learned sequences of subgoals and operators that can accomplish a goal), and Selection rules (guidelines for deciding between multiple models). Part of GOMS’s utility lies in the particular preciseness with which it will predict the time it will take a user to perform tasks. Thus, one can play with the model, removing, adding operators or methods to find an optimal way of carrying out routine tasks.
The simplest instantiation of GOMS is the Keystroke-Level Model (KLM). KLM-GOMS decomposes routines into keystroke, mental, mouse pointer, and hand movement operations. To illustrate, suppose our goal is to fix the sentence

The fox jumps over the lazy quick brown dog.

by cutting and pasting the phrase “quick brown” in front of “fox”:

The quick brown fox jumps over the lazy dog.

To accomplish this goal, KLM specification might resemble:

**Top-level Goal.** Edit manuscript (move “quick brown” to before “fox”)

**Subgoal.** Highlight text

**Operators.** Move-mouse, Click mouse-button, Type characters


**Selection Rules.** If the text to move is 1/2 characters long, use retype method Else if remember shortcuts, use shortcuts method Else use the menus method

Table 2.1 shows the sequence of operators used to accomplish the goal of cutting and pasting with the menubar of the text editor. The subgoal is to highlight the appropriate text to be cut and pasted. KLM-GOMS predicts the task will take 14.90 seconds. The user mentally prepares operations such as selecting a word with a mouse to be copied and using the menubar to execute a paste command. Importantly, each operator’s duration were set to estimates from literature (e.g., Fitt’s law for motor movement (Card et al., 1978)) and is fixed (e.g., one operator doesn’t get faster after following the use of a particular operator). This example only demonstrates one variant of GOMS. Other variants augment KLM-GOMS: Card-Moran-Newell GOMS (CMN-GOMS) allows a hierarchical model for
Table 2.1: KLM-GOMS Prediction of Cut-and-Paste-with-Menus Task (Operators: Mental=1.35s, Perception=1.10s, Keystroke=0.20s)

<table>
<thead>
<tr>
<th>Sequence #</th>
<th>Description</th>
<th>Operator</th>
<th>Duration (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mentally prepare</td>
<td>M</td>
<td>1.35</td>
</tr>
<tr>
<td>2</td>
<td>Move cursor to “quick”</td>
<td>P</td>
<td>1.10</td>
</tr>
<tr>
<td>3</td>
<td>Double-click mouse button</td>
<td>K</td>
<td>0.40</td>
</tr>
<tr>
<td>4</td>
<td>Move cursor to “brown”</td>
<td>P</td>
<td>1.10</td>
</tr>
<tr>
<td>5</td>
<td>Shift-click mouse button</td>
<td>K</td>
<td>0.40</td>
</tr>
<tr>
<td>6</td>
<td>Mentally prepare</td>
<td>M</td>
<td>1.35</td>
</tr>
<tr>
<td>7</td>
<td>Move cursor to Edit menu</td>
<td>P</td>
<td>1.10</td>
</tr>
<tr>
<td>8</td>
<td>Click mouse button</td>
<td>K</td>
<td>0.20</td>
</tr>
<tr>
<td>9</td>
<td>Move cursor to Cut menu item</td>
<td>P</td>
<td>1.10</td>
</tr>
<tr>
<td>10</td>
<td>Click mouse button</td>
<td>K</td>
<td>0.20</td>
</tr>
<tr>
<td>11</td>
<td>Mentally prepare</td>
<td>M</td>
<td>1.35</td>
</tr>
<tr>
<td>12</td>
<td>Move cursor to before “fox”</td>
<td>P</td>
<td>1.10</td>
</tr>
<tr>
<td>13</td>
<td>Click mouse button</td>
<td>K</td>
<td>0.20</td>
</tr>
<tr>
<td>14</td>
<td>Mentally prepare</td>
<td>M</td>
<td>1.35</td>
</tr>
<tr>
<td>15</td>
<td>Move cursor to Edit menu</td>
<td>P</td>
<td>1.10</td>
</tr>
<tr>
<td>16</td>
<td>Click mouse button</td>
<td>K</td>
<td>0.20</td>
</tr>
<tr>
<td>17</td>
<td>Move cursor to Paste menu item</td>
<td>P</td>
<td>1.10</td>
</tr>
<tr>
<td>18</td>
<td>Click mouse button</td>
<td>K</td>
<td>0.20</td>
</tr>
</tbody>
</table>

**Total Predicted Time**  14.90

goals (Card et al., 1983), Cognitive-Perceptual-Motor GOMS (CPM-GOMS) allows parallel processes to occur (John, 1990), and Natural GOMS Language (NGOMSL) predicts the learning time of new tasks (Kieras, 1994).

Perhaps the exemplar of GOMS’s value is the Ernestine project (Gray et al., 1993). The NYNEX telephone company was slated to purchase new workstations to improve the efficacy of single toll & assistance operators (TAOs). On the contrary, analysis via GOMS revealed that the new machines would actually be slower and cost an additional two million dollars per year to operate. Because of the preponderance of parallel processing in TAO work, CPM-GOMS was chosen. In particular, the critical path method of CPM-GOMS discovers “the sequence of activities that takes the longest and determines the total time for the entire task” (Gray et al., 1993). Procedurally, models for the current workstation were constructed from video taped observations of TAOs; models for the new workstations were
based purely on the specifications (e.g., response times) provided by the manufacturer.

In project Ernestine, GOMS showed remarkably fidelity in its results: 78,240 sampled calls with the new workstations showed it to be 4% slower, GOMS predicted it to be 3% slower. Critical path analyses found that while the new workstation eliminated keystrokes for TAOs, none of the operators removed were in the critical path. These operators occurred in parallel with the critical path (when the TAO was greeting the customer), implying that no time was saved anyways. Even worse, the new machines added keystrokes to the end of the call, which lies on the critical path. Indeed, the Ernestine case has perhaps become the poster child of GOMS’s success.

We observe here that GOMS has been applied to what is ostensibly a very routine class of tasks: “the TAO’s task is so constrained that there are virtually no situations in which alternative methods arise, so selection rules do not play a role in these analyses”(Gray et al., 1993). GOMS was designed to model expert usage. How does GOMS handle incongruities in expert behavior? Portions of the Ernestine model based on observations are necessarily simplifications: “calls within a category vary considerably...primarily due to variations in customer conversation...we strove to script a single benchmark call for each category so that the set of benchmarks would be representative of the types of calls TAOs would actually handle.” When experts confusingly kept using “inefficient keying strategies,” “misunderstanding of procedures,” or “slips,” the authors chose to have the model simply include the inefficiencies to be as close to real behavior. On the other hand, the model for which only the workstation specifications (the new workstations) were available obviously could not include errors into the model. Because of the results show the old machines to be in fact faster despite the bias for the new workstations to be more efficient, it bolsters the author’s final results.

GOMS filled NYNEX’s investigative requirements admirably because of its emphasis on expert performance time (the ultimate metric produced by GOMS) in an easily modeled
task. The previous paragraph illustrated some ways of how GOMS practically deals with anomalous situations. Adherents to GOMS acknowledge its limitations in modeling variable skill levels, errors, parallel processes, organizational behavior, and mental status (e.g., stress, fatigue). GOMS’s narrow but useful domain perhaps lies on the extreme side of “routineness” where there is little variability and the “scripts” by which people do work is evident.

2.3.3 The Temporal Dimension of Routines

In this final review of routines, we look at two later developments in the analysis of routines. Both emphasize the temporal or sequential aspect of routines.

2.3.4 Routines in Organizational Research

Routines as a unit of analysis have been examined from an organizational perspective. Feldman and Pentland (2003) build upon the “standard” definition of routines: “repetition, a recognizable pattern of action, multiple participants, and interdependent actions.” Routines are repeated over time, seem to be a collection of activities one can categorize, involve (sometimes subtly) multiple people, and are situated in the context created by other people. However, they argue that routines have both ostensive and performative aspects. The ostensive aspect is the routine in principle, or the abstract patterns reified through the performative actions. The performative is the actual situated actions of a particular moment taken when accomplishing a routine. Both facets are important, but the authors note that the performative is often ignored: “by directing attention to the peformative, improvisational aspect of routines, our theory emphasizes the contingent and potentially contested

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2The ostensive is not the “standard operating procedure.” Because the ostensive aspect is multiple and changing (though less than the performative), it will usually not be laid out in a complete, stable detail.
nature of routines as a source of their variability...the emphasis on the ostensive aspects of organizational routines has led to too much emphasis on the stability of routines and the insufficient ability to understand their potential for change.” Indeed, the authors note (invoking Wittgenstein) the philosophical dilemma in trying to fully specify a routine ostensively:

No amount of rules is sufficient to specify a pattern of behavior fully, because the interpretation of any rule, or any part of a rule, requires more rules. At some point, one must simply know how to go on. In this sense, the significance of a rule, or of the ostensive aspect of a routine, becomes apparent through its performance.

Similar to the aforementioned arguments (Whalen et al., 2002; Schegloff, 1986), Feldman and Pentland (2003) emphasize the importance of agency: the fact that routines are done by human actors, with all their associated baggage: their environment, relations, artifacts, and collective social behavior. This is in contrast to previous notions of routines in the organizational literature that emphasize the need for processes to be standardized and all variability to be eliminated (cf. Yates and Orlikowski (1992) on Taylorism).

However, Feldman & Pentland’s 2003 analyses lay stress on the duality of routines (cf. (Orlikowski and Yates, 2003)). On one hand, routines can never be performed exactly the same each time. On the other hand, routines can be unproblematically labeled as such. Drawing from structuration theory (Giddens, 1979), Feldman and Pentland (2003) unpack the relationship between the ostensive and performative facets of routines. In one “direction” (from the ostensive to the performative), the ostensive can allow us to explain and justify our actions by associating it with a routine. Stating that an activity you’re doing is part of X routine can quickly quell any raised eyebrows over the activity by a supervisor. In the other direction (from the performative to the ostensive), one may discover a more efficient
way of doing a part of the routine when doing the routine; this may later become a codified part of the routine, hence modifying the ostensive aspect of the routine. As a whole, the work by Feldman & Pentland (Feldman and Pentland, 2003; Feldman, 2000; Pentland and Feldman, 2005; Feldman and Pentland, 2008) has many parallels to the ethnomethological viewpoint of routines, but with a structuration bent on the relationship between how people talk about routines and then actually do them.

While there is little work on measuring routineness explicitly, organizational research has touched upon a related concept, job and task variability (Withey et al., 1983). Task variety measures the number of unusual (unfamiliar) cases encountered in the work. Job variety measures the number of different classes of tasks required to accomplish the work. Both measures depend on survey instruments. Pentland (2003) argue that such measures ignore the sequential nature of work. He proposes two different measures of the sequential variety of work. Using the diary method, he analyzed work sequences of different departments in a bank’s customer support line, and found that departments that had higher task/job variety also had lower sequential variety (and vice versa). Pentland concludes that “traditional measures of task variety and job variety have more to do with the content of the work than with the process of the work.” However, he notes that with his data set (in which 99% of all customer calls were completed satisfactorily), it is impossible to tell whether process variety is good or bad, and more importantly: “how to design systems that foster ‘good’ variety (that results in increased customer satisfaction, for example) and limit ‘bad’ variety (that results in substandard performance). Later work (Pentland and Feldman, 2007) to examine process variability proposes the usage of narrative networks that map out a blueprint of sequential “narrative fragments,” to map out the range of patterns (e.g., patterns of media usage) and range of possibilities when seeking to accomplish a goal.
2.4 The Temporal Dimension of Computer-mediated Communication

We have now discussed the research literature on routines. Routines have been both examined from an ethnomethological as well as a cognitive point of view. We turn now to discuss the growing literature which examines media usage in terms of its temporal properties. The advent of email and instant messaging has made it difficult for researchers to fit media usage into sequential single units of processing. Here we summarize some of the key findings in email and instant messaging usage in the workplace.

2.4.1 Email and Instant Messaging

There have been numerous studies on the particular attributes of email and instant messaging into the workplace. Here, we focus on temporal aspects that have been covered.

Email has been shown to have several temporal characteristics:

1. Email messages are often part of a larger more complex discussion (Milewski and Smith, 1997). Thus email can be part of a “transaction,” a series of activities between people that eventually reach some planned conclusion. Such transactions are often “closed” by the initiator. A canonical example would be someone emailing people for suggestions on a restaurant for lunch. While discussion may occur intermittently over days or weeks until the day of the event, the transaction will likely close when the initiator has emailed everyone where she has decided to eat.

2. Long discussion of email are prevalent in high levels of management (Rice et al., 1988; Markus, 1994; Camino et al., 1998).
3. Email can be quickly addressed to numerous people simultaneously, something it shares in common with face to face and is perhaps better equipped to handle than voice (Markus, 1994).

4. Email is often used to coordinate communication to switch other media (e.g., meetings) (Whittaker et al., 2006).

5. Email boxes do not always “belong” to a single user. Assistants often work closely to use email as a site for collaboration (Muller and Gruen, 2005).

6. Email (like IM) messages are often thought of as belonging to “conversations,” or threads. Emails in single conversations are not continually being sent back and forth, but the expectation of a reply is still there (Venolia and Neustaedter, 2003).

7. Use of email is often non-communicative, and instead more reflective of task management (Whittaker et al., 2005); e.g., asking people to send copies of files over so that you have them in a safe archive, or asking people to email you so that you have a record of the communication.

8. A study on email rhythms (Tyler and Tang, 2003) revealed that people strive to maintain an image of (email) responsiveness as well as couple email with other media (e.g., voice mail to signal the importance of a just sent email). People use actions that may be perceived as quick, casual, excited, etc. so that they may influence the timing of others (either to increase others’ speed of response or to deter too frequent message exchanges). One can draw ties to Goffman’s 1959 analogy of the theater, in which people adopt multiple facades depending on the situation. Finally, specific usage of certain mediums such as email (Bellotti et al., 2004) have been observed to have rhythms (e.g., at the beginning of the day). Tyler and Tang (2003) found that coworkers perceive a sense of timing in the responses they receive to email from specific individuals.
IM, on the other hand, displays more transient characteristics. Nardi et al. (2000) describe IM as utilizing outeraction: actions that instigate information exchange:

1. IM conversations take place in bursts of isolated chats. Once a chat is opened, even if there is no active dialogue being exchanged, the social connection is still present (Voida et al., 2002).

2. IM is often used to “ping” the other person to inquire about availability. Once availability is established, the media may switch to phone or face to face. Thus IM allows one to manage other types of media interactions that may follow.

3. In one workplace study of IM (Isaacs et al., 2002), heavy IM users had many fast-paced interactions on many threads, while light IM users frequently coordinated in longer discussions with fewer fragmentation. These two styles reflect 1) working together and 2) coordinating together, respectively. Thus IM has a multifarious nature, making it difficult to determine whether it is most appropriate for unambiguous or ambiguous tasks.

### 2.4.2 Multitasking and Interruptions

More quantitatively oriented work has attempted to examine the fast and fragmented nature of media use. This group of work focuses on multitasking. González and Mark (2004) found that people on average worked on 10 different working spheres, and spent about 12 minutes before switching to another sphere. Working spheres can be thought of as a project with a well-defined goal, though the concept deemphasizes that the project must be affiliated with a workplace (Mark and Poltrock, 2004). Individual events, on the other hand, lasted only 3 minutes before being interrupted. This highlights the fragmented nature of information work, and also highlights that media usage itself is fragmented. Communication
among different groups of people is also fragmented (Su et al., 2007). Task switching was
found to be often caused by communication such as telephone as well (Czerwinski et al.,
2004). Iqbal and Horvitz (2007b) examined the influence of conversation when multitask-
ing on the computer. 48% of conversations caused users to become temporarily inactive in
their computer usage. For most of these cases, users became active again as the conversa-
tion continued on. Computer usage in parallel with conversation was characterized by
significantly lower application switch rates. Moreover, people often switched to peripheral
applications (akin to switching working spheres). While the study indicates the detrimental
effects of interruptions. They have also been shown to be helpful: Jett and George (2003)
demonstrated that interruptions can provide relief from fatigue and informal feedback, lead-
ing to greater productivity. Finally, Harr and Kaptelinin (2007) note that interruptions can
have social dimensions, one interruption can cause “collateral disruptions” to those around
them (Orlikowski and Yates emphasize this social aspect of time).

Past work on managers have long noticed the ephemeral, disjointed nature of manage-
rial work (Horne and Lupton, 1965; Kotter, 1982; Kurke and Aldrich, 1983; Horne and
Lupton, 1965; Mintzberg, 1973). In a retrospective interview, Mintzberg (de Holan and
Mintzberg, 2004) argued that “the frenetic nature of the job...has gotten worse...managerial
work is the essence of human activity...it is not a profession.” Perlow (1999) found that en-
geineers also constantly face a barrage of interruptions, which ends up affecting their work,
and thus causing them to get behind. This “vicious” cycle is then repeated *ad hominem.*
She proposed a “quiet time” in order for people to help control such a cycle and man-
age multitasking (Perlow, 1997). Mintzberg noted that managers constantly communicate
on a regular basis (Mintzberg, 1973; Horne and Lupton, 1965). This research points out
how interactions are in general fleeting, no matter what the medium (with the exception of
planned meetings). Finally, a study by Hudson et al. (2002) on IBM managers found that
while interruptions could be viewed negatively, interruptions also served to direct and drive
managers towards accomplishing goals (e.g., reducing short-term memory load). Hudson
et al. also noted that workers managed interruptions differently depending on the medium used (e.g., ignoring telephone is easier than ignoring face-to-face conversations).

More recent work has looked into the media switching (Grandhi et al., 2003). Reder and Schwab 1990; 1998, through a method of shadowing (Bakeman and Gottman, 1997) predating González and Mark (2004), examined the multi-channel nature of collaboration in the workgroup. They push forth their agenda: “To model channel selection and effects in complex organizational environments, the overall communicative economy must be carefully considered.” 12 members of project groups were shadowed for approximately 4 days each over a 3 month period. The overall group members who were not shadowed were observed as well. Reder and Schwab (1990) identify multi-channel genres such as emails with face to face conversations. Close spatial proximity further encouraged informants to use email to switch to face to face. As with IM (Nardi et al., 2000), email is also used for channel switching. Reder and Schwab also argue that people choose media tactically—to influence, manipulate and control. Who you choose to be on your CC list can dramatically influence others. The researchers caution the reader to not assume that “new communication technologies may be effectively added to the repertoire of a workgroup without necessitating considerable readjustment of the equilibrium already established among existing channels in its communicative economy.”

Communicative chains, interactions happening one after another for an individual on a given task, were found to be common (Reder and Schwab, 1998). 60.2% of all chains were found to have had at least one channel switch, indicating that chains with media switches are a common phenomenon. Later work by Su and Mark (2008) used the concept of alignment (Pickering and Garrod, 2004; Fujimura, 1988) (continual management of media to accomplish tasks that “align” with one’s self and with those around you) to explain switching behavior in interactions. In addition to looking at media switches, Su and Mark also looked at organizational switches—the number of workplace connectors switches in a
chain to different groups of people in an organization (e.g., switching from interacting with your home department to your family). The length of chains and degree of switching could be predicted upon the first link of the chain, giving credence to the fact that chains may be “catalyzed” and have their character determined by that initial interaction. Stress was found to be associated with average chain length and duration, but was mitigated by the amount of media switching suggesting that switching may indicate the free, and deliberate usage of media that better integrate with multitasking.

Finally, some studies have noted the paradoxical situation in which technologies that seem to ought to bring in more communication actually cause overall communication to go down. Sarbaugh-Thompson and Feldman (1998) noted an increase in email usage lead to a decrease in overall organizational communication. Interestingly, much of the lost communication was in greetings. Email increases “absence availability,” thus decreasing the need for co-presence. Garrett and Danziger (2008) noted that while overall work communication (across all media) did not get reduced with IM use, interruptions were reduced, and conversational communication was similarly reduced (both personal and work-related). This gives credence to the hypothesis that CMC can allow people to self manage their temporal rhythms.

### 2.4.3 Rhythm Analysis

Several works have used work rhythms as a unit of analysis in analyzing media usage in the workplace. By visualizing work rhythms, Begole et al. (2002) and Tang (2007) point out that work patterns differ across time, location, and week. By examining past, recurring work rhythms, one can predict future presence based on current events. One can guess, for example, the amount of time needed for a certain individual to prepare and leave for an appointment. Golder et al. (2007) reported a similar result of predictable work rhythms.
with students using Facebook to communicate. Reddy and Dourish 2002; 2006 conducted
an ethnography at a hospital to examine how people use work rhythms to accomplish infor-
mation seeking. For example, rhythms can provide valuable information between nurses
and doctors. The regular rotation of doctors at intervals allows nurses to simply wait, rather
than waste resources and time when he or she needs to seek a physician. Their work builds
on work by (Zerubavel, 1985) that observed hospital workers maintaining awareness of sur-
roundings happenings. Similarly if you know a meeting is going to occur, you may defer
speaking with a person because you know you can speak to them a few minutes before or
after a meeting (Mirivel and Tracy, 2005).

Work rhythms suggest that media choice may not simply always be a proactive activity. By
gauging other people’s rhythms and thus knowing what others are doing, one may be able
to choose the appropriate media to communicate. For example, lunchtime is probably not
a good time to conduct phone calls because everyone will be out. On the other hand, you
may leave a voice mail, knowing that the person will undoubtedly check it after lunchtime.
Moreover, complex media sequences may be influenced be work rhythms: e.g., bursts
of email, or opportune times to combine media readily (e.g., the use of a speaker phone
coupled with instant messaging may be more easily accomplished when people are not
around).

2.4.4 Linguistic Analysis

Another angle is to look at CMC as a linguistic dialogue. This has proven especially rel-
evant to examining communication through video conferencing. These works present a
rejoinder to work that seemed to indicate the primacy of audio, and the relevant little to be
gained through video (Chapanis et al., 1972, 1977). Though not strictly involving temporal
analysis, the linguistic point of view sees dialogue as a back and forth (cf. Have, 1999)
process involving subtle corrections and readjustments. Common ground (Olson and Olson, 1990; Clark and Marshall, 1981)—mutual knowledge, goals, and understanding—can be established through dialogue but linguistics have long noted that people need to be able to reestablish and repair their conversations (Garfinkel and Sacks, 1970). Grounding is the process of updating common ground and its two main factors are purpose (what two people are trying to accomplish) and the medium of communication (the techniques the medium provides to communicate). For example, the medium can restrict the sequentiality of turns (Clark and Brennan, 1991): “In face-to-face conversation, turns ordinarily form a sequence that does not include intervening turns from different conversations from other people. With email, answering machines, and letters, a message and its reply may be separated by any number of irrelevant messages or activities; interruptions do not have the same force.” Similarly, mediums restrict us in reviewability, revisability, simultaneity, etc.

Studies have examined to what extent does CMC allow effective grounding. Fussell and Kraut (2004) argued that a shared visual space in CMC is “essential for collaborative repair because it facilitates” common grounding. Gergle et al. (2004b) asked how much history of the chat dialogue is needed in instant messaging chats. History was found to be essential in lowering the cost of conversational grounding in lexically complex tasks. Their results also confirmed findings of Fussell and Kraut (2004) and Gergle et al. (2004a) on the importance of shared visual spaces. Isaacs and Tang (1994) study on video in remote collaboration revealed that the effectiveness of video conferencing depends critically on transmission speed. In particular, being in sync with audio drastically effected the quality of collaboration. The quality of video also effects peripheral cues and side conversations that are part of normal face-to-face interactions. Video did offer advantages, such as less social pressure (eye contact was not as visible) and less wasted time (social talk).

The linguistic turn on media usage draws from a conversational, interchange perspective. It implies that the temporal analysis of media might be framed in terms of how media allows
one to continually produce a series of question and answer statements that eventually reach the successful conclusion of a task’s goal. It brings to focus that this active engagement in interaction may be influenced by the variety of media choices, and that being able to sync, or align, each conversational fragment through appropriate media is crucial in establishing common ground. We will later discuss in this dissertation (Chapter 9) how historical records of conversation may be similarly applied to patterns of action. While we do not focus on video because it was rarely used in our field site other than for planned meetings, literature on video as a medium has shown the importance of temporal aspects in facilitating conversations.

2.5 Combining Two Perspectives: Routine uses of Media

Our interest in this survey chapter is find ways of explaining and analyzing how people appropriate multiple media temporally. Previous theories of “multiple media” have relied heavily on rich media choice, which has been highly criticized. Media Richness Theory (Daft and Lengel, 1983; Trevino et al., 1990) is a model based on the interaction between two key concepts: richness and equivocality. The model proposes that efficient work is accomplished when the optimal medium is chosen for a task’s degree of equivocality. More specifically, “rich” media are best for highly ambiguous tasks, while media lacking richness are best for routine tasks requiring little cognitive effort. The media in descending order of richness are: face to face, telephone, personal written communication (e.g., letters), formal written communication (e.g., memos) and finally numeric documents (e.g., spreadsheets, computer output). Note that the seminal work of Daft and Lengel (1983) largely predated the widespread usage of email, instant messaging and video conferencing we see now. It has been criticized as being overly rational (Fulk et al., 1990) and too simplistic in assigning a constant “richness” to a medium at all times (despite the context of its usage) (Whittaker,
Instead, it may be worthwhile to examine (without claiming it to be a grand unified theory) media usage from a temporal aspect, or more specifically, the patterns of media activity that occur throughout the day. While the routineness theory does not explicitly turn to time based analyses, it nevertheless deals with a sense of a recurring, identifiable pattern. We are interested in two particular components of media, its relation to each other to form ensembles, or temporal patterns of action.

In the next subsections, we outline several “problems” of media usage that merit further investigation. These areas, we believe have not been investigated in great detail in past literature. While this dissertation does not claim to answer all the problems we have listed, we believe it a step forward in addressing how media is appropriated through temporal structures in our everyday work.

2.5.1 Examining Media Relations

Problem: People use more than one media, and combine them (possibly with actants other than just other media) in unique ways.

Routines Routines and its techniques (e.g., narrative networks) allow us to see media as actants in a network. Narrative networks allow us to map the number of different possible combinations of media usage in accomplishing a task. Moreover, Actor-network Theory (Callon, 1996) notes that each actant is similarly composed of its own networks. Thus one can imagine media and its combination being nodes in the network. Crucially, this asks why some media is combined, why some are broke apart, and why some media are preferred over others.

An Ecology of Media By taking an ecological approach to media usage (Nardi et al.,
2002a; Tacchi et al., 2003), we may better understand the relation of an object’s possible affordances (Norman, 1990; Gibson, 1986) in the environment with the task at hand. Of particular interest is how in Gibson’s definition of affordance (Gibson, 1986), we perceive only a subset of the total actions available with a medium. Also, Nardi et al. (2002a) point out that key elements of media ecologies include 1) tasks, 2) relationships, and 3) temporal flow. In their discussion, they frame media ecologies in part in terms of how much face to face is needed, and when can CMC substitute or complement face to face interactions.

**Integrating Media into Multitasking** What is the relation between communication via media and solitary work? What drives the other, shaping the workday? Should the equivocality of solitary tasks be examined?

**Interlocking Affordances** Multimodal interactions are difficult to code (Voida and Mynatt, 2006) but nevertheless can lead to an understanding of how affordances complement each other. If we have a variety of media at hand, how is it that we combine media together to perform tasks? What kinds of media combos (or genres) are there? Media switching gives a hint of how media usage is combined sequentially, but media usage is also combined together simultaneously. Media usage is also done sequentially, but sometimes with long gaps. This raises issues of defining what is a combination. Consider that phone call follows to an email (asking, “Did you get that email?”) might be a combo of interest. The use of IM to facilitate conversation or awareness is another combo. Furthermore, one might ask, are there media usage savants? What patterns arise comparing savvy users with others less deft in media assemblage? How do people combine media with people and/or solitary work?
Design  Chalmers and Galani (2004) noted that people will weave interaction systems into their social lives without technological help. How does one design artifacts with the proper affordance that encourages its combination with other artifacts (that may not have been invented yet)?

Compensating for Cost  Clark and Brennan (1991) hypothesize that there are different costs to using different media in different ways. For example, production costs explain that it costs more to produce an utterance in some mediums than others (more effort to type than to speak). Start-up costs explain how talking on the telephone requires less effort than email (installing software, etc.) While these costs may not be comprehensive or even correct (starting up an email client and leaving it open may make email have a lower cost overall), the notion of communication as being costly may be useful. People may combine media together to make it less costly to use overall.

2.5.2  Addressing the Temporal Aspects of Media (and its combinations)

Problem: People use media to interact with many people for different reasons.

Managing Groups of People  Certain media may be better suited for dealing with certain groups of people. For example, communication with your friends and family are private, and media like IM (Grinter and Eldridge, 2001) which facilitate multitasking (e.g., quickly hiding the screen or integrating it with work) might be appropriate. Email and mobile phones have been shown to facilitate the “escape” of certain interactions (Markus, 1994; Ishii, 2006). Interaction is also a visible process, and how people attempt to increase or decrease visibility may be of interest. Other research has shown that CMC can help facilitate certain types of social ties (e.g., family versus
weak ties) (Kim et al., 2007). How do media combinations relate to people combinations?

**Ripple Effect of Interruptions** Harr and Kaptelinin (2007) note that interruptions have an inherently social dimension to them. One interruption can cause a ripple effect among several different people. For example, interrupting a conversation can cause another conversation to halt. From the media perspective, we might wonder if certain media and tasks are more likely to lead to ripple effects, and ask how to quickly recover from the domino effect instigated by interruptions.

**Problem:** Media usage is influenced by time.

**Routines and Work Patterns** The interplay between work patterns/routines and media would reveal how knowledge of other’s work rhythms may influence media usage.

**Longitudinal Studies for Media Usage** Overtime, people find strategies to fix media’s shortcomings. How this process occurs and evolves is little understood and studies over a period of time are needed (Feldman, 1987).

### 2.6 Conclusion

In this survey we have extensively covered the literature on routines/time in the workplace. We have also covered the literature covering the temporal aspects of computer-mediated communication (CMC). We propose to bring the two forms of literature together. We are interested in how media is appropriated and deftly combined to provide solutions throughout the workday. Routines provide a useful framework in that they explain the subtle, achievement that is worked upon by employees to carry out routines unproblematically. On the other hand, the CMC research has shown that people shape the technology to fit
their multitasking needs: people switch rapidly between working spheres, are disrupted by interactions, and can discern (and utilize) the remote and local working rhythms of others. CMC is also situated in a linguistic context, and thus must support grounding of conversation for different levels of communicative complexity and purpose. Finally, many of the costs of media usage are peculiar to a certain type of media.

Hence, an approach from a viewpoint of routines into CMC usage may be beneficial. Routines encapsulate the notion that such a phenomenon is readily identifiable, yet difficult to encapsulate in a standardized script. Techniques that first recognize and discern between different routine uses of media, and then analyze the context to which these media uses are being carried out may bring up towards answering the ways people appropriate multiple media temporally.

In the next chapter, we turn to explaining in detail the field site and methods we draw from to tackle the analyses of the temporal nature of media in the workplace.
Chapter 3

Field Site and Methods

3.1 Introduction

In this chapter, we will outline the shadowing methodology, as well as the two field sites (Loquor and Audite) from whence our informants came from. The shadowing method we use directly draws from studies by González and Mark (González and Mark, 2004; Mark et al., 2005). The reader should note that the coding done on the two field sites is slightly different from each other.

3.2 Shadowing

Observations at both field sites were conducted through the shadowing method. Shadowing is an intense form of observation in which the researcher observes and follows the informant whenever possible. The researcher carried a notepad and would record and timestamp the informant’s activities. As much as possible, the researcher would sit directly behind the informant to fully observe the informant’s focus of attention, e.g. a computer screen or pa-
pers on the desk. The key data points that were recorded were an activity’s start/end times, artifacts utilized (e.g., PDA, cell phone or stationary), person(s) (if any) interacted with, goal of the activity and relevant quotes. We made it clear that the informant could at any-time ask the researcher to temporarily leave to return at a later time, or ask the researcher to stop taking notes whenever they felt uncomfortable with a certain event being recorded. The researcher remained as unobtrusive as possible, and informants were asked to act as they normally would. Whenever something unclear would arise during the shadowing sessions, the observer would typically reserve questions until the end of the day.

Shadowing has been shown to be an effective technique for gathering data rich for qualitative and quantitative analysis (Perlow, 1999; Mark et al., 2005; Su and Mark, 2008). Our goal was to get a snapshot of a person’s daily work life. To capture this egocentric viewpoint, it necessitates that one becomes fully entrenched in the informant’s own cultural setting. Informal interactions, other social arrangements and nuanced practices that every worker has nurtured are an important part of work life that can only be seen by stepping into their shoes. As such, we felt that diary studies or surveys would be ill suited for a deep analysis of interaction in the workplace.

We asked informants themselves to choose the days for shadowing. We only asked that the days be relatively normal—if one were to look back on the days chosen for shadowing, it would be a reasonable representation of what their worklife is like. In other words, we asked that they avoid days featuring special events, circumstances, or meetings. For example, a day when an informant had to attend an in-company conference the entire day was unusual and hence avoided. The days need not be contiguous (e.g., shadowing could happen on Monday, then next week’s Wednesday, followed by a Thursday two weeks later).

For both field sites, all events written on the notepad were coded into a particular medium. When transcribed to a spreadsheet, each row represents the time spent on a single artifact
or communicative channel (hence referred to as the medium utilized) doing an activity. The medium categories we used are listed in detail in Table 3.1.

### 3.2.1 Coding Details

For only the Audite field site, we also utilized the working sphere construct. Following procedures from González & Mark 2004, we hand-coded each activity into a working sphere (WS), a useful higher-level abstraction of tasks/projects in the workplace. The concept of working spheres (Mark and Poltrock, 2004) encapsulates the notion of “projects” in the workplace. A WS is a “whole web of motives, people, resources, and tools that distinguishes it from other working spheres” (González and Mark, 2004). Thus, WSs perhaps better convey the notion that projects are not simply about office work, but a set of interrelated events that share a common goal, involves communication with a particular set of people, uses unique resources, and has its own time framework.

Because the focus on Audite was on “routine” tasks, the routine projects informants did were identified as working spheres (albeit, routine working spheres). Each informant at Audite was pre-interviewed and asked to detail what their current routines were. We also asked them what their current projects were regardless of whether or not the projects were considered routine. While this created an initial subset of WSs that the observer could expect, we also queried the informant when new WSs were encountered. This was done either during an opportune moment near the new WS instance (e.g., when walking to a meeting), or during interviews we conducted after each shadowing day ended at the close of business. After each shadowing session ended, we coded each event (see previous section for details on what events were recorded) into their respective WSs.
<table>
<thead>
<tr>
<th>Media Event</th>
<th>Abbreviation</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face-to-face</td>
<td>F2F</td>
<td>Ad-hoc <em>(unplanned)</em> conversation with coworker.</td>
</tr>
<tr>
<td>Meeting</td>
<td>Meeting</td>
<td>Attending a <em>planned</em> in-person or teleconference meeting.</td>
</tr>
<tr>
<td>Email</td>
<td>Email</td>
<td>Writing an email to the boss.</td>
</tr>
<tr>
<td>Instant messaging</td>
<td>IM</td>
<td>Receiving an IM from a friend.</td>
</tr>
<tr>
<td>Phone</td>
<td>Phone</td>
<td>Calling a customer.</td>
</tr>
<tr>
<td>Internet browser</td>
<td>Browser</td>
<td>Using a travel reimbursement website.</td>
</tr>
<tr>
<td>Operating System and Utilities</td>
<td>OS</td>
<td>Browsing or launching applications through Terminal, Explorer, or the Start Menu. Running low-level systems applications (e.g., System Administrator, Defragmenter, etc.).</td>
</tr>
<tr>
<td>PowerPoint</td>
<td>PP</td>
<td>Creating slides for a meeting.</td>
</tr>
<tr>
<td>Spreadsheet or database</td>
<td>SS</td>
<td>Entering data into Excel or Access.</td>
</tr>
<tr>
<td>Word processing</td>
<td>WP</td>
<td>Editing a document in Microsoft Word or Notepad.</td>
</tr>
<tr>
<td>Calendar</td>
<td>Calendar</td>
<td>Adding a meeting entry to a Palm pilot calendar or Outlook’s calendar functionality.</td>
</tr>
<tr>
<td>Stationery</td>
<td>Stationery</td>
<td>Writing on paper forms or Post-It notes.</td>
</tr>
<tr>
<td>Misc. applications</td>
<td>App</td>
<td>Starting an MP3 (software) player or playing video games.</td>
</tr>
<tr>
<td>Hardware</td>
<td>Hardware</td>
<td>Debugging a printer or copy machine.</td>
</tr>
<tr>
<td>Self</td>
<td>Self</td>
<td>Informant <em>is</em> the medium: walking, snacking, bathroom breaks, etc.</td>
</tr>
</tbody>
</table>
Regarding “Parallel” Events

Sometimes, events would arise that made sequential-style transcription especially difficult. Fast movement of the eye, saccade, made it near impossible to discern what medium the informant was focusing in on certain events. The speed at which written notations (even with shorthand) could be taken precluded accurate note taking in such sessions. The most obvious example is, for example, when someone is rapidly moving focus between a piece of paper attached to the monitor and a productivity application such as PowerPoint.

In such cases, the observer would notate both events as occurring, but give one a “priority” label. If the observer determined that the “main” event was editing a PowerPoint, with occasional glances to a piece of paper, then the PowerPoint media event was designated with a priority label. This sort of coding was only done on events switched with extreme rapidity, and the majority of events we observed did not have this problem.

3.2.2 Survey Administration

Both field sites’ informants were administered at least three surveys at the end of the entire shadowing session. First, we had informants fill out the Job Content Questionnaire (JCQ), an instrument which operationalizes “job strain” into job demand and job decision latitude (Karasek, 1979). Our version of the JCQ uses a 7-point Likert scale. Second, we gave the polychronicity scale (Bluedorn et al., 1999) to each informant. The polychronicity scale measures the extent to which one prefers multitasking and believes multitasking is a good strategy for work—i.e., carrying out more than one task simultaneously. Third, a subset of inherent personality traits were measured through the Big-5 scale (John and Srivastava, 1999).

At the second field site, Audite, in addition to the above scales, we also administered three
surveys at the end of each day. These include the NASA-TLX (Task Load Index) scale (Hart and Staveland, 1988), a standard survey used to measure stress as a composite of perceived workload, time pressure, effort and frustration; questions adapted from the Job Diagnostic Survey (JDS) (Hackman and Oldham, 1974) and its revised version (Idaszak and Drasgow, 1987) to measure job autonomy; and questions adapted from the Health and Work Questionnaire (HWQ) to measure worker productivity (Halpern et al., 2001). Final composite scores of productivity, autonomy, and workload were calculated by simply summing up the individual questions.

As a caveat, productivity and job autonomy were self rated. While metrics could have been used, for example, to automatically derive one’s productivity, it is difficult and time consuming to derive a single score that adequately captures whether one’s day was productive. This is a possible limitation in our study, but we believe that like stress, measures such as autonomy and productivity can be self-reported and account for what the informant (who should be able to compare with his or her own past work days) feels the day was like.

To reiterate, each day has measures of stress, productivity, and autonomy, while each informant has a personality, JCQ, and polychronicity measure. Statistical analyses were carried out in R (http://www.r-project.org).

All the surveys we used have a history of reliability, generalizability, and validity. Fields (2002) provides an excellent guide to survey instruments in the organizational research domain. Rick et al. (2001) conducted a detailed review of survey instruments dealing with psychosocial hazards (e.g., workplace stress). Please refer to Appendix B for the survey instruments.
3.3 The Field Sites

Informants were recruited by email from an initial pool suggested by our contacts at both field sites. We then used a snowball sampling technique to recruit other potential informants. Internal directory services were also used to find and contact potential subjects. After an email contact, the researcher spent 15 minutes in a face-to-face conversation detailing the goals and methods of the study. A pre-interview was conducted to ascertain what regular interactions they participated in. After the pre-interview three full days of observations were initiated; the observer would meet the informant as he or she came into work and end the session once their work day was over.

3.3.1 The Loquor Corporation

Loquor Corporation is a large corporation headquartered on the U.S. West coast with offices also distributed across the U.S. The corporation serves in an advisory role by providing expertise on scientific and technical issues for its customers. It currently houses over 2,000 employees. It is a non-profit entity.

In total, twenty informants were recruited and shadowed from Loquor over a two year period. Shadowing at Loquor as completed before shadowing at Audite. Below is the makeup of our informants’ job positions:

- Administrative Assistant 1
- Library Staff 2
- Business Manager 1
Unlike Audite, we shadowed each informant at Loquor for 3.5 workdays. Because we were not under a tight time constraint, we were able to more gently introduce informants to the shadowing concept by first asking potential informants to try just half a day of shadowing. An initial half day shadowing session was done so that the informant would get used to having a shadow, and so that the observer would get acclimated to the informant’s environment. At Audite, through managerial connections, we were able to immediately commence with the three full days of observations.

### 3.3.2 The Audite Corporation

Data was collected *in situ* over a three month period at a for-profit corporation, Audite (all names and places are pseudonyms), specializing in research with over 200 employees. We
shadowed a total of 10 employees for a total of 29 observed sessions. All but one informant (who was shadowed only two whole days due to scheduling constraints) were shadowed for three whole work days (each approximately eight hours). We have approximately 235 hours worth of transcribed data. We screened for subjects who had a WS that needed to be done at least once every month. The majority of our informants are part of the support or technostructure (Mintzberg, 1980) of Audite. Below is the makeup of our informants’ job positions:

- Accounting Staff: 3
- IT Staff: 2
- Library Services Staff: 2
- Intellectual Property Staff: 1
- Lab Administration: 1
- Research Manager: 1

To ensure a good mix of WSs we asked people to describe tasks done routinely (periodically), but not entirely routine (trivial) to accomplish. In general, such tasks were not as routinized as ones in project Ernestine (Chapter 2). We then scheduled shadowing to coincide with a day where the informant believed it likely he or she would work on that routine WS (n.b., the three days of observation were not required to be contiguous). Importantly, people were asked to work as they normally would—indeed, sometimes people never got around to working on their self-identified routine WS. Routines our informants did on a monthly basis included status reports of projects, the closing of company revenues, the gathering and summarizing of IT metrics (e.g., phone or OS usage statistics), and paying off company corporate bills. Examples of routine WSs done on a weekly basis included serving on help desk “duty” for an IT department, processing travel expense reports, and doing a literature review.
Audite also allowed us to video record informants as they worked as well as install software to log screenshots of their computer activity. We also mounted a stationary video camera in the room to record all work done in the office. Since operating the camera simultaneously during note-taking was found to be difficult, our video record does not include events when the informant was mobile. The video was used to clarify events when the observer notes were found to be unclear or have errors.

3.4 Some Personal Reflections on Shadowing

![Figure 3.1: A researcher observing his informant.](image)

This section presents some personal reflections on the shadowing method. *Kitchen Stories* is a movie about researchers conducting observations of Swedish single men in hopes to develop the “optimal” kitchen (Bergmark and Hamer, 2003). Each researcher is assigned a household and literally sits in a high chair placed in the corner of the kitchen, observing their informant’s movements and activities. In a climatic scene late at night, Folke goggily opens the door to a disconsolate fellow researcher (Green):

**Green:** Were you asleep? Tor and I are in a bit of a pinch.

**Folke:** Tor?
**Green:** My host...we’re all out of booze. You wouldn’t happen to have any liquor to lend us?

**Folke:** We aren’t allowed to drink on the job.

**Green:** Not allowed to drink, not allowed to talk... Shit, Folke, what the hell are we doing? We sit up there on our pedestals and think we understand everything. How can we think we can understand anything about people simply by observing them?

**Folke:** That’s the nature of our research.

**Green:** We have to talk to each other! People have to communicate! Don’t you at least have some beer?

**Folke:** Our research is based on a positivistic approach.

**Folke:** Positivistic? I’ve decided to quit—that’s the most “positivistic” thing I can do... Just a couple of beers...

**Folke:** No.

**Green:** Come on...

**Folke:** No, Green!

**Green:** Shit! I thought I could talk to you. Stupid idiot. Observe yourself, for Christ’s sake! [storms off]

Folke then offers his own confession as Green angrily leaves:

**Folke:** Wait, Green! I have also talked...I have also talked to my host.

While this frank discussion among researchers is perhaps an overly dramatic one, it illustrates an important tension that we have encountered in our ethnographic research—it is difficult to maintain a passive, non-participatory role when closely observing a person.

Like Folke, we too have confessions and this section will detail our own observations on being an observer. This section does not deal with the specific dissertation topic we are pursuing per se; rather it is a vignette on the method itself. It espouses our nascent opinions about observing and will also offer the gentle reader “tricks of the trade.”
As mentioned, shadowing is a technique whereby the observer watches the informant for long periods of time (three full days) and follows them where ever they go. In essence, they are the informant’s shadow and like the proverbial fly on the wall, the informant should act as they normally would without regard for the observer. The observer takes copious notes and is as unobtrusive as possible. However, the observer is free to ask questions during the session and the informant will, if comfortable, use the talk-aloud technique.

A subset of participatory observation (Spradley, 1980), shadowing has the peculiar assumption that one does not know “enough about the organization a priori to identify relevant problems and hypotheses and that they must discover these in the course of the research” (Becker, 1958). Thus, shadowing is a grounded theory approach to cultural analysis (Strauss and Corbin, 1998).

### 3.4.1 Bias

First off, as an observer you should give up the notion that your study will be fully objective. While it is a goal you should strive for, it is not one that you will ever achieve. This is a mindset that I have found helpful. There will be times when you miss an observation you thought was vital. You may feel that you have sacrificed some of your data’s integrity. As a researcher you must strive to record data accurately and completely, but the nature of qualitative research is such that it is impossible to separate the observer from the observations. As such, your bias and the informant’s bias will be reflected in your work. Your subject’s behavior will change to some degree because of your presence (Hawthorne effect)—this is a common comment we get asked when we are asked to describe the study’s methods and goals. However, it should be noted that most studies are affected by bias; consider that the very choice of questions in a survey instrument necessarily biases the results. For our
research goals, we deemed shadowing as the best way to truly understand how individuals navigate through their social networks.

### 3.4.2 Tools of the Trade

Our particular arsenal of tools include a notepad, pen, pedometer, digital watch and a book. We found that paper and pen work best for quick data entry. Reporter style notepad are particularly useful for jotting quick records. You will also need to develop a system for writing notes down. The format will largely depend on what data items you are collecting, but it will include abbreviations. Consider using diagrams also as shortcuts. For example, I have devised shortcuts for 1) the start/end times, 2) media types (e.g., F2F = face-to-face), 3) parallel events, 4) when an event occurs that is related to a previous event (e.g., an event is a continuation of a previous interrupted event), 5) whether an interaction is directed towards, or was received from someone, and 6) various miscellaneous events (e.g., observer had to go to the bathroom or informant wanted this activity censured). Figure 3.2 shows a sample page from my notes.

Latter notes were taken with the Livescribe pulse smartpen (www.livescribe.com), a digital pen. Like a traditional pen, notes are written with ink as usual on a paper pad. However, the paper pad needed for the digital pen is marked with discrete points. Coupled with a camera on the pen, the notes are digitized and uploaded to the computer. The included software can perform optical character recognition (OCR) on the strokes, allowing one to quickly search through handwritten notes. A special feature of the Livescribe pen is that it can record audio while one is writing notes. One can then reference the audio that was heard when a particular stroke was written. This is particularly useful when the informant is thinking aloud about his or her current task. This can also remind the observer of what was happening during the note-taking, thus allowing clarification of possibly il-
Figure 3.2: A sample of my notes.
legible notes. We found the pen particularly useful for storing notes digitally in a portable format that can be quickly shared and backed up. The pen can also help clear up the exact time between events (should the event involve an auditory component). However, one must always reference the time to whatever one determines as his or her “global” clock. In our case, the global clock was the wristwatch of the observer.

Laptops are useful, but lack mobility. PDAs are certainly portable, but their data entry methods make them less then ideal. If your informant is stationary, then a laptop may be viable, but consider that very few people remain stationary all day long. Important conversations will arise in trips to the cafeteria, the bathroom, on the way to pick up mail, etc. These events often happen suddenly and without warning. You will find that the most interesting conversations do not occur in “official” places of work (e.g., offices or laboratories) but rather “informal” places of work. Lugging around a laptop or profusely trying to enter Graffiti into your Palm while walking will be an exercise in futility. However, if your study focuses on a stationary environment (e.g., VTC meetings) then a laptop will prove useful since customized (albeit, a priori defined) macros can be created to quickly record data events.

Just as a digital photographer carries many batteries, a shadow should carry many pens. We cannot emphasize how many times pens have broken during note taking. Pen have leaked profusely over a page and the ball in the “ballpoint” pen has literally fallen out. Please carry at least three pens at all times.

Depending on the nature of your research, one will bring different tools. For example, our research was at one time concerned with mobility (not anymore) and event switching. So, we used a digital watch to timestamp data as well as a clip-on pedometer to measure distance covered.

Why bring a book or other reading material to your shadowing session? While you may be
taking copious notes, there will be times when note taking is not required. This situation may arise if you have already recorded an event and the event is lasting several hours. The book will help pass the time. Let your observer know beforehand that when you are reading a book, you mean no offense and that it simply means you have finished recording a particular data event. A book will put the informant at ease. When you are reading a book, people feel less pressure to engage in small-talk and also are less likely to be worried about “boring” you. It also indicates to them that you are not jotting down whatever they are currently saying.

However, you should also use free time to observe your environment, and to clean up your notes. The later is especially important. For example, we frequently find ourselves rewriting “4s” and “9s” because they often look alike when written quickly. It is essential that you clarify your notes as soon as possible, because after a few days much of it may be illegible and difficult to recall.

Another tool that is not mentioned often in ethnographic manuals is clothing. As a shadow, you should blend into your environment. The best advice is to “dress accordingly.” If you will be shadowing a programmer, then perhaps jeans and a T-shirt will be acceptable. If you will be shadowing a CEO, then perhaps a suit will be better.

### 3.4.3 Prepping your Informant

A point we cannot stress enough is that you should be explicit in what your methodology is to your informant. A good way to do this is to have a brief chat with your potential informant describing the methodology you will be doing. For example, I assure my informants that I will not be following them to the bathroom. Not only will you be defining what you will be doing (e.g., taking notes, peering over their shoulder, etc.), but you will also be defining what the informant must do.
By this, I mean that you should develop a precise protocol of how the informant will notify you of trouble. Trouble can come in many forms, but the most common ones deal with privacy. People will inevitably talk about personal matters with others and sometimes they would rather you not be there. You should assure the informant that it is alright to ask you to leave. Also, as is standard in any human-subjects study, informants should be notified of their right to drop out from the study.

Unless your informant lives a solitary life, you also need a protocol for third parties. You should have a quick one-liner about your research that you can blurt out in your sleep. Avoid academic-speak and make your one-liner the kind you can tell your grandparents when they ask you what you did your PhD in. You should ask your informant to somehow announce your presence if they are going to meetings. It is helpful to have your informant notify their immediate department of your presence as they are likely to be in close contact with the informant throughout the day.

One of the most common comments we get from people whom we are trying to recruit is, “Well I’m fine with it, but you know my day is pretty boring.” People think their days are boring simply because they experience it each day. Explain to your subjects that whatever it is they do, you will be interested.

Another issue is lunch. For some informants, lunch is a time to relax. You should allow your informant to relax without your presence. On the other hand, lunch conversations can be a valuable source of data full of ad-hoc interactions. We generally enjoy accompanying informants to lunch. For example, one can learn a lot about the informal communities people interact with at work through lunch time shadowing.

At the end of a day, we prefer to ask informants if their experience was OK: “Was there anything that made you uncomfortable?”; “Was there anything you want me to do differently while I observe you?” For example, one informant told me that I was sometimes
encroaching his/her private space. So, we arranged to have me sit in a different location during office observations that was more comfortable for both of us.

3.4.4 Observing

Most people try to be nice and courteous to others, especially to people they don’t know very well. As a result, you will find that many people will not tell you if they are uncomfortable or want some privacy. Indeed, as an observer, you must be attuned to physical signals that a person may unconsciously be making. For example, we have encountered informants talking to their co-workers about a funeral or a recent illness. In such situations, you may very well maintain a larger distance from your informant as you normally would and avoid overt eavesdropping. Similarly, a quick frown or a sigh can indicate to you that you should perhaps stop taking notes momentarily. At the same time, do give yourself credit in that the informant has agreed to participate and it is their responsibility to tell you if they experience any discomfort.

In our specific study, people sometimes try to schedule a day of shadowing on days they think will be interesting (e.g., days with lots of meetings, unusual events, etc.). In our case, we were seeking data that in total would be representative of their work life, so it was important to tell our informants that they should be shadowed in a variety of days, not just the “exciting” ones. It is your job, not the informant’s to decide what is interesting.

As Folke found out, you may develop a rapport with your informants. An advantage of shadowing is that you meet a diverse set of people you might not normally encounter. As such, from day to day, you will find many topics that will pique your interest. Pictures hung on the office wall, music CDs strewn on the desk and dog-eared books will become potential ice-breakers for you and your informant.
It is important to establish trust between you and your informant. If you remain aloof and refuse to engage in dialog, trust will never be established. That is why we recommend that you go ahead and converse with your informants. This does not have to be about work, but it can be about anything—hobbies, music, etc. Establishing trust will lead to a more unbiased observation. The informant will in fact feel comfortable doing whatever it is they usually do. Furthermore you must reciprocate this trust; the informants will trust that you will not divulge private or sensitive information to others. Geertz’s famous piece on Balinese Cockfighting is a vivid illustration of establishing trust (Geertz, 1973).

In any organization, there will be so-called water cooler conversations. Some of your most important data will come from these sources. In both the companies we studied, acronyms play a big role. What set of acronyms one knows immediately conveys to others who a person knows and what a person does. You should be aware that gossip often deals with sensitive material and you must act accordingly (next section).

An excellent way to get situated in your environment is to ask the informant to describe their actions as they do it. This is most crucial in the beginning phases. For example, in our studies, we do a pre-shadowing session—a half-day session as opposed to a whole day—to have the informant and observer familiarize themselves with each other. Now, this sort of verbalization is apt to slow your informant’s normal work done. So, it may not be necessary after a few hours.

Asking questions is an important part of shadowing, but when possible try to limit it. Patience is a virtue in observation and good things come to those who wait: “Many things that are unclear or not understood early in fieldwork will probably become clear through experience” (DeWalt and DeWalt, 2002). For example, it often happens that I am uncertain about the content and participant of a telephone conversation. I have learned, however, that people will often immediately follow up on the phone call via email. I can then interpolate the missing data. You can save unanswered questions for the end of the day.
3.4.5 Observing the Observer

As an observer, you will be observed. We don’t mean that your advisor or manager will be checking upon you from time to time; rather, your informants will be looking at what you do. They will notice when you write things and when you don’t and where you are gazing. You should be cognizant of this. People are remarkably adept at noticing things in their “blind spot.”

You should take advantage of the informant’s alertness by also openly showing when you are not taking notes. Shutting your notebook when you are informally speaking with your informant is a good gesture to indicate that you appreciate him or her labelling you as a confidant. The informant will be more at ease if they notice you putting your pen down when they, for example, speak with family members (in our case, personal data is not recorded, but if your study focuses on personal matters, then you may very well be taking notes in this case).

When you are observing your informant, do so in a comfortable location. This is not primarily for your comfort but for the informant’s. If they see you standing for a long period of time, they will feel undue sympathy for you. In my case, I made sure I observed people in a chair that was mobile and small. People have meetings in their office, shuffle papers in and out of drawers and cabinets and will do paperwork and computer work in different areas. Because your informant is mobile in their office as well, you must be also to observe them and to stay out of their way (and their guests’).

3.4.6 Summary

Though it may sound hackneyed, by the time one finishes the last session of shadowing with an informant, it always feel a tinge of sadness. After three days of shadowing you are
bound to have established some sort of connection and empathy for the informant’s life. However, do not end your connection after the shadowing. Keep the relationship going as you are likely to meet up with them during your other shadowing sessions. As such people at your respective organization will gradually not see you as simply a strange observer in their culture, but as a member of it.

### 3.5 Methodological Limitations

To perform effective “shadowing” of informants, the observer cannot be a source of interruptions. We thus kept clarification questions for the end of the day or for the post-interviews. Another limitation is that our observations are limited to one fieldsite. This is also true of a number of workplace studies (Orlikowski, 1992; Perlow, 1999; Sproull, 1984). It is very possible that factors unique to the organization affect the type of communities we observed. For example, social communities (drama clubs, scrapbook clubs) seem to not be common practice in many organizations. We would need to investigate other organizations to understand more completely how organizational factors affect the types of communities that exist.

As with all studies focusing on a limited number of sites, the issue of generalizability can be problematic. While the number of people we observed (30) is greater than other such studies, e.g. by Perlow (1999) and Sproull and Kiesler (1991), we nevertheless cannot claim that our sample is broadly representative. We did observe a wide variety of people which we believe provided a good mix of what an “information worker” is. Despite this, cross-organizational studies are needed to investigate the prevalence and effects of communication chains in the workplace. Certainly, most studies only cull data from a single site—we believe a strength of our dataset is having two field sites from which to derive results from.
3.6 Conclusion

Shadowing offers a method to directly capture the real-life behavior of information workers in their natural “habitat.” While labor intensive, the resultant data is amenable to both qualitative and quantitative analysis. Successful shadowing requires a particular sensitivity to the informant’s privacy, social needs, and physical spacing. Careful planning can ensure successful recruitment (e.g., a “trial” period of shadowing someone for just half a day). While automated tools for gathering in situ data may assist the observer, we have found the traditional paper notepad most flexible in adapting to the variety of (mobile) situations that most information workers encounter. A grounded theory approach can allow one to slowly shape the form in which “coding” of the gathered data shall be done.

Having described the field sites and methodological approach of our dataset, we now delve into the analysis. We first examine in what way do people multitask with the multiple communities one encounters in the course of their workday?
Chapter 4

Interacting Across Groups of People

4.1 Introduction

Through a wide range of information technologies information workers are continuing to expand their circle of contacts. In tandem, research is also focusing more and more on the role that both face-to-face and distributed interactions play in accomplishing work. Though some empirical studies have illustrated the importance of informal interaction and networks in establishing collaborations (Nardi et al., 2002a; Whittaker et al., 1997a), there is still a need for more in situ research to understand how different types of interactions support group work.

Various constructs have been used to characterize different types of workplace interactions. Much attention has been directed to the notion of community of practice (Brown and Duguid, 1991; Wenger, 1998) which explains how people are part of a professional community and slowly become acculturated into a specific work practice. Wenger applied the concept to explain how claims processors learn from each other, moving inwards to the core of the community where seasoned veterans of the organization are situated.
Aside from communities of practice (CoPs), other social constructs have been used as well (e.g., networks, knots, coalitions and teams) that attempt to explain how and why people interact—see Nardi et al.’s (2002) work for a review. Indeed, many of these concepts overlap, and it is difficult sometimes to discern what sets one apart from another. As a case in point, Nardi et al. describe the difficulties in discerning between knots, ephemeral collections of people and artifacts and their own theory of intensional social networks. Moreover, theories are often promulgated as being flexible enough to account for newer phenomenon, further occluding perceived benefits of one theory over another. For example, while CoPs was originally presented as an alternative to the traditional teacher-student model of learning (Lave and Wenger, 1991), it has been expanded considerably as a model for virtual as well as cross-organizational learning (Wenger et al., 2002).

Recognizing that socially grounded work can occur in many forms, we are interested in understanding what types of contexts exist in the workplace that lead people to form multiple forms of social interaction. For example, an individual might regularly interact with others face-to-face in the same collocated business unit. As members of the same department, they may share a common identity and provide mutual support. Other types of relationships in the workplace may be associated with other social properties that are shared among the interactants. For example, at the same workplace one can interact with others in the same organization who are in different business units. Social networks may be formed with others outside of the company. One may also be a member of more formalized communities in the workplace, such as CoPs where shared goals are important. Similarly, one’s private life communities consisting of friends and family may also be a part of the workplace. Perlow (1998) has written about how the borders of work life and home life are often blurred. We maintain that these various types of workplace relationships offer different functions for people and have different salient social properties that influence work.

Membership in various types of social arrangements involves maintenance work. Com-
munities not only provide support to its members but people also must contribute to the community to insure its continuation and their status as members (McMillan and Chavis, 1986). Interacting and maintaining membership in multiple types of social structures in the workplace therefore involves work that is above and beyond the visible work of producing identifiable and measurable task results.

4.2 Moving beyond communities of practice in the workplace

The notion of formal CoPs has gained much attention in recent years. The increasing popularization of knowledge management and organizational sciences in general has fostered a movement towards cross-organizational sharing. Through explicit procedures and policies, companies seek to nurture an environment conducive to knowledge sharing in order to reduce redundancy and the loss of so-called tacit knowledge (Nonaka and Takeuchi, 1996) when employees leave a corporation. A popular way of implementing such a strategy is through the sponsorship of formal communities of practice. Various works in literature are specifically aimed at teaching one how to create and integrate these communities in the organizational (Wenger et al., 2002) and technological levels (Kim, 2000) of workplaces.

Indeed, the view now that knowledge management techniques will improve an organization is indicative of an overall trend to reconcile rational and natural perspectives of organizational strategies (Scott, 1998). The rational perspective emphasizes the formalized structures put in place through processes and procedures. On the other hand, the natural perspective emphasizes the informal nature of relationships that inevitably arise due to multiple motivations. The notion of formal communities attempts to impose rationality to a usually natural phenomenon. The hope is that formal policies will bring about increased
informal interactions with a more focused lens toward achieving the organization’s goals.

However, formal CoPs is just one type of social arrangement in the workplace. Through ethnographic investigations and grounded theory (Strauss and Corbin, 1998), we have shifted our focus of understanding work from a perspective of CoPs to rather a more basic starting point of investigating the different kinds of contexts that lead social arrangements to form. We believe that by understanding better the commonalities or affinities that facilitate the creation of these different social structures, we can better learn how people accomplish everyday work.

We have elected to term these commonalities connectors. We believe connectors, defined by the Oxford American Dictionary as something that links two or more things together, nicely conveys the notion of the shared contextual experience that serves as a basis for linking people together into a social configuration. These connectors are what drive, in both overtly intentional and subtle ways, workers to form social arrangements such as formal CoPs, informal communities, or social networks. This chapter will identify the types of connectors that exist to bind people together in the workplace.

The initial impetus of our study was to investigate the community work lives of people in a high-tech corporation. The company is currently in the process of advocating and rolling out formal communities. We discovered though that we had the opportunity to compare workers’ participation in these formal communities with other types of social interactions. Our interest was in discovering what current types of contexts exist in the company to connect people and the role each type of social structure plays for the employee. Our larger research interest is in understanding how these various social structures in the workplace facilitate people in accomplishing their day-to-day work.

The purpose of this chapter is twofold. First, our goal is through ethnographic observations to identify the different types of connectors, or common contexts that link people together,
that exist in the workplace. Our second goal is to investigate the extent to which people switch among these different social entities throughout the workday. We are interested in people’s patterns of social engagement and how they distribute their time among these different social entities. González and Mark (2004) found that people’s workday consists of continually switching between projects. We also expect that people continually switch among different social structures. If so, we expect that people must invest effort in managing these different social arrangements, such as maintaining identity or influencing the community.

### 4.3 Shadowing Interactions

The dataset in this chapter comes from Loquor Corporation, during the first phase of shadowing. It consists of 10 informants’ data. Our goal was to get a snapshot of a person’s daily work life. To capture this egocentric viewpoint, it necessitates that one becomes fully entrenched in the informant’s own cultural setting. Furthermore, discerning “social activity” itself is a difficult task in that the boundaries between social structures are not clearly defined. Formal communities in the modern organization have been aggressively advocated by knowledge management practitioners through activities in various forms called CoPs, communities of interest, topic groups or committees. While these communities may be easier to delineate as they are organizationally specified, informal communities or other kinds of social arrangements that every worker has nurtured are an important part of work life that can only be seen by stepping in their shoes. As such, we felt that diary studies or surveys would be ill suited for a deep analysis of interaction in the workplace.

Studies in “identifying” communities in the workplace have taken different approaches. Andriessen (2005) uncovers several “archetypes” of knowledge communities by scrutinizing nine case studies of organizations. From his analysis, key dimensions were realized

75
and then applied to the case studies. This method is advantageous in that it compares a wide range of different organizational settings; however, it is a study which relies solely on third-hand accounts of organizational behavior. We believe a study that seeks to uncover types of communities or social arrangements in the workplace needs a deep, ethnographic inquiry into an organization’s culture. Quan-Haase and Wellman (2005) take an approach similar to ours in that they do observations of an employee for one full workday. However, their focus was on how the availability of instant interaction technologies has shaped trust in communities. Moreover, understanding the social structures that a person experiences necessitates an understanding of that worker’s work life. We therefore felt one day would not be enough to get fully acclimated to each informant’s particular working habits and environments.

4.4 Coding Interactions

Our technique closely follows that of other researchers who have used this shadowing and measuring technique to identify employees’ different activities in the workplace (González and Mark, 2004; Mark et al., 2005; Perlow, 1999; Sproull, 1984). However, in contrast, our data collection methods are more geared towards collecting both the specific intent as well as the participants of an activity.

Social structures in the workplace influence the worker in various ways. They can be viewed as a medium through which one conducts work. Work at Loquor is not performed within a vacuum, but as researchers in the field of social studies of science elaborate for scientific work (Callon, 1996), work is conducted within a social medium. If an information worker is, for example, designing a new project plan for their business unit, they are working within a social medium surrounded by others in their business unit who may have given input to this plan and who will be affected by this plan. Working with the knowl-
edge that they are within a social medium can have either positive or negative motivational consequences. For example, a positive atmosphere in an open office environment where people chat and share humor through their cubicle walls can motivate people to work hard. Conversely, a negative atmosphere can de-motivate people. As a medium, communities, or more broadly any social structures, facilitate work (positive or negative). For example, an informal community of business managers might facilitate decision-making for a member who faces a similar problem that had previously been discussed in the group.

When coding for social structure, we insisted that there be at least two people involved. The involvement may be face-to-face, or technology mediated (e.g. instant messaging or email). In this sense, the notion of a social structure as a medium is analogous to Wenger’s 1998 concept of community participation: I will not say that a computer “participates” in a community of practice, even though it may be part of that practice and play an active role in getting certain things done...In this regard, what I take to characterize participation is the possibility of mutual recognition. This type of coding is in contrast to actor network theory (Callon, 1996; Latour, 1992) in that working with artifacts (e.g., receiving events from artifacts or inputting information into artifacts) does not, from the informant’s point of view, constitute interaction with a community.

The motivation for following this scheme is that associating an artifact with a community or social structure is problematic. While specialized artifacts such as departmental forms or laboratories can be seen as belonging to a specific community (or communities), artifacts are multifaceted in that they cross boundaries (Star and Griesemer, 1989). Community work from an “artifact’s perspective” is highly contextual.

Our coding scheme seeks to capture the notion of a social structure as an entity that is facilitating work. This facilitation allows one to accomplish their work while at the same time reinforcing and reaffirming a person’s own membership in a particular social structure (Dourish and Button, 1998).
4.4.1 Criteria for Community Membership

To identify different social structures we turned to social properties associated with communities because we believed that these properties are general ones that could apply to a range of formal and informal types of social structures. The problem of defining community is one that has been revisited many times. Psychologists McMillan and Chavis 1986 defined and operationalized sense of community (SOC). Since then, various measures (predominantly through survey instruments) of SOC have been employed (Chavis et al., 1986; MacQueen et al., 2001). In IT-related fields such as CSCW and HCI, research on online and virtual communities has also defined communities within the backdrop of IT (Preece, 2000; Roberts, 1998; Whittaker et al., 1997b) Many of these definitions in fact overlap (e.g. common ground and support appear in one form or the other with most definitions). Using these community definitions as a springboard, we have refined the dimensions which define social structures to be applicable to the workplace as follows:

**Shared Goal.** Does the informant share with other members a common goal, interest, need or activity members that provides the primary reason for belonging to the social arrangement?

**Reputation.** How much do the perceptions and opinions of other members matter to the informant?

**Common Ground.** Does the informant have implicitly and explicitly shared experiences, behaviors and discourse with the other members? Identity. Does the informant place importance on being identified or associated with this social group?

**Support.** Does the informant feel that the social arrangement provides support such as help or advice from others? For example, sharing expertise or information is a type of valued support.
**Influence.** Does the informant feel that his or her opinion matters? Does the informant have the ability to influence or shape his or her group or community? For example, can one improve the community?

In our coding scheme, we considered that these six dimensions must be present for an informant to be considered a participant of a particular social structure. In going through all the recorded activities, we asked these questions as a litmus test to determine whether the activity was involved with a unique social entity. It is important to note here that this litmus test is something that only someone who has become familiar with an informant’s particular interaction patterns and environment would be able to meaningfully answer. By becoming ingrained in the corporate environment of Loquor, the ethnographer becomes an “expert” of a culture and the informant’s work life. Only then can the observer readily glean of which communities an informant is actually a member.

### 4.5 Results

We discovered that people were continually switching interactions between various social entities throughout the workday. In this section we will explain the types of connectors that linked people together as well as the extent to which people switched interactions.

#### 4.5.1 Connectors in the Workplace

We found that connectors (commonalities) among people in these different social groups could be characterized and could serve to delineate different social entities. In general, connectors could be *organizationally determined*, based on organizational boundaries, formal, where links among people were *formally* determined by the organization, and *informal*,
where links were formed in a bottom-up approach. Specifically, we identified the following and describe what their function was for the informants. Figure 4.1 summarizes the informants we shadowed, with the total percent time of interactions with each type of connector, described below.

<table>
<thead>
<tr>
<th>Job Position</th>
<th>Work Home</th>
<th>Company</th>
<th>Common Workrole</th>
<th>Social</th>
<th>Private</th>
<th>Professional</th>
<th>Formal CoP</th>
<th>Other</th>
<th>Unknown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Library Man.</td>
<td>49.52</td>
<td>26.55</td>
<td>0.16</td>
<td>--</td>
<td>3.28</td>
<td>2.39</td>
<td>12.89</td>
<td>3.39</td>
<td>1.81</td>
</tr>
<tr>
<td>General Man.</td>
<td>48.36</td>
<td>28.51</td>
<td>6.56</td>
<td>2.69</td>
<td>2.00</td>
<td>--</td>
<td>--</td>
<td>0.83</td>
<td>11.05</td>
</tr>
<tr>
<td>Sr. Proj. Lead.</td>
<td>50.47</td>
<td>8.54</td>
<td>--</td>
<td>0.39</td>
<td>0.93</td>
<td>--</td>
<td>38.86</td>
<td>0.23</td>
<td>0.59</td>
</tr>
<tr>
<td>Business Assoc.</td>
<td>54.76</td>
<td>29.62</td>
<td>1.10</td>
<td>0.10</td>
<td>6.81</td>
<td>--</td>
<td>--</td>
<td>2.00</td>
<td>5.60</td>
</tr>
<tr>
<td>Business Man.</td>
<td>38.75</td>
<td>16.98</td>
<td>34.92</td>
<td>--</td>
<td>3.64</td>
<td>--</td>
<td>1.44</td>
<td>1.16</td>
<td>3.13</td>
</tr>
<tr>
<td>Scientist</td>
<td>53.62</td>
<td>32.24</td>
<td>0.95</td>
<td>--</td>
<td>8.08</td>
<td>1.91</td>
<td>--</td>
<td>2.12</td>
<td>1.09</td>
</tr>
<tr>
<td>Semi-retired Eng.</td>
<td>74.28</td>
<td>16.94</td>
<td>0.35</td>
<td>--</td>
<td>0.41</td>
<td>--</td>
<td>0.49</td>
<td>7.4</td>
<td>0.13</td>
</tr>
<tr>
<td>Eng. Intern</td>
<td>47.58</td>
<td>1.00</td>
<td>28.83</td>
<td>--</td>
<td>18.54</td>
<td>--</td>
<td>--</td>
<td>3.7</td>
<td>0.34</td>
</tr>
<tr>
<td>Proj. Lead.</td>
<td>38.68</td>
<td>8.51</td>
<td>--</td>
<td>0.83</td>
<td>11.16</td>
<td>--</td>
<td>37.50</td>
<td>0.37</td>
<td>2.95</td>
</tr>
<tr>
<td>KM Staff</td>
<td>27.19</td>
<td>27.61</td>
<td>--</td>
<td>--</td>
<td>14.62</td>
<td>--</td>
<td>28.65</td>
<td>--</td>
<td>1.93</td>
</tr>
</tbody>
</table>

Figure 4.1: Percentage of time informants spent in each connector type.

**Work Home Connectors.** These are organizationally determined linkages and exist within a person’s business unit. Though membership in such communities has an external criterion for belonging (e.g. as a member of the Alpha department), social properties may be important to different degrees with others in one’s business unit. For example, the semi-retired engineer who spent 74.28% of his interactions in the work home was the expert of a specialized software tool. This was valuable only to a specific subset of the engineer’s department. Work home is a hotbed of informal interactions because of the close physical proximity of its members.

Work home connectors facilitate a strong sense of identity for its members. For example, upon first meeting people, informants would often exchange business cards. The first things informants noted was what department others were in. Many people have a preconceived notion of how certain departments work and their own “tricks of the trade” to interact effectively with those departments. Thus, there is a strong association of a particular department with work features and with identity.
Company Connectors. The second most common type of connector was the entire organization. As with the work home, this type of connector creates social entities that are organizationally determined (its borders define who belongs). People experience a shared identity as employees of Loquor; since Loquor’s “product” is in providing first-class expert advice, reputation is especially important to maintain company-wide. People with primarily service-oriented work roles (benefiting members inside Loquor) tended to spend the most time through these company connectors. Librarians often interact with a select “set” of clients company wide (26.55% of their interactions) established over time (some people always prefer a certain librarian when asking for assistance).

Interaction is often conducted remotely. One problem we encountered was that interactions with different departments often brought to light different standards and conventions (Mark, 2002). The business manager, who spent nearly 17% of his interactions in company-wide interactions, was responsible for people on the east and west coast. Each coast interpreted field names on common forms differently. Sometimes only one coast was unaware of a certain company-wide policy and did their paperwork incorrectly until the other coast pointed it out. Company connectors are especially necessary for those in managerial positions—certain roles “envelope” a larger range of communities. The general manager spends 28.51% in interactions with his subdivisions, whereas a scientist is primarily only responsible in his or her subdivision. Furthermore, junior employees such as the engineering intern are just in the nascent stages of forming company connectors (1% of their interactions).

Formal Community Connectors. These are connectors that have been formally created and sponsored by the company through its knowledge management division. This includes formal CoPs initiated by the company with the intent of encouraging cross-departmental knowledge sharing. Formal communities are still in the incipient stages in the company. The most obvious indicator of Loquor’s push for communities is its advocacy of a content
management system to support them, CM. CM is intended to be a comprehensive solution for the corporation’s collaborative storage needs. In addition to replacing shared drives, it supports discussion forums and meeting management utilities. By creating a standard “template” folder structure for communities, the knowledge management staff hopes to encourage people to form communities that utilize CM.

While the knowledge management staff, project leader and librarian play a large role in maintaining and advocating the use of formal community tools and policies, those who have not been explicitly “chosen” as champions for formal communities did not use the content management system as rigorously. One issue was that CM’s initial roll-out faced technical problems and was subsequently viewed as unstable. The association of CM with CoPs may have turned people away from the very organizational policies meant to encourage knowledge sharing. Another issue is in the formal community’s legitimacy. People are unsure whether they can properly “bill” their managers for time spent doing community work, as Lotus adopters faced in Orlikowki’s 1992 study. Recent stability improvements and explicit announcements from upper management has lessened the initial bad impression people had of the system. Our results thus seem to confirm Alatta’s 2003 conjecture that grouping employees by their informal communication networks leads to something more akin to CoPs, rather than the formalized communities that Loquor sponsors. The informants were skeptical of artificially created connectors that do not conform to a natural process of social production.

*Professional Connectors.* Communities and networks formed by these informal connectors allow members to develop, enhance or share professional skills. For example, one community helps foster unix-like tools within the organization. This allows members to use alternative open source email clients or calendaring systems. The librarian spends only 2.39% of interactions in the Librarian Association, yet identifies with it, receives support,
influences other users, is concerned with maintaining her reputation, and has common
ground with other librarians in the field.

The informants’ goals for participating in these communities are to increase their “worth”
to the organization and also expand their job opportunities. Being part of a professional
community is especially important for those whose reputation is defined by their profes-
sional “clout.” For example, the scientist spent only 1.91% of interactions with professional
organizations but did so to keep on the forefront of the latest research news and activities.

Social Connectors. These are informal connectors within the company that emphasize
social interaction, often around a common hobby or belief. Examples of connectors of
Loquor employees include a company drama club and scrapbook club. Members of these
communities span the company; and the primary activity is sharing a social experience.

Within the company, social connectors provide a way for employees to expand their social
networks. Religious organizations were also examples of social communities at Loquor.
The project leader shadowed often commented on how a person with who he just inter-
acted was part of a religious organization, or part of a certain social group. Belonging to
social communities sponsored by the company enables people to acquire a legitimacy to
speak with people they normally would not. Furthermore, people utilize social connections
gained from these social communities to accomplish their work. For example, the project
leader drew on people she knew from her scrapbook club to help her accomplish tasks
meant for her home unit. Social communities can also allow one to “jump” levels in the
hierarchy, asking advice from a senior executive with whom many others might normally
be hesitant.

Less organized forms of social connectors took the form of baseball simulations, pitting
virtual teams’ stats against each other. While high up in the ladder, a general manager
maintained ties to the people in different departments with who he had long ago started the virtual baseball league.

_Private Connectors._ These are informal linkages with people outside the company such as family and friends. Wenger 1998 described identity as an innate part of a worker that cannot be simply turned off or on: they certainly do not cease to be parents because they are at work. At times people talked about their kids at Loquor; and more generally, the tidbits of conversation they interweave with their exchanges of work-related information continually reflect their participation in other practices. Indeed, while private connector interaction constitutes a relatively small percentage compared to other social groups, activities where the private community is the main topic do exist. For instance, the scientist at Loquor always made sure to call her husband once she arrived at work. The project leader mentioned after a particularly long day that she “missed her husband,” and called him (11.16% of her interactions were private).

However, another important portion of private social groups is in simply enabling people to get personal tasks done during the work day. The business manager (3.64%) made use of his little free time to call the mechanic to check up on his wife’s car in the shop. He performed an action for someone who was a member in his private community: his wife. Similarly, after a particularly long period of debugging, the Senior Project Leader called his wife.

Interaction with private connectors was often done through alternative media. For example, private email was usually done through webmail. Phone calls were often done through the informant’s cell phone. The intern (18.54% of the time) made extensive use of instant messaging with friends and family. This separation of company and private media perhaps allows people to more easily manage their communities and keep them from overtly intersecting each other. Thus, personal communities constitute an important component of work life by enabling people to maintain their personal identity while in the workplace. It
is interesting to note that *everyone* had private communities that they tapped into during work days.

*Common Work Role Connectors.* These connectors bind people together through employees’ common work role or rank within the organization. Common work role groups provide an important way to share knowledge and common experience related to the work role. For instance, the business manager met with other managers in the same building (34.92% of the time) regularly since they were intimate with the facility issues in the building. Employees of the same rank share a common skill set and experience and many experienced the same career ladder path. The engineering intern consulted with other engineering interns 28.83% of the time, even if they were from different disciplines. The scientist lamented that she was isolated from the rest of the engineers while sitting at her computer. As a result, she would walk over to a building at least once a week where there were engineers and sit down at an empty desk there. Though she did not explicitly set up appointments, she knew that the *chances* of encountering fellow engineers there was greater. Should an idea pop up, it would be trivial to walk to the next door to speak with individuals who share her work role (she did 0.95% of the time). Common work roles are an important vehicle for sharing specialized knowledge.

Thus, throughout the workday, people quickly tap into an arsenal of connectors to get work done in social settings. Connectors allow us to examine what different commonalities spur people to interact with various communities, networks or groups whose membership often overlap.

### 4.5.2 Switching Interactions in the Workplace

Once we identified different types of connectors we next turned to analyzing how often people switched interaction contexts based on timing activities in observations. Figure
4.2 lists average times spent per interaction in the cells for different social arrangements throughout the workday. For example, the F2F/Work Home cell refers to the average time a face-to-face interaction lasted with people linked through their work home.

If we do not count time spent in formal meetings (since meeting length is usually beyond the informants’ control) then we found that the informants averaged about a quarter of their day (1 hr. 52 min.) interacting in various social arrangements. However, the average time for each interaction is quite fleeting (1 min. 56 sec. on average). The results confirm our expectation that people rapidly switch interactions.

We found that people spent the majority of time in interactions with people related by their work home connectors (about 34% of their non-formal “meeting” interactions). This result highlights the importance of the influence that the work home has on the individual, and correspondingly, the influence that the individual contributes to their work home. Company connectors take up 11% of non-formal meeting interactions. A small proportion of non-formal meeting interactions occurs through formal connectors (about 6%). However, most of this time can be attributed to people whose work roles officially promote formal CoPs as opposed to workers intended to benefit from such communities (e.g. see the business manager and engineer in Figure 4.1).

Though a small proportion of work time, both common work role and private connectors constitute an important portion of the workday. Interestingly, more time is spent on private connectors that often go beyond company boundaries, rather than on social connectors that tend to stay within the corporation. This may point to the fact that while people see social activities as best left for non-work hours, private lives are an integral part that cannot be separated from work lives.

Looking at the interaction types, we see that aside from meetings, face to face interactions make up a significant percentage of interactions (28.40%). Though the proportion of the
day spent on email and phone are roughly equal, phone interactions last twice as long as
email on average. IM and paper average less than 2% of interactions. Interestingly the
informants averaged less than 3% of interactions using the company promoted CM system.

Finally, several interesting points arise when we analyze the interplay between interaction
type and connector. Work home is the connector where people spend the largest proportion
of their day in interactions but spend the shortest amount of time in face-to-face interac-
tions. This may indicate that technology is well distributed (and easily attainable) in the
work home. There is also a longer face-to-face interaction in connector types where people
spend a small proportion of their day. Informants may feel that when the opportunity to
interact through these connectors arises, they take full advantage of it by utilizing richer
communication media, and spending longer durations. IM is used in most communities
and networks and is used in short snippets compared to email or F2F. Meetings, when they
exist, take up an inordinate amount of time in all contexts. Some interaction contexts have
a total (or almost total) absence of certain media technologies. This may be indicative of
whether others are accessible through the technology, e.g. using the company intranet. It
could also mean that people have certain habits with technology communication, such as
preferring to use email or phone with private communities.
### Table 2: Connectors & Interaction Type: Avg. Time/Interaction (h:m:s) (sd)

<table>
<thead>
<tr>
<th>Interaction Type</th>
<th>Work Home</th>
<th>Company</th>
<th>Common Workrole</th>
<th>Social</th>
<th>Private</th>
<th>Professional</th>
</tr>
</thead>
<tbody>
<tr>
<td>F2F</td>
<td>0:02:36 (0:06:03)</td>
<td>0:02:43 (0:05:26)</td>
<td>0:03:10 (0:04:44)</td>
<td>0:01:00 (0:00:50)</td>
<td>0:01:11 (0:00:35)</td>
<td>—</td>
</tr>
<tr>
<td>Email</td>
<td>0:01:12 (0:01:43)</td>
<td>0:00:59 (0:01:23)</td>
<td>0:01:19 (0:02:10)</td>
<td>0:00:36 (0:00:38)</td>
<td>0:01:22 (0:02:22)</td>
<td>0:01:26 (0:00:59)</td>
</tr>
<tr>
<td>IM</td>
<td>0:00:30 (0:00:31)</td>
<td>0:02:44 (0:03:40)</td>
<td>0:00:41 (0:00:46)</td>
<td>—</td>
<td>0:00:48 (0:01:04)</td>
<td>—</td>
</tr>
<tr>
<td>Meeting</td>
<td>0:31:36 (0:24:35)</td>
<td>0:28:31 (0:35:20)</td>
<td>0:28:20 (0:37:15)</td>
<td>0:27:35 (0:00:00)</td>
<td>0:28:03 (0:02:20)</td>
<td>—</td>
</tr>
<tr>
<td>Paper</td>
<td>0:01:32 (0:01:40)</td>
<td>0:01:28 (0:01:33)</td>
<td>—</td>
<td>—</td>
<td>0:01:05 (0:01:45)</td>
<td>0:01:06 (0:00:24)</td>
</tr>
<tr>
<td>Phone</td>
<td>0:02:46 (0:03:47)</td>
<td>0:02:30 (0:03:20)</td>
<td>0:04:09 (0:03:09)</td>
<td>0:02:44 (0:01:58)</td>
<td>0:02:42 (0:02:18)</td>
<td>—</td>
</tr>
<tr>
<td>CM</td>
<td>0:02:02 (0:02:47)</td>
<td>0:03:44 (0:04:57)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>All types but “Meeting”</td>
<td>0:02:05 (0:04:36)</td>
<td>0:01:40 (0:03:05)</td>
<td>0:02:09 (0:03:27)</td>
<td>0:1:06 (0:01:15)</td>
<td>0:01:52 (0:02:15)</td>
<td>0:01:25 (0:00:57)</td>
</tr>
<tr>
<td>% all interactions</td>
<td>33.9</td>
<td>10.74</td>
<td>2.52</td>
<td>0.28</td>
<td>3.98</td>
<td>0.44</td>
</tr>
<tr>
<td>All media</td>
<td>0:02:50 (0:07:30)</td>
<td>0:03:02 (0:10:16)</td>
<td>0:04:54 (0:14:31)</td>
<td>0:02:15 (0:05:39)</td>
<td>0:02:47 (0:09:18)</td>
<td>0:01:25 (0:00:57)</td>
</tr>
<tr>
<td>% all interactions</td>
<td>46.95</td>
<td>20.55</td>
<td>6.42</td>
<td>0.60</td>
<td>6.00</td>
<td>0.44</td>
</tr>
</tbody>
</table>

1. In contrast to meetings, face-to-face interactions are not planned in advance.
2. Paper based media that include faxes, “where-you-were-out” notes and internal postal mail.
3. Includes cell phones as well as PDAs will cell phone functionality.

### Figure 4.2: Connectors & Interaction Type: Avg. Time/Interaction (h:m:s) (sd)
4.6 Discussion

Combining Lave and Wenger’s with Orr’s work, Brown and Duguid (1991) discuss how actual work practices (of copy machine maintenance workers) often differ from official textual descriptions that outline business processes and flows. Our results show how work is enacted not through canonical formal CoPs but rather through a variety of social structures: informal communities, groups, and networks that continually change throughout the workday.

4.6.1 Formal and Informal Connectors

Our study suggests that the majority of work in the workplace is done through connectors that are organizationally determined. This is thus the principal opportunity through which knowledge can be shared. In contrast, most informants spent only a small proportion of their day interacting through formal connectors established and promoted by the organization. In formal communities where people deliberately meet to share knowledge, knowledge is exchanged outside of their work context, whereas knowledge exchanged especially in the work home is embedded in the work context. This result suggests that formal communities might be designed to avoid recontextualizing knowledge.

Some researchers have discovered that much knowledge sharing occurs through personal networks in the organization (Nardi et al., 2002a). We did not make a distinction between work conducted through personal networks, or as part of organizationally determined teams. To a large extent the role of these social entities is blurred. Some members on project teams primarily exchange formal results related to the project while others form networks for exchanging a wider array of informal information. Similarly, some informants formed what could be called personal networks with only a certain subset of people in their
own department. The exchange of information in the organization is a complex web of networks, organizationally determined relationships and other types of communities that exert continual influence on people throughout the workday.

### 4.6.2 Connectors as a Unit of Analysis

Following Lave and Wenger’s 1991 notion of “legitimate peripheral participation” in communities, we have tried in this chapter to understand the different sources of learning in the workplace through identifying what makes different types of social entities exist. Contrary to the notion of a single work identity, our results suggest instead that people negotiate multiple identities, as well as multiple goals, reputations, influence, and common ground as they move in and out of different communities and networks throughout the workday.

Our unit of analysis, connectors, shares similarities with the notion of legitimate peripheral participation. Like legitimacy, connectors often come in the form of shared interests or experiences. And, likewise, connectors allow one to begin the trajectory towards the “core” of a community. However, connectors are not intimately tied to the theory of CoPs. What we have gleaned from our ethnographic investigations is that CoPs do exist, but so do many other social configurations. Instead, we posit that connectors necessarily moves the focus away from seeing legitimacy as an enabler for CoP building, to an enabler for a variety of social configurations, of which CoPs are just one. Furthermore, connectors allow us to understand how it is that a variety of social configurations are maintained and navigated by different commonalities— not necessarily just to maintain CoPs, but other forms such as social networks or knots. Connectors are not a means to an end, but rather a separate unit of analysis worthy of study.

The term connector may also bring to mind the techniques used in social network analysis. In the classic sense, social networks are formed by “ties” between actors. Algorithms
that utilize metrics such as social cohesion (Bruggeman, 2008) exist to automatically determine what subset of actors form a “community.” While ties and connectors do indeed link people together, connectors is a relationship not always easily quantifiable into a numeric “strength.” Though connectors may have different strengths (e.g. people may have a strong bond through professional connectors), what we wish to convey, from an egocentric viewpoint, is a link that is constantly changing, disappearing in and out, to facilitate a person’s work. Connectors essentially give one multiple hats to wear. As events change, people will use the connector most appropriate to facilitate their work.

Geertz (1994) describes that as long as the group exists so does one’s identity as a member of the group. In the workplace people maintain multiple types of identities. Yet especially when people switch so rapidly between groups, boundaries can be fuzzy and identities can become blurred. Our study suggests that identity is intimately tied with the connectors that continually change and are contextual in the workplace. One identifies with one’s work role when the reference group involves others of a common work role, or as an Alpha department employee when the frame of reference is the work home.

Our notion of identity here draws partially from an ethnomethodological viewpoint (Dourish and Button, 1998). To us, identity is not a construct wholly formed by the individual. Rather, it is a group construct that is continually created, maintained, and changed. Identity is a publicly viewable entity. We argue that a major process by which this sort of identity is made dynamic and multifarious is in fact through our daily interactions in the workplace. MacQueen et al. (2001), in attempting to define the pervasive phrase “community,” note that joint action is a “source of community cohesion and identity.” Moreover, the “conscious intent to generate community through action was not viewed [by informants] as necessary; rather, the joint action was seen as leading naturally to the creation of community [emphasis added].” Examples of joint actions given by MacQueen et al. are socializing, working together, etc.—precisely the events conducted through workplace connectors. In-
deed, many of the workplace connectors are not explicitly created by information workers (other than formal workplace connectors, which are usually created by the corporation); that is, workers don’t self-consciously think of the act of creating connectors (or communities). Rather, what “connects” us provides opportunities for repeated patterns of interaction, which thus leads us to form and solidify a sense of identity among certain groups of people. This joint action of interacting becomes second nature, leading to patterns of communication that allow people to draw from connectors to accomplish work deftly. However, as we will see in later chapters, the effective management of different workplace connectors (and hence identities among different groups) may be taxing.

We believe that our study can help in understanding the larger picture of how work is fragmented and what its impact is on information workers. Not only does work consist of multiple projects but also of multiple communities, groups and networks. Maintaining and switching different identities is the invisible work that people engage in at the workplace.

4.7 Conclusion

Our results have shown that multiple types of communities, groups and networks influence people in the workplace. We have introduced connectors as a unit of analysis to characterize how work is done in multiple contexts. The seven distinct classes of connectors were derived through using a grounded theory approach on ethnographic observations. The connectors we have introduced can provide a useful framework for investigating how and why people navigate between multiple formal and informal communities in their work life. These results are consistent with other ethnographic studies which show that people are involved in multiple activities that they constantly move in and out of in the workplace.

The variety of connectors we discovered are largely prevalent to some degree for each of
the informants. The communities which an informant participates in reveals a rich tapestry of interaction patterns that belies the traditional view that IT has made people more isolated (McPherson et al., 2006; Putnam, 1995).

In our next chapter we will apply the workplace connector construct to understand how rapid fire communication across different groups of people effect our perception of job stress.
Chapter 5

Interacting Rapid Fire: Communication Chains

5.1 Introduction

There has been recent interest in how information workers rely increasingly more on large networks of people irrespective of geographical location (e.g. Nardi et al. (2002b)). These studies underscore how effective networking involves being skilled not only in the use of different media but also in more subtle practices which involve understanding which media best suits different types of interactions.

We maintain that understanding communication practices of information workers must be viewed within a larger context of understanding the management of work. Lately there has been much interest in the CHI community on how people can manage multitasking and interruptions in the course of their work (see Section 2.4.2). A recent study revealed that information workers manage on average 12 different projects (Naur, 2007). Each project often involves a unique set of contacts (colleagues, managers, customers, vendors, etc.).
Thus, information workers manage and switch among multiple projects throughout the workday, and at the same time they are managing a large social network of individuals associated with these different projects.

The hectic nature of work has long been documented, even before email and IM entered the workplace, for example dating back to Mintzberg’s 1973 study of managers. Yet in focusing on present-day work, we have more communication media available than in Mintzberg’s era of information work. The documented high level of multitasking and interruptions leads to a currently unanswerable question: has the prevalence of communication media in the workplace created more opportunities for interaction, and consequently interruptions, or rather has the expanded number of projects that people are involved in created more need for communication and thus interruptions? Are these two phenomena inseparable?

5.2 Alignment in Multitasking

Multitasking is a combination of switching among different tasks and also switching between solitary work and communication with others. We are interested in understanding the behaviors involved in communication when people handle multiple projects.

Strauss (1985) described work as a trajectory of multiple tasks. We consider the process of following such a work trajectory to be a process of alignment, involving both self-alignment in keeping track of one’s own work but also alignment with others especially for collaborative work. Self-alignment can involve returning back to the point left off in a task when one was interrupted or to a new task, but it can also involve switching between local and global perspectives of one’s different tasks in order to maintain an overview (González and Mark, 2005).
Aligning with others involves continual coordination and communication (González and Mark, 2004). This communication activity serves multiple purposes with respect to helping manage multitasking: for example, providing awareness of others’ actions and information about work, articulation of collaborative work, helping one prioritize projects, getting access to key information needed in work and coordinating with others. Continual alignment with others is especially critical when work is tightly-coupled (Hollan et al., 2000).

Communication is a joint activity; each partner cooperates so as to insure both achieve the same representation. Communication in the workplace may have many different functions (Kraut et al., 1990; Bailey and Konstan, 2006) but following Pickering and Garrod (2004), an important function is for people to align their work with others and in the organizational context.

In this chapter we report on an ethnographic investigation of the workplace, focusing on the role of communication in multitasking. We noted continuously that communication acts that occur as breaks from solitary work are not single acts. Rather, they often follow one after another in quick succession as chains of communication acts. Thus, from our observations, people also switch communication partners in a similar way to how they switch among tasks in solitary work (González and Mark, 2004). The concept of communication chains was first introduced by Reder and Schwab (1990) who discovered that, as part of cooperative work, people need to insure that they are available to others and also at appropriate times they need to make an effort to contact others. We were interested in building upon this work to gain a better understanding of why people shifted from a solitary work mode, where they switched among multiple tasks, to a type of communication mode, where they showed patterns of switching among multiple communication partners with different media.

Chains of communication may at first glance seem random and disorderly. But in fact, they do have an order, a structure. Following Pickering and Garrod we propose that this structure
is developed both as a strategy to accomplish alignment with others and also is shaped by certain factors. We were interested to understand more deeply what the structures of these communication chains are. Using Reder and Schwab’s perspective of examining work as temporal activity, we set out to understand how communication chains are integrated (or not) into the solitary work pattern of multitasking. Guided by an ethnographic analysis, we hypothesized that the process of aligning with others through communication is affected by media, by the organizational context of the partners, and involves stress.

1) Media-switching. Several studies have focused on patterns of activity related to communication in multitasking such as resumption of tasks after conversations (Iqbal and Horvitz, 2007b,a). Other studies have focused on patterns of media use with a single communication medium such as IM or email (Nardi et al., 2002b; Venolia and Neustaedter, 2003). To our knowledge, no one has examined patterns of media switching for communication while multitasking. We expect that media choice is related to how people align with others. For example, because face-to-face communication acts are longer than communication with IM or email (Sanderson and Fisher, 1994), we might expect different patterns of media switching that can reveal interesting information about alignment. Certain media sequences may be better suited for integrating with the multitasking of solitary work.

2) Organizational context. Information work often involves communicating with people in one’s business unit or department but also with others outside of one’s department or even organization (Nardi et al., 2002b). Professional networks can span organizations. We expect that communication sequences might follow different patterns depending on what the communication partners’ organizational context is. In fact, we expect that different media may be used depending on partners’ organizational contexts.

3) Stress. Though there have been a lot of anecdotal reports that multitasking leads to stress (González and Mark, 2004) as yet this has not been empirically measured. We were
interested to discover to what extent stress might be related in particular to the length and structure of communication chains.

## 5.3 Research Settings & Methods

This chapter’s work is based on data from the Loquor Corporation, headquartered on the west coast of the U.S. with offices also distributed across the U.S. The corporation serves in an advisory role by providing expertise on scientific and technical issues for its customers.

In total, 19 informants’ data were utilized, resulting in approximately 13,000 separately recorded events representing over 550 hours of data over a period of about 18 months. We recorded a mean time of 7 hr. 48 min. of data per day per informant.

The informants were in a wide range of professions: library manager, library staff, two general managers, two project leaders, business associate, business manager, two scientists, (semi-retired) engineer, technical staff director, knowledge management staff, two engineers, distinguished engineer, principal director, intern engineer and senior business director. All used information and communication technologies in their work.

## 5.4 Data Coding

All paper notes were transcribed into a spreadsheet. Each line of the spreadsheet represented an activity with its date, start time, end time, media used, people involved and general context of the activity. Communication media use was categorized into face-to-face (F2F), meeting, phone, instant messaging (IM) and email. Meetings were interactions planned at least half a day ahead and included teleconferences. Each recorded segment of data is based on “events,” as opposed to how Reder and Schwab defined “tasks”: “Tasks
are accomplished by workers through ‘events,’ which we define as observable actions.” For example, someone working on a demo may prepare slides and then create a picture in a drawing program. While both events are part of the working sphere (González and Mark, 2004) of “demo”: for data analysis purposes, we consider them as two tasks. That is, the immediate goal of one is to edit a slide and the other is to create a picture. From hereon, we use the terms tasks and solitary work events interchangeably.

Solitary work, as opposed to communication acts, consisted of working alone using productivity software (word processors, spreadsheets, slides), browsers, specialty tools (e.g., for labs or software development) and paper.

5.4.1 Communication Action Chains

We now operationally define communication chains. Chains are composed of communication acts that can be thought of as links. Each link represents a F2F, email, phone or IM communication act where there is a discernable target and source person(s). For example, an email from someone and the subsequent email reply to the person would represent two sequential links in a chain. A communication act need not be reciprocated to be considered a link in a chain. Email that is read without replying or phone calls that result in a voice message are both still valid links in a chain. The intent to communicate is the important factor for our analysis. While paper was sometimes used as a communication medium (e.g., leaving Post-It notes on someone’s desk), we found it difficult to discern in many cases whether paper usage was really a communication act (e.g., signing an equipment approval form). Thus, paper usage was classified as being part of solitary work. On average 36 min. per day were spent with paper work, yet only about 7% of such events could be considered communicative.

We observed that while interactions often happened one after another, sometimes these in-
Gap Time = 0:00:30 (Hour:Minute:Second)  

C: Communication Act  
T: Task/Solitary Work  

<table>
<thead>
<tr>
<th>C1</th>
<th>T1</th>
<th>C2</th>
<th>T2</th>
<th>T3</th>
<th>C3</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:02:45</td>
<td>8:03:00</td>
<td>8:03:45</td>
<td>8:04:10</td>
<td>8:04:25</td>
<td>8:04:55</td>
</tr>
</tbody>
</table>

0:00:45 elapsed  
0:00:15 elapsed  

8:04:18  

1st Chain with a single link  
2nd Chain with two links  

Figure 5.1: Two chains in a sequence of events.

Interactions were interspersed with short tasks such as glancing at paper reports or searching the Internet. We thus define a gap time of 30 seconds to allow two communication acts with solitary work in between them to still be considered sequential links in a chain. This value of 30 seconds falls within a time scale that Naur (2007) cites as the specious present: a moment in which our object of focus is still influenced by what we focused on a few seconds before. Between 20 to 40 seconds, we will begin to forget this “previous” focus. If tasks between two communication acts are less than the gap time, then the communication acts are still considered as if they were sequential. Figure 5.1 illustrates how two chains are identified in a particular time segment.

For each chain, we counted the number of media switches. A media switch occurs when two consecutive links use different media. For example, a chain of [F2F → Email → Email → Phone] would have two media switches. A chain of length one has zero media switches.

5.4.2 Organizational Contexts

We were also interested in the organizational context in which chains occur. Nardi et al.’s 2002a work on ‘intensional’ networks captures the notion that people are members
of multiple social networks in the workplace that transgress beyond one’s own department. Thus, each communication act was coarsely coded into one of three organizational contexts (see Section 4.5.1: *work home*, *company* and *outside*, depending on with *who* the person was communicating. This represents a subset of our workplace connectors construct.

In cases where interactions involved more than one person, we typically chose the organizational context that best encompassed all participants. For example, meetings with people from the ‘Work home’ and ‘Company’ were coded as ‘Company’. Group discussions involving outside participants were always coded as ‘Outside’ because most meetings with outside people were focused around them. These contexts represent a simplification of the workplace connectors we used in Chapter 4 to analyze interaction among multiple groups in the workplace. Analogous to media switches, we also examined the number of organizational switches within a chain.

5.5 Descriptive Statistics

Having described the nomenclature for our data segmentation scheme, we now report descriptive statistics.

5.5.1 Summary of Communication Acts & Solitary Work

Figure 5.2 shows the average time spent per day for each informant on communication acts in the different organizational contexts and tasks. Informants averaged about 3 hr. on solitary work per day, while averaging 2 hr. 18 min. on communication acts per day. Table 1 does not include data on meetings (average of 1 hr. 46 min. per day per person), paper-based work or unknown events. Unknown events include activities the researcher was not permitted to observe (e.g., family conversations) or communication acts whose context was
indiscernible due to the researchers inability to adequately record the event. The average duration of solitary work and average duration of communication acts is correlated across informants, $r = 0.58$, $t(17) = 2.97$, $p < 0.05$.

Informants spent the majority of communication time with others in their ‘Work home’ context (46%), about a third of the time in their ‘Company’ context and about 12% of time in the ‘Outside’ context. We did not find significant differences in average communication event times between the interaction contexts. This suggests that organizational boundaries by themselves do not predict the length of communication act events.

### 5.5.2 Chain Attributes

Figure 5.3 shows descriptive statistics of communication chain attributes. The data show that each person does not communicate in single acts; rather, most interactions occur in chains (averaging 2.5 links). The average chain link lasts 2 min. 27 sec. Chain duration, the average total time of all links in a chain is 5 min. 17 sec. On average for each chain, media switches are few (0.44), as are organizational switches (0.57).

Figure 5.4 is a histogram of the average chain lengths per informant per day and shows that...
<table>
<thead>
<tr>
<th>Measure</th>
<th>Avg. / day</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td># of Chains</td>
<td>27.36</td>
<td>30.21</td>
</tr>
<tr>
<td>(9.81)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chain Duration¹</td>
<td>0:05:17</td>
<td>02:32</td>
</tr>
<tr>
<td>(0:07:51)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chain Length²</td>
<td>2.51</td>
<td>1.67</td>
</tr>
<tr>
<td>(2.24)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Link Duration</td>
<td>0:02:27</td>
<td>02:14</td>
</tr>
<tr>
<td>(0:02:04)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Media Switches</td>
<td>0.44</td>
<td>0.026</td>
</tr>
<tr>
<td>(0.88)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Org. Switches</td>
<td>0.57</td>
<td>0.053</td>
</tr>
<tr>
<td>(1.18)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹Sum of link durations in a chains. ²# of links in a chain.

Figure 5.3: Averages per day per informant on various metrics of communication chains.

The chain length data is skewed to the right. More than 40 of the 76 (19 informants x 4 days) average chain lengths per day are 2–3 links long.

### 5.6 Probability of switching media

What is the *expected* number of chain links when someone starts interacting with a particular communication media, e.g. email? To answer this question, we can model the data with Markov chains. While we will not delve into its theory, the “Markov property” defines the next state as depending solely on the current state (Nelson, 1995). This assumption has been used in a wide variety of observational studies and in practice is a good approximation to analysis of data that does not strictly follow the Markov property (Bakeman and
Gottman, 1997). Below are the transition probabilities in matrix $M$:

\[
\begin{pmatrix}
F2F & Email & IM & Phone & End \\
F2F & 0.38 & 0.085 & 0.0087 & 0.057 & 0.47 \\
Email & 0.075 & 0.54 & 0.0061 & 0.072 & 0.31 \\
IM & 0.097 & 0.097 & 0.26 & 0.030 & 0.51 \\
Phone & 0.15 & 0.17 & 0.011 & 0.24 & 0.44 \\
End & 0 & 0 & 0 & 0 & 1
\end{pmatrix}
\]

For example, entry $m_{12}$ states that the probability of switching to email given F2F is 0.085. Entry $m_{25}$ states that the probability that the chain will end with an email is 0.31. “End” is the \textit{absorbing state}, representing the end of a chain. A chain ends when a task/sequence of tasks exceeds the gap time (see Figure 5.1).

The vector on the right of $M$ defines the simple probability of starting a chain with a certain

![Histogram of observed chain lengths per day](image-url)
medium. For example, the highest probability of starting a communication chain is by F2F (0.44) and it is next most likely to expect that a chain is started with email (0.36). These probabilities (and those of $M$) are derived from frequency counts of the observed data. We can derive the expected time to “absorption” via the above matrix’s fundamental matrix (Grinstead and Snell, 1997). The expected number of transitions with various media as the first link is:

<table>
<thead>
<tr>
<th>Media</th>
<th>Expected Links</th>
</tr>
</thead>
<tbody>
<tr>
<td>Email</td>
<td>2.93 links</td>
</tr>
<tr>
<td>Phone</td>
<td>2.43 links</td>
</tr>
<tr>
<td>F2F</td>
<td>2.28 links</td>
</tr>
<tr>
<td>IM</td>
<td>2.14 links</td>
</tr>
</tbody>
</table>

Thus we see here that although F2F-started chains are the most probable, email and phone-initiated chains are longer, with IM-initiated chains having the shortest expected length.

We can use the simple and transition probabilities to calculate the probability of a chain (i.e., of a particular sequence of media usage). For example, the probability of a [F2F→Email→F2F] chain would be $0.44 \times 0.085 \times 0.075 \times 0.47 \approx 0.0013$. After identifying all chains in our dataset, we can summarize the average probability of chains across informants as 0.084 (sd=0.076). From our Markov analysis, we can also say, for example that a chain with many Email→IM transitions would be in general “less probable” than a chain with many F2F→F2F transitions.

As we will confirm later, the benefit of Markov analysis is that it allows us to not only assign a probability to a particular chain, but to also accurately predict the length of the chain (number of links) based on the first link of the chain.
5.7 Catalysts for Chains

What types of events catalyze chains and how do these catalysts affect communication chains? In this section, we examine the effect that interruptions have as catalysts and also examine how media choice and organizational context affect a chain’s properties.

5.7.1 External Interruptions

As there has been much recent research showing the prevalence of interruptions in the workplace, we were interested to discover the effect that interruptions have on chain properties. By interruptions we refer to external interruptions. We might expect that chains begun as a result of interruptions, i.e. unplanned communication acts from others, might lead to longer chains. One reason is that once people are interrupted from a task they may take the opportunity to catch up with other communication needed to align their work with others. On the other hand, self-initiated chains (i.e., where the communication act is intentionally started by the informant) might be more purposeful and directed towards fewer people. Self-initiated chains also include communication acts that were (nearly) initiated mutually by both parties (e.g., running into people in the hallway).

A \( t \)-test\(^1\) revealed that external interruptions (\( M = 2.8, sd = 2.8 \)) did indeed lead to significantly more links in a chain compared to self-initiated communication (\( M = 2.4, sd = 2.4 \)), \( t(1020) = 2.46, p < 0.05 \). However, we found no significant difference in chain duration in externally triggered and self-initiated chains.

Yet though having more links, chains triggered by external interruptions (\( M = 0.07, sd = 0.07 \)) had a significantly lower probability of occurring (lower than the norm chain probability, 0.084) than self-initiated chains (\( M = 0.09, sd = 0.08 \)), \( t(1390) = -6.59, p < 0.001 \).

\(^1\)All \( t \)-tests in this chapter use Welch’s approximation for non-equal variances.
In other words, externally-initiated chains had rarer media transitions than self-initiated chains. We conjecture that external interruptions may force people to try different and novel media combinations to accomplish goals instigated by the initial external communication act.

5.7.2 Media Choice

We now examine the effect of certain communication media as the first link on the chain. Observations during our shadowing sessions seemed to indicate that F2F conversations often served as cues to others that informants were available for further interactions, leading to longer chains. We thus surmise that when F2F is the first communication act it will lead to the longest chains. In addition, synchronous F2F communication tends to last longer than asynchronous methods like email (Sanderson and Fisher, 1994).

We tested whether F2F-initiated chains had the most links. An ANOVA showed that when conducting multiple comparisons\(^2\) tests, the results showed significant differences among media \((F(3, 1925) = 13.96, p < 0.001)\) but did not entirely confirm our expectation. Email-initiated chains \((M = 3.03, sd = 2.96)\) had significantly more links than F2F-initiated, \((M = 2.25, sd = 2.26), p < 0.001\), phone-initiated, \((M = 2.32, sd = 2.19), p < 0.001\), and IM-initiated chains, \((M = 2.07, sd = 2.34), p < 0.05\). This actually conforms to estimates of chain length from our Markov analysis.

We also tested with multiple comparisons whether F2F-initiated chains would have the longest duration. We did find significant differences among media: \(F(3, 1925) = 5.72, p < 0.001\). IM-initiated chains \((M=0:01:44, sd=0:02:43)\) lasted significantly shorter than email \((M=0:04:31, sd=0:07:18), p < 0.05\), F2F \((M=0:05:30, sd=0:09:31), p < 0.05\), and phone \((M=0:05:46, sd=0:07:52), p < 0.05\). Email-initiated chains showed a trend to be

\(^2\)All pairwise \(t\)-tests from this chapter hereon use Holm’s correction.
shorter in duration than chains initiated by F2F and phone, $p < 0.10$, and there was no significant difference between F2F and phone in chain duration. Thus, chains initiated by synchronous events were of longer duration.

Following our idea that external interruptions might trigger people to catch up with their communication, we also expected that externally-initiated chains would have more media switches. A $t$-test shows this to be weakly significant, $t(1110)=1.7$, $p < 0.10$; the mean media switches for externally-initiated chains ($M = 0.52$, $sd = 1.05$) was greater than for self-initiated chains ($M = 0.43$, $sd = 1.00$).

5.7.3 Organizational Context

We were interested in how chain length might be related to the organizational context of the communication. Our field observations indicated that ‘Outside’ context interactions varied widely (from quick chats to family, to longer discussions with customers), but ‘Company’ context interactions were longer and more consistent perhaps due to the amount of time needed to establish common ground (as opposed to the ‘Work home’ context).

We first tested whether chains initiated in a ‘Company’ context had more links. Results showed this to be the case: $F(2,1771) = 8.60$, $p < 0.001$. A multiple comparisons test found ‘Company’-initiated chains ($M = 2.85$, $sd = 2.75$) had more links than chains initiated in the ‘Work home’ ($M = 2.31$, $sd = 2.44$), $p < 0.001$ and ‘Outside’ contexts ($M = 2.41$, $sd = 2.37$), $p < 0.05$. No significant differences were found for chain duration.

Again, following our notion about external interruptions, we tested whether externally-initiated chains (which were shown to have more links) would also have more organizational switches. A $t$-test showed this to be the case: $t(1023) = 2.12$, $p < 0.05$. Chains
catalyzed by an external source had more organizational switches \((M = 0.69, sd = 1.47)\) than self-initiated chains \((M = 0.54, sd = 1.28)\).

When communicating in the ‘Outside’ contexts, we surmised that informants would use a greater variety of media channels in order to align to others’ media preferences. For example, if an informant is trying to track down a customer (an ‘Outside’ context), she might often have to switch from phone to email (0.17 probability in the Markov matrix), as opposed to interactions in the ‘Work home’ context, where many quick consecutive F2F interactions occur (0.38 probability). An ANOVA confirmed this: \(F(2, 1771) = 67.45, p < 0.001\). Pairwise t-tests revealed ‘Outside’-initiated chains \((M = 0.05, sd = 0.05)\), are less probable (have less common media transitions) than ‘Company’-initiated chains \((M = 0.07, sd = 0.07)\) and ‘Work home’-initiated chains \((M = 0.10, sd = 0.09)\). All pairwise contrasts here had statistically significant differences, \(p < 0.05\), in probability. Finally, note that ‘Outside’ and ‘Company’ initiated chains have probabilities less than the overall chain probability mean (0.084), while ‘Work home’ initiated chains have a greater probability.

We asked the question of which media triggered chains with more organizational switching. A multiple comparisons test \((F(3, 1925) = 14.98, p < 0.001)\) showed that chains begun with email \((M = 0.85, sd = 1.61)\) had significantly more organizational switches than chains begun with phone \((M = 0.53, sd = 1.14)\), \(p < 0.001\), and F2F \((M = 0.40, sd = 1.13)\), \(p < 0.001\). Email had weakly significant differences with IM \((M = 0.46, sd = 1.27)\), \(p < 0.10\).

We expected that more organizational switching should be correlated with more media switching as people might use a variety of media to reach others at a distance. Across informants, we found the correlation between the average number of organizational switches and average number of media switches per day to be significant: \(r = 0.82, t(17) = 5.90, p < 0.001\).
5.8 Predicting Stress

We now examine the question of whether some types of communication chains might be more stressful than others. Using the JCQ instrument, we examined five variables to see which might predict job stress. We used a backwards stepwise regression with the Akaike Information Criterion (AIC) (Burnham and Anderson, 1998). This avoids some of the deficiencies with traditional stepwise techniques that rely on p-values for variable removal.

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Average (sd)</th>
<th>Instrument Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job Strain(^1)</td>
<td>0.78 (0.25)</td>
<td>0.14-7</td>
</tr>
<tr>
<td>Job Demands</td>
<td>55.9 (11.35)</td>
<td>12-84</td>
</tr>
<tr>
<td>Job Decision Latitude</td>
<td>148 (17.53)</td>
<td>24-168</td>
</tr>
</tbody>
</table>

\(^1\)Job Strain=(Job Demands x 2) ÷ (Job Decision Latitude)

Figure 5.5: Averages per informant on stress measures.

Figure 5.5 shows the average measures of job strain (the composite measure of stress) and its two components: job demands and job decision latitude. Job decision latitude is made up of skill discretion (the degree to which you are allowed to learn and do creative things) and decision-making authority. Job demands (i.e., pressure) is positively related to job strain. Job decision latitude is inversely related to job strain, i.e. the higher the measure of job decision latitude the lower the job strain.

Figure 5.6 shows the models predicting job strain, job demands and job decision latitude. We used median values due to the presence of outliers (e.g., rare, inordinately long chains skewed the dataset). Multicollinearity was measured by calculating the Variance Inflation Factors (VIF) for each regression equation. Based on a cutoff value of VIF=10, we found no evidence of multicollinearity; the maximum VIF was 2.98.
<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Job Strain</th>
<th>Job Demands</th>
<th>Job Decision Latitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-0.0018 (0.29)</td>
<td>30.19** (9.54)</td>
<td>153.78*** (3.48)</td>
</tr>
<tr>
<td>Median Chain Duration (seconds)</td>
<td>--</td>
<td>0.153* (0.063)</td>
<td>--</td>
</tr>
<tr>
<td>Median Chain Length</td>
<td>0.31' (0.16)</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Median Link Duration (seconds)</td>
<td>0.0015* (0.00055)</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Median Media Switches</td>
<td>-1.64' (0.80)</td>
<td>--</td>
<td>133.96' (66.07)</td>
</tr>
<tr>
<td>Median Org. Switches</td>
<td>2.27** (0.59)</td>
<td>43.21' (22.35)</td>
<td>-182.82** (48.86)</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.72</td>
<td>0.47</td>
<td>0.49</td>
</tr>
</tbody>
</table>

*: 0.05<p<0.1, *: p<0.05, **: p<0.01, ***: p<0.001

Figure 5.6: Models for Stress derived from AIC Stepwise Regression. The standard errors of coefficients are in parenthesis.

The regression model shows that organizational switching in chains is the most predictive factor for job strain. If we break down the job strain measure into its components we find that this is due mostly to the job decision latitude component. We interpret this finding to indicate that switching across organizational boundaries is associated with stress due to less control in decisions and less influence that people have outside their work homes.

Median chain duration is predictive of job demands. This suggests evidence that chains spanning a lengthy time period has a significant relation to more stress. This stress may stem from the fact that such chains leave less time for solitary work. Finally, median link duration is predictive of overall job strain. This adds credence to past literature that communication acts (and in particular, longer lasting ones) are the source of much stress and workload.

There is a trend showing that as media switches increase job strain decreases. This is due
mainly to job decision latitude. This might be explained by the notion that when media switches are frequent, people are choosing the appropriate media that can best fit in their multitasking practices, thus increasing their latitude in decision making.

Interestingly, job decision latitude increased with media switching but decreased with organizational switching. Our results might stem from the fact that informants who experience a lot of organizational switching have little control over groups outside their primary area of work (usually their work home, or department). The main result thus suggests that alignment work that involves switching organizational contexts is stressful. A possibility is that people in administrative or operational roles perhaps have less decision latitude and also more cross-workplace connector interactions. However, in this chapter we do not have enough informants in each of these job position categories to verify quantitatively such a conjecture.

5.9 Qualitative Data

Our analysis characterized communication chains and how their properties are related to interruptions, media choice, organizational context and stress. We now triangulate our data with an analysis of informants’ post-interviews.

5.10 Managing Media Switching with Multitasking

We found that different media affected the number of communication acts (links) in a chain and its duration. From the interviews we discovered that informants switched media strategically in their process of alignment. Even if informants were aware of others’ media preferences, their own media choice was influenced by how well the technology allowed
them to manage different interaction contexts without disrupting the flow of their work. However, when an individual’s preferences override another’s preferences, opportunities for interactions can sometimes be lost. For example, a knowledge management staff member grudgingly admitted that she does not check her voice mails even though many in her ‘Company’ interaction context may prefer phone calls:

I have a tendency to email more than phone, and I know, like when I check my voicemail, I always have millions of messages because I never check my voicemail even though it’s the same people trying to contact me all the time. So it’s just like preference of communication. I prefer emails, I prefer phone...It’s a problem when the person prefers the phone to be contacted through phone because they know I just won’t ever call them <laughs>. I’ll just email them. I just never pick up the phone to call them...it takes longer probably than they would prefer because it’s like through email instead.

As a result, interactions with people in her ‘Company’ interaction context are potentially lost because her preference is to do email. As one of the younger employees at Loquor, this informant felt she had more control over her interactions when using email, e.g. she could control when she communicated. The next quote describes her hesitation to add yet another type of media with her boss in her ‘Work home’ context because it would intrude her personal life (once she got a BlackBerry, her boss did indeed contact her on weekends):

Yeah, he asked me before and I’m like, mm...no. It was like a year after he got his [BlackBerry], that’s when I got mine... I was just like, I didn’t want it because I knew then that he could tap me in the weekends, you know, after work...
Upon looking at his communication statistics, a general manager remarked that his biggest weakness was not making a better effort to use the phone in his ‘Company’ context:

I think the weakest part of my performance is that I don’t just pick up the phone and call my peers as often as I should. I just tend to blast an email to them...there’s lots of people who much prefer phone chats to email. Fortunately my boss is not one of those people, so we just do email.

Many people prefer email because it offers control (we found that email-initiated chains had more links and email communications tended to last shorter than F2F or phone). The business director of Loquor called her email checking her “down time”:

I don’t find it stressful because I’m in control with it...on the phone, I’ve got to be thinking and my brain is listening and thinking at the same what it’s going to say back...that kind of interaction, it’s live and you’ve got to be on...it feels more like break time when I’m doing email.

This control perhaps allows one to better integrate their communication into their multi-tasking worklife. This last excerpt suggests that strategic use of media might even help manage stress in the workplace.

5.10.1 Managing Organizational Context with Multitasking

Informants also used media strategically and in patterns to manage interaction in different organizational contexts. Brenda, a business associate in a technical department often interacts with business associates in other departments on the opposite U.S. Coast, exchanging information needed to compile reports. Her medium of choice is often IM:
[My] IM [lasts] seconds. That’s what I would expect, “Are you there?” “Did you get the file?” “I’ll be sending this.” “Check your email.” You know, which makes sense. [I’ll IM] our East Coast offices, I’ll say, “Are you there?” If they’re online, I’ll be sending you this or this invoice. I think it’ll take longer to call the number, put in my authorization code, wait for the phone to ring.

Indeed here Brenda knows that she’ll have to either phone and then email or IM and then email. For her, email is the main medium of communication; the use of IM or phone is used to get others to check their email. Because the phone call must go to another company division, an authorization code is necessary (while technically still part of Loquor, it is a long distance phone call). To Brenda, shaving off those few seconds of inputting a simple authorization call is valuable amidst her multitasking, especially when all she needs to do is get someone’s attention to check their email.

Some informants expressed frustration that others would use ineffective media patterns. Here, a scientist expresses her predicament over her new “phoners” in the ‘Outside’ and ‘Company’ context:

At the time I was working with you, I got to spend more time just sitting and working on something. I say things have degraded simply because I’ve lost time to do that kind of thing...Now I have people that are “phoners” <laughs>. They’ll send me emails, and then they’ll phone. They just go do both. And then they’ll tell me everything that’s in their email. It’s very redundant...of course, it’s hard to leave the phone ringing.

This is an example of how certain media patterns can be inefficient. It also illustrates a mismatch in expectations when aligning with others especially across organizational contexts.
The interviews revealed that the informants tried to use their limited work time efficiently for communication. One example of this occurred when an informant felt it worthwhile to communicate F2F with others in the ‘Company’ context even though it took more time to physically reach the other. Loquor’s campus is spread over several blocks. A business manager relates why he invests more time in F2F with others in his ‘Company’ context:

Well, that’s because we’re stuck out here in Building 8. If I want to go to anybody else other than the other organizations that are in Building 8, I have to walk all the way over there...so I’m going to spend a little bit more time in there because after walking all that distance you know. Cause you see I obviously spend less time on the phone but if I’m going to take the hike, I’m going to spend a little bit more time talking to them face-to-face.

The business manager described that the ‘Company’ context is more stressful for interaction because of his lack of authority there; he chooses F2F interaction to get more “buy-in” when he needs something to accomplish his work.

My social group at [Loquor], I don’t really bump into them very often. And, I know them well enough that I will either pick up the phone or just blast them an email...They don’t need to see me at all, so that makes sense.

This is an example of a concerted effort by the informant to touch base with his ‘Company’ context. This could explain why ‘Company’ context communication chains have more links: people try to maintain communication with others company-wide to get a broader picture of the organization.
5.11 Discussion and Conclusion

Our study suggests that a significant part of multitasking involves not only switching among tasks but also switching communication partners, involving the use of different media in different organizational contexts. We argue that communication chains are a consequence of how people strategically use communication and media in conjunction with their multitasking work styles to align their work with others.

Our quantitative and qualitative data suggest several reasons why people communicate in “chains” as opposed to single communication acts. First, perhaps once people are interrupted from solitary work it may be more efficient to conduct a series of communication acts to reduce the cost of multiple reorientations to an interrupted task (Mark et al., 2005). Our interview data suggest that some people develop communication sequences or patterns as ways to improve the chances of reaching others. Another reason is that when people multitask in solitary work they may store up information needs and then interact with others in chains to get the information they need in order to continue with solitary work. There may also be social reasons for communication chains that some of our informants described and that need to be further explored. Some chains may occur because one communication act begets another.

We found differences depending on which media initiated communication chains. Email-initiated chains had longer links on average but were of shorter duration than chains initiated by synchronous communication (IM-initiated chains were even shorter). This suggests that in a multitasking environment, when people are under time pressure, asynchronous communication may be best suited for multitasking.

Though recent work has identified how interruptions affect a task such as in reorientation and timing (e.g. Bailey and Konstan (2006); Czerwinski et al. (2004); Mark et al. (2005)) our data shows the consequence of interruptions on communication patterns. When
chains are triggered by external interruptions, they have more links, a trend for more media switches, rarer media transitions and more organizational switches. Both chain length and organizational switches are associated with job strain. This has implications for the design of systems to support people in handling interruptions which we discuss shortly.

We return again to Reder & Schwab’s work and examine their recommendation on dealing with channel (media) switching: “the multimedia approach to workstation design is definitely the right development model.” However, examining this more closely, we see that simply providing a range of media choice for communication may not be sufficient for managing multitasking.

Our study suggests that the design of so-called interruption management systems must take a multifaceted approach in how to transform interruptions so that they are less stressful. Much of the work people do is alignment with different people—this is very difficult work and causes stress; however, the freedom to navigate between different people in different organizational contexts with choice of media may allow one to cope better with this stress. Thus while the interruptions we observed usually caused more alignment work on the organizational level to occur, future systems might be able to determine which interruptions are likely to result in long chains requiring multiple parties to be contacted. Systems that could filter out interruptions that are likely to have many links of longer duration may help facilitate users in conducting solitary, creative multitasking work.

Hence, simply providing more media choices for the user for interaction also exposes one to more interruptions and longer chains. Rather, media should be strategically provided when the current situation is less likely to invoke chains that lead to higher stress.
5.11.1 Content and Context

Our coarse-grained separation of communication acts by organizational context provides only a rough idea of the content and context of the event. We plan to address this concern by coding our data into working spheres, thematically connected events. By examining the content of interactions, we hope to unpack the relation between projects and interactions. The next chapter incorporates the use of working spheres to examine communication from a routines perspective. It will also integrate solitary work into our analyses—something we ignored in this chapter for theoretical focus.

Because of our focus on informal interactions, our data excluded meetings. However, meetings often serve as a hub for communication acts. Spontaneous communication occurs before and after the meeting. While studies often cite meetings as a primary annoyance for workers, the effects of meetings may be even more pronounced when one considers them as catalysts for chains.
Chapter 6

Working Routinely: Temporal Patterns of Media Usage in Working Spheres

6.1 Introduction

On first glance, the notes on a sheet of piano music resemble the punch cards of yore. Immutable notes prescribe which keys the pianist plays, metronome marks dictate the tempo of the piece, and dynamic markings state when to play piano or forte. Yet, listen to the great virtuoso, Vladimir Horowitz, play the same Chopin polonaise live, or even on different recordings, and it becomes evident that a different though recognizably same piece is being played. How the music notation, or the “source code”, is executed—interpreted—differs with every performance.

Unlike the subroutines of a computer program, the routines of everyday life are in fact irregular. Intuitively, routines seem to be second nature to the point of not requiring conscious attention, allowing some level of parallelism in accomplishing one’s goals (e.g., (1) driving a familiar route while (2) listening to music and (3) weighing different business strategies);
the first two tasks require little conscious attention. Performed repetitively, with little variation, such activities seem to nicely fit into the computer’s template of rational, plan-oriented processing. Hence, a promising area of research has been the design of systems that model human patterns of routine work and assist/automate people’s information-oriented tasks. Such systems have shown some potential in constrained situations but few if any have become adopted widely. In part, this is because the variance in human routines is not as trivial as that handled by computing systems. Daily activities may follow a general pattern but the implementation of that pattern varies, at least slightly, from day-to-day.

A considerable body of research in the fields of computer supported cooperative work (CSCW) and human-computer interaction (HCI) has demonstrated the often subtle and sometimes stark variation in human routines of activity. Past research has often begun with the premise that certain tasks, events, or jobs are “routine” and then proceeding to dissect it. CSCW literature of an ethnomethodological bent has a long tradition of showing that routines are in fact not. That is, upon closer scrutiny routines are filled with exception handling, and this exception handling itself is often complex, nuanced, and ephemeral. Certainly, the rhetoric of CSCW (Bowker et al., 1997) is further bolstered when even the most mundane is shown to be full of subtly.

What then is at the heart of human perception of the “routineness” of some tasks? Accepting that exceptions to routine are the norm, the research reported here has aimed to find the kernel of truth to the perception of human routine. We start from the position that it is useful to examine tasks from a less discrete scale of routine versus not-routine. Namely, we propose the utilization of a statistical technique called T-pattern analysis (Magnusson, 2000) to derive and characterize the routine-ness of a task from a temporal viewpoint. Moreover, we argue that routineness is a useful unit of analysis in unpacking multitasking in the workplace. From Mintzberg’s 1973 early study on managers to more recent work on information workers (Czerwinski et al., 2004; González and Mark, 2004), multitasking has
been shown to consist of frenetic and constant switching between media (~2 minutes) as well as projects (~12 minutes). Routineness can help answer how much of this multitasking is normal and how much of it is abnormal.

A useful way of characterizing routineness might allow one to determine what the effects are on workers when routine projects suddenly become rife with anomalies. The psychological impacts of routines in the workplace is little understood. Additionally, a grasp on routineness can actually parse out what is predictable, sequential, and planned, and what do people do when their days are, truly, routine. We emphasize this last point, because it seems that research has often tried (for good reasons) to find the strange and wondrous in routines, but has often ignored the utility of finding out what happens when the expected happens, and how that affects and shapes the information worker’s day. Indeed, if interfaces are to be designed to assist people in their routines, events, people, or tasks that are highly routine may be the best choices for intelligent, automated facilitation.

To summarize, we have three goals: (1) introduce t-patterns as a useful statistical tool for characterizing routines in terms of temporal patterns of work in observational data, (2) uncover the psychological relationship of routines to information workers, and (3) unpack the notion of routineness in tasks.

### 6.1.1 Uncovering Temporal Patterns

One of our goals in this chapter is to advocate the usage of T-patterns in the analysis of human-computer interaction.

We now give a brief primer on T-pattern detection (Magnusson, 2000). T-patterns are recurrent events that occur within a similar temporal configuration, or critical interval (CI). The T-pattern detection algorithm uses a CI test to ascertain whether certain temporal distances
between all occurrences of two events are more likely to be random or not. The CI test is based on the null hypothesis that two events A and B are independently and purely randomly (Poisson) distributed over the observation period. The test is applied on all observed temporal distances between the two events A and B and their frequencies, identifying the distances that are supposedly not random according to a specified $p$-value. Beginning first by isolating all pairs of events that are not random (the significant base patterns), the T-pattern algorithm then successively constructs larger patterns by combining events and the significant base patterns. In brief, T-pattern detection identifies highly significant, hierarchically arranged temporal patterns that are composed of statistically related events that repeatedly appear in the same, relatively invariant, temporal configuration.

T-patterns have recently proven useful in examining the affect of behavioral patterns in fields with rigorous statistical standards. In a psychiatry study using T-patterns to discover the temporal patterns of self-injurious behavior correlated with a stress hormone, Kemp et al. (2008) reported that “these methods merit further application to investigate the temporal contingencies which may reveal causal relations.” Examining the temporal relations between peak levels of hormones (testosterone and progesterone) and sexual behavior among healthy males, Hirschenauser and Frigerio (2005) suggest that T-patterns should be regarded as an important emerging tool in the field of behavioral endocrinology. Using their ambient intelligence testbed (AmI), Tavenard et al. (2008) report the T-pattern algorithm to be the best approach among the methods that try to discover re-usable and interpretable patterns in temporal event data from AmI sensors. Additionally, Magnusson and his colleagues have applied the T-pattern algorithm successfully to a wide variety of behavioral observations, ranging from children interactions (Magnusson, 2000) over behavior in sport games (Borrie et al., 2002) to human dog interaction (Kerepesi et al., 2005).

T-patterns provide significant advantages over traditional sequence analyses (Bakeman and Gottman, 1997) by incorporating time. While traditional sequential pattern mining tech-
niques (Srikant and Agrawal, 1996; Pei et al., 2001) uncover frequently occurring ordered events or subsequences as patterns, these methods ignore the temporal interval information which patterns can contain. Instead, the focus is on detecting a frequent sequence of events that are characterized by their support and confidence values. Because time delays are not modeled, the temporal structure of the pattern is essentially discarded. Alternatively, Markov Models (Rabiner, 1989) are well-known for their application in temporal pattern mining and recognition. However, these models generally do not address time either—the first order Markovian assumption does not hold since patterns are constructed as long \((n > 2)\) sequences. Moreover, Markov models have problems handling patterns that have very long time intervals. Temporal logic approaches such as Allen’s 1983 temporal logic have been used to describe temporal relationships between events. Algorithms for mining these relationships have been proposed (Hoppner, 2001) recently. While temporal logic is suitable for describing relationships like event A happened before event B, or event C happened during event D, temporal logic fails in modeling and quantifying duration information. In conclusion, most of the approaches outlined here do not provide statistical values such as significance or probabilities.

**T-pattern Parameters**

Our implementation of the T-pattern detection algorithm is based on the description by Magnusson 2000. We used the following parameters (c.f. (Kemp et al., 2008) for others) for the T-pattern detection algorithm we implemented in Java:

1. *Min Occurrence* = 2 specifies that a pattern must occur at least twice to be included in the results.

2. *Significance Level* = 0.05 specifies the probability that a given pattern would occur in a random (Poisson) distribution.

3. *Max Pattern Length* = 4 sets the maximum number of events that a pattern can be
composed of to reduce algorithm runtime and ensure reasonably interpretable pattern sizes.

In general, T-patterns are more likely to be detected when the distance between events is small. For example, detecting a pattern occurring over an hour span would be highly unlikely, unless, for some circumstance, a person repeated a pattern at the exact same distance interval. At an hour span, it would have to be relatively consistent at the minute and second span as well.

6.2 Operationalizing Routines: Facets of Routineness

In this section, we describe how we operationalize the routineness of a working sphere. An initial motivator for using T-pattern analysis is that it melds nicely with the organizational science’s canonical definition of routines as “repetition, a recognizable pattern of action, multiple participants, and interdependent actions” (Feldman and Pentland, 2003). To the best of our knowledge, there is no work that examines how the temporal facets of routines affect employee’s mental perceptions. If routines are an important demonstrable phenomenon of organizations, we may expect to see that the day’s routineness (how routine were your WSs today?) to have significant effects on an information worker’s perception of the workday (e.g., productivity). Fast-paced routines may lead to stress whereas casual routines may not.

Melding working spheres and T-pattern detection yields several interesting avenues to examine routineness by. Figure 6.1 illustrates the detection of a T-pattern in the WS labeled “Monthly Status Report.” The T-pattern is fully specified in the white box entitled “T-pattern: Email–F2F.” For each T-pattern class $t$, our program outputs the media events comprising $t$ (e.g, $[Email \rightarrow F2F]$), it’s minimal and maximal temporal length, $d_{1t}$ and $d_{2t}$: $d_{2t} \geq d_{1t} \geq 0$, the number of instances of $t$, $n_{sig}$, and $n_{total}$, the total number of patterns.
Figure 6.1: T-Pattern of Email then F2F within 20 to 53 secs found in the Monthly Status Report WS.

with the same media events.

For example, in Figure 6.1, three significant instances of the temporal pattern Email followed by F2F were found. These are the solid lined brackets above the media patterns (e.g., the first one has Email starting at 8:00:00AM and F2F starting at 8:00:45AM). Thus \( n_{\text{sig}} = 3 \). On the other hand, the bottom dotted lines in Figure 6.1 indicates three non-significant temporal patterns with the same media pattern, \([Email \rightarrow F2F]\), were found. Thus \( n_{\text{total}} = 6 \). Note that it is only the media pattern of Email followed by F2F within 20 to 53 seconds that is a T-pattern, or significant media pattern.

T-patterns are calculated separately for each WS each day, and, as Figure 6.1 shows, WSs that are fragmented in a particular day are analyzed by concatenating them together and then running T-pattern detection on the resulting combination of media events.

From these attributes of T-patterns, we can derive the following routineness metrics (\( T \) represents the T-patterns comprising a WS on a particular day):

1. \( N_T \): number of classes (types) of T-patterns per WS. This measures the variety of media patterns utilized in a WS.

2. \( X_T = \frac{\sum_{i=1}^{N_T} n_{\text{hits}}}{N_T} \): average number of instances (occurrences) each T-pattern appears per
WS. This measures how often the same T-patterns are reused in a WS.

3. \( \text{Ratio}_T = \frac{\sum N_T \left( n_{sig_t}/n_{total_t} \right)}{N_T} \): ratio of significant instances of the T-patterns to the total number of instances of patterns with the same media pattern per WS. This measures the proportion to which a WS is composed of significant patterns (i.e., T-patterns).

4. \( D_T = \frac{\sum N_T \left( d_{1t} n_{sig_t} \right)}{\sum N_T n_{sig_t}} \): mean minimum temporal length (\( d_{1t} \)) of T-patterns instances per WS. This measure examines whether the WS consists of T-patterns spread out over short or long intervals of time in the day.

5. \( \text{VarD}_T = \frac{\sum N_T \left( (d_{1t}-D_T)^2 \right)}{(\sum N_T n_{sig_t}-1)} \): variance of the minimum temporal length of T-patterns instances per WS. This measure examines how variable the time between events in T-patterns are for the WS.

Armed with these metrics for routineness, we now describe the descriptive statistics for the routineness of WSs of our informants at Audite.

### 6.3 Descriptive Statistics

The dataset in this work comes from shadowing 10 people who reported doing a certain project on a routine basis (e.g., writing weekly status reports) at the Audite Corporation; as we stated in Chapter 3, all informants were observed for three days, except for one, who was observed for only two days. In Figure 6.2 the distributions of \( N_T \) (\( M=9.00, SD=7.43, \) median=7.00), \( X_T \) (\( M=4.30, SD=2.48, \) median=3.29), \( \text{Ratio}_T \) (\( M=0.81, SD=0.09, \) median=0.83), \( D_T \) (\( M=61.32, SD=33.64, \) median=51.15), and \( \sqrt{\text{VarD}_T} \) (\( M=142.60, SD=186.9, \) median=77.64) are drawn in beanplots. The long solid and dotted lines illustrate the mean and median, respectively, and the smaller lines indicate individual measures for a day (29 points in all). For example, one of the smaller lines in the plot for \( X_T \) is calculated by first gathering the averages of the number of instances of each T-pattern class in each WS for a
Figure 6.2: Beanplots of routineness measures averaged over all WS per day.
given day and then averaging those resulting “averages” across the WS for that day. The
number of unique WS per day has $M=24.25$, $SD=4.26$, median=24.75; the duration of
each WS has $M=0:17:45$, $SD=0:35:03$, median=0:03:07.

On average, each WS per day has approximately 9 classes of T-patterns, 39 instances of
T-patterns, and 81% of its possible patterns in fact as significant patterns of media usage.
The proportion of the WS composed of significant patterns ($Ratio_T$) give some evidence of
bimodality (see Section 6.5 for a detailed look into this). Additionally, each WS on average
has T-patterns composed of events separated by at least 1 min. 1 sec.; such T-patterns may
vary ± 2 min. 22 sec. across days. Though not graphed, the $d_2$ version of $D_T$’s ($M=97.66,$
$SD=33.88$, median=92.97), i.e., the maximum temporal length of the patterns found, stats
reveal that, at most, the distance typically only extends to 1 min. 37 sec. We surmise
that T-patterns encapsulate what a WS/task/project is in terms of time: the utilization of a
relatively small arsenal of temporal patterns, reused repetitively, each consisting of media
activity separated by less than 2 min.

Table 6.1 lists the summary statistics for workplace and personality instruments averaged
over days. Workload is one’s mental, physical, temporal, effort and frustration demands
coupled with success in accomplishing tasks in a day; perceived productivity is one’s effi-
ciency plus the quality and quantity of work done in a day; and autonomy is the extent one
had control and freedom in making judgments. Extraversion is one’s degree of sociability
and predilection for positive emotions; agreeableness is one’s degree of cooperation and
empathy; and openness is one’s degree of creativity and aestheticism.
Table 6.1: Psychometric score summaries per day for informants at Audite.

<table>
<thead>
<tr>
<th>Workplace Instruments</th>
<th>Personality Instruments(^{\dagger})</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Workload</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>52.97</td>
</tr>
<tr>
<td>(16.00)</td>
<td>(9.65)</td>
</tr>
<tr>
<td>Median</td>
<td>50.00</td>
</tr>
<tr>
<td>Theoretical Range</td>
<td>[12, 120]</td>
</tr>
</tbody>
</table>

\(^{\dagger}\) Personality traits were assumed invariant across work days.

6.4 The Psychology of Routines

Having described our dataset, we now turn to the task of uncovering what are the psychological effects of routineness in the workplace. We do this by looking at the regression of psychometric measures related to the workplace and to general personality traits on our set of five routineness measures. We are primarily interested in how the descriptive nature of the regression equation reveals associations. That is, what is the relationship between temporal routines and affective state? While research on routines has indicated that they are necessary, can lead to productivity, and may stifle creativity (Ahuja and Carley, 1998), there is little on how the temporal aspects of routines affects people’s mental states. There has been research examining how interactions are the source of many interruptions (e.g., Iqbal and Horvitz (2007b)), leading to a conjecture that one might experience less routineness when interactions are the norm. This is not to say that interactions (as we will show later) are not part of a routine, but rather that interactions may contribute to a very different kind of routine as characterized by our notion of “routineness.” Hence, the personality traits we have chosen are related to having a predisposition for interaction.

The best predictors were selected via all-subsets regression using the leaps-and-bounds algorithm and Mallows’ \(C_p\) criterion to avoid overfitting the model (Berk, 2004). The Breusch-Pagan test gave no evidence for heteroscedasticity. Q-Q plots and the D’Agostino-
Table 6.2: Regression on workplace psychometrics and personality traits.

<table>
<thead>
<tr>
<th>Workplace Instruments</th>
<th>Personality Instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workload</td>
<td>Autonomy</td>
</tr>
<tr>
<td>Intercept</td>
<td>61.30***</td>
</tr>
<tr>
<td></td>
<td>(5.61)</td>
</tr>
<tr>
<td>( N_T )</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>–</td>
</tr>
<tr>
<td>( X_T )</td>
<td>–2.74**</td>
</tr>
<tr>
<td></td>
<td>(1.07)</td>
</tr>
<tr>
<td>( Ratio_T )</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>–</td>
</tr>
<tr>
<td>( D_T )</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>–</td>
</tr>
<tr>
<td>( VarD_T )</td>
<td>1.71\times 10^{-4}***</td>
</tr>
<tr>
<td></td>
<td>(7.52\times 10^{-5})</td>
</tr>
<tr>
<td></td>
<td>37.37%</td>
</tr>
</tbody>
</table>

\( R^2 \) 0.30 0.34 0.24 0.43 0.31 –

Standard errors are in parenthesis. * , ** , *** indicates significance at 90% , 95% , 99% , respectively. Relative importance (LMG metric) are in italics.

Pearson test showed no signs of non-normality in the residuals. Variance-inflation factors were all less than five (max was 1.24), providing no indicators for multicollinearity. Although standardized coefficients (\( \beta \)) have been used to gauge the proportionate contribution (i.e., importance) of each predictor to \( R^2 \), this is fraught with complications (e.g., when predictors are correlated with each other); instead, we use LMG (Gromping, 2007) and report the raw coefficients. We emphasize that these linear models are not meant to be precise predictive tools; however, the \( R^2 \) values are well within the range used for models in the human-computer interaction literature (e.g., see work by Dabbish and Kraut (2006) on email “overload” and Mark et al. (2008) on the stress/speed of interruptions) that describe social phenomena from observational data. Table 6.2 illustrates the results of our regression analysis. The omnibus test for all fits except openness had \( p < 0.05 \).
6.4.1 Relating Workplace Instruments with Routineness

We now summarize the significant relationships between workplace instruments and our routineness metrics. To facilitate the discussion, we will draw on our “arsenal” metaphor. T-pattern classes can be thought of as the various weapons contained in one’s arsenal. A T-pattern instance is equivalent to using, or firing, a particular weapon from our arsenal. Aside from our arsenal (located at-hand), there are weapons available back at the home base—these are the media patterns that were not detected as significant. Each weapon has a certain firing rate, this can be regarded as the temporal distance for the T-pattern. A longer temporal distance means a lower firing rate.

1. A significant relation in an increase in instances of T-patterns that are reused per WS per day with a decrease in amount of workload perceived. In other words, a relation was found between decreased workload and an increase in the average usage of any particular weapons in our arsenal.

2. An increase in the proportions of a WS that is made up of T-patterns in a day is significantly related to an increase in autonomy. In other words, there was a relationship with informants who used mostly weapons from their immediate arsenal and an increase in the amount of control informants had to carry out the work the way they wanted to.

3. As the variability in the minimum T-pattern temporal distances increases in WSs in a day, perceived workload increases but autonomy decreases. In other words, as the variability in firing rate for our weapons increase, we found a significant drop in reported control over how much control people have in their work processes.

4. A reduction in the number of T-pattern classes utilized per WS per day significantly decreases productivity. In other words, as the weapons in our arsenal decreased, a significant amount of informants reported reduced perceived productivity.
Thus, the reuse of routine temporal patterns was found to be significantly related to less reported stress, but that variability in the actual distance in events increases stress. In other words, informants who experienced WS consisting of patterns whose temporal distance fluctuates perceived their day as having a greater workload. However, being able to reuse the same pattern over and over in a WS leads to a seemingly less stressful (less workload) day.

Indeed, routines can be productive—informants noted so when days were filled with WS of repeated patterns of media usage. We find it interesting, however, that routines can reduce productivity if one starts employing a great number of different media patterns. Thus, just the mere utilization of a wide array of different media pattern classes, no matter whether each class is used a great deal or not, can make ones day seem less productive. While variety may be the “spice of life,” in the workplace, it may not be so welcome.

Curiously, informants reported that they felt their freedom to control how they work was increased when the variance of temporal distances decreased in their WSs. This might indicate that people who are able to use a variety of media with relatively stable temporal durations (e.g., productivity software vs. interruptions from interactions) have more control over how they work.

In addition, the absence of a factor is also interesting. We note that we found no evidence that the minimum distance of the temporal patterns affected working states. Variability, certainly, but not the distance itself.

In sum, we surmise that deft media appropriation may be related to routinely using media pattern classes. Having too many “weapons” in your arsenal can be counterproductive, leading to too many choices and decreasing the chances of efficiently using particular weapons more than once. Instead, repeated usage of certain weapons may be productive.
6.4.2 Relating Personality with Routineness

We were also interested to see how one’s personality traits were related to the routineness of their WSs. While it is tempting to interpret Table 6.2 as stating that the routineness measures are causing changes to personality, we believe it more appropriate to interpret the results as to how one’s personality traits give rise to a certain style of work in terms of routineness. We have taken the assumption that personality traits are an inherent trait, not malleable factors effected by the environment. Next we find for personality types (using the arsenal metaphor from the previous section):

1. A reduction in reuse of and proportion of T-patterns per WS per day is significantly related to increased extraversion. In other words, people who enjoy human interaction (are assertive and outgoing) reported a significant decrease in the number of weapons in their arsenal and an increase in reliance on weapons in the home base (weapons not at-hand).

2. An increase in the temporal length of T-patterns per WS of a day is significantly related to increased extraversion and agreeableness. In other words, people who are extraverted, friendly, and prefer cooperation, reported a significant decrease in the firing rate of each weapon.

3. A reduction in the variability of the temporal length of T-patterns per WS of a day is significantly related to increased extraversion and agreeableness. In other words, people who are extraverted and agreeable (in general, open to and seeking interactions), reported using weapons with a significantly reduced variability in firing rate.

People who are extraverted value and seek interactions; thus, it might be that extraversion here is negatively related to having an extremely routine day (a day with many routine WSs).
Additionally, interactions are often unpredictable, lengthy, and stressful (Su and Mark, 2008) when compared to isolated activities in the workplace. This fits well with our results: a decrease in reuse of T-patterns and proportion of patterns that are T-patterns, and increased distance is statistically related to increased extraversion. Nevertheless, we do see here that decreased variability in minimum distance is related to increased extraversion. We see a similar result for agreeableness, though $D_T$ dominates (about four times as much) $VarD_T$ in contributing to $R^2$. One possibility is that since an increase in variability decreases autonomy, extraversion and agreeableness are similarly decreased because one has less control or opportunities to actively initiate social networks at work. Note there is no significant relation with $N_T$, the number of T-pattern classes; though, $X_T$ and $Ratio_T$ indicate that the amount of reuse/repetition of routine patterns is lower for extraverted people. Namely, such personality types “exploit” routines to a smaller degree than other people. In other words, we surmise that extraverted people have a less routine day simply because they interact more readily with people. Interactions are do not exhibit a regularity that allows to be recognized as a T-pattern. Thus, the repertoire of regular patterns extraverted people instantiate is smaller.

Following our metaphor, we found evidence that informants who routinely use T-patterns with a communication medium as a “weapon” may have working spheres characterized by greater instability. This instability is due to the temporal aspects of T-patterns—greater minimum temporal distance and greater variability in that distance. People who are more sociable (extraversion and agreeableness) were found to be significantly associated with using T-patterns with some element that is a communicative act (e.g., $Email \rightarrow Stationery$ versus just $PowerPoint \rightarrow Stationery$).

We did not find any significant predictors for openness, providing no evidence of creativity being particularly associated with temporal routineness. Finally, we analyzed T-patterns
found across all mediums in a day *ignoring WSs* and found no significant relationship between mental state and routineness.

### 6.5 Unpacking Patterns of Routineness

We now turn to looking at several sample WSs with different values of routineness measures to better grasp what these measures *are* truly measuring, and how they might relate to systems. In total, 136 WSs were observed. As before, we elected to consider WSs occurring on different days as separate instances. In other words, although Jane may have worked on her monthly reports on day 1 and day 2 of observations, we did *not* concatenate the events of day 1 and day 2 into one WS. This is simply because we believe the amount of time elapsed from day 1 and day 2 is too long to be considered simply one WS that is being worked on continuously for two days straight.

To assist us in our exploratory qualitative analysis, we performed cluster analysis. We used the results of spectral cluster analysis (Ng et al., 2002) which has advantages over traditional clustering methods such as k-means in that it is not limited to clustering data points falling into a convex set. We used the `specc` function from the *kernlab* (Karatzoglou et al., 2004) package with the radial basis kernel function (Gaussian).

Determining the number of clusters is a difficult and subjective problem, but one method is to visually inspect a plot of a cluster index (i.e., a metric to measure the quality of the clustering) over a range of *k* clusters. Figure 6.3 illustrates the result of running cluster analysis 5,000 times for *k* from 2 to 10. The right-hand screeplot shows the result when k-means (run with random selection of centroids) minimizes the sum of squares (wss) from points to their assigned cluster. The left-hand screeplot shows the sorted eigenvalues of the affinity matrix with spectral clustering (cf. Zelnik-Manor and Perona (2005) for details of
this approach). Based on the screeplot, it is not obvious where the “elbow-point” (Kaufman
and Rousseeuw, 1990) (especially in the wss example) is but one possible interpretation is
an eigengap (e.g., discernible drop in magnitude) between eigenvalue 4 and 5. Moreover,
spectral clustering gave “uninteresting” clusters when \( k > 4 \); for example, clusters with
only one member were generated. Thus, we choose 4 as \( k \).

![Screeplot](image)

Figure 6.3: Screeplot of the eigenvalues of the affinity matrix (left-hand side) and within-
sum squared (right-hand side) across varying \( k \) with spectral clustering and \( k \)-means, re-
spectively.

We ran the cluster analysis 5,000 times, minimizing the silhouette coefficient. The si-
houette coefficient (Tan et al., 2006) attempts to maximize both the cohesion of individual
elements in a cluster and the separation of the clusters from other clusters. Figure 6.4
visualizes the final clustering assignments for each working sphere. Since each WS is rep-
resented by more than 2 variables, dimensional reduction can be useful. The left-hand plot
uses the first two canonical variates (65%, and 24% of the between-class variance) from
canonical correlation analysis, while the right-hand plot uses the first two principal compo-
nents (37% and 31% of the total variance in the data) from principal components analysis.
We wish to stress here that our intent here is to use clustering as an exploratory tool
(cf. Webb (2002), pg. 403), not as a way to derive a statistically definitive solution or prediction model for data mining WSs.

Table 6.3 lists the descriptive statistics for each cluster. “Size” indicates the number of WSs labeled into the cluster. With the clusterings as an exploratory guide, we can now examine an example WS from each cluster. The last row is a summary of all the WSs’ routineness measures. For each cluster, we choose an exemplar WS that lies close to the centroid of the cluster. The following subsections are titled with the key characteristics of the cluster. Additionally, we state the exemplar WS’s label and its routineness metrics. Drawing from our video data, screenshots, and raw notes, we unpack some of the T-patterns detected in the WS. Please refer to Table 3.1 for the media abbreviations we used in the T-pattern listings. Recall that the T-pattern analysis is limited to patterns of length four and proceeds in a breadth-first search matter, building upon patterns found previously.
Figure 6.4: 2 different visualizations of working spheres categorized into 4 clusters by spectral clustering.
Table 6.3: Summary statistics for each cluster (mean and standard deviation).

<table>
<thead>
<tr>
<th>Cluster</th>
<th>$N_T$</th>
<th>$X_T$</th>
<th>$Ratio_T$</th>
<th>$D_T$</th>
<th>$\sqrt{VarD_T}$</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>24.80</td>
<td>11.85</td>
<td>0.70</td>
<td>33.91</td>
<td>162.94</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>(18.82)</td>
<td>(5.02)</td>
<td>(0.08)</td>
<td>(27.71)</td>
<td>(263.19)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>3.04</td>
<td>2.30</td>
<td>0.96</td>
<td>49.87</td>
<td>47.50</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>(3.16)</td>
<td>(0.45)</td>
<td>(0.06)</td>
<td>(43.35)</td>
<td>(77.42)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>9.80</td>
<td>2.99</td>
<td>0.75</td>
<td>281.71</td>
<td>520.11</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>(8.59)</td>
<td>(0.61)</td>
<td>(0.15)</td>
<td>(91.09)</td>
<td>(492.27)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>7.88</td>
<td>3.70</td>
<td>0.69</td>
<td>53.82</td>
<td>91.02</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>(6.46)</td>
<td>(1.48)</td>
<td>(0.15)</td>
<td>(37.72)</td>
<td>(120.35)</td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>7.82</td>
<td>4.00</td>
<td>0.80</td>
<td>58.4</td>
<td>132.10</td>
<td>136</td>
</tr>
<tr>
<td></td>
<td>(10.15)</td>
<td>(3.43)</td>
<td>(0.17)</td>
<td>(60.55)</td>
<td>(264.00)</td>
<td></td>
</tr>
</tbody>
</table>

6.5.1 Cluster 1: High # of media T-patterns classes and instances of each. High variability in temporal distance

Cluster characteristics: Cluster 1 is characterized by a large number of media T-pattern classes ($\approx 25$) and multiple reuses ($\approx 12$) of each class. Additionally, the variability of the temporal distance between media elements is relatively large ($\approx 3$ min.). As our regression model from Section 6.4 notes, WS with high $N_T$ and $X_T$ are related to less workload and productivity and are associated with less extraverted personalities.

Exemplar WS: [Updating IT Metrics: $N_T = 26, X_T = 6.62, Ratio_T = 0.75, D_T = 19.23, \sqrt{VarD_T} = 49.37$] We will now examine an exemplar WS in this cluster. This WS is carried out on a monthly basis by Robert, the head of IT at Audite. To make informed decisions on future IT purchases or infrastructure balancing, Robert updates a spreadsheet with IT metrics gathered from a variety of sources. For example, he calculates available storage space from the OS, and goes to telephone records on the telecommunication company’s website to get usage statistics of incoming/outcoming calls at Audite.

T-pattern analysis revealed extremely routinized media patterns used to calculate metrics
from each of the different sources Robert seeks. We now list and unpack each of the T-pattern classes detected in Robert’s WS:

1. (a) \([\text{Browser} \rightarrow \text{SS}] \rightarrow \text{Browser}] \quad (d_1 = 8 \text{ sec.}, \ d_2 = 46 \text{ sec.})

(b) \([\text{Browser} \rightarrow \text{SS} \rightarrow \text{Browser}] \quad (d_1 = 4 \text{ sec.}, \ d_2 = 30 \text{ sec.})

(c) \([\text{SS} \rightarrow \text{Browser}] \quad (d_1 = 4 \text{ sec.}, \ d_2 = 16 \text{ sec.})

(d) \([\text{Browser} \rightarrow \text{Browser} \rightarrow \text{SS}] \quad (d_1 = 8 \text{ sec.}, \ d_2 = 45 \text{ sec.})

(e) \([\text{Browser} \rightarrow \text{SS}] \quad (d_1 = 4 \text{ sec.}, \ d_2 = 30 \text{ sec.})

(f) \([\text{SS} \rightarrow \text{Browser} \rightarrow \text{Browser}] \quad (d_1 = 14 \text{ sec.}, \ d_2 = 59 \text{ sec.})

(g) \([\text{Browser} \rightarrow \text{SS} \rightarrow \text{SS} \rightarrow \text{Browser}] \quad (d_1 = 12 \text{ sec.}, \ d_2 = 68 \text{ sec.})

(h) \([\text{SS} \rightarrow \text{Browser} \rightarrow \text{Browser} \rightarrow \text{SS}] \quad (d_1 = 14 \text{ sec.}, \ d_2 = 33 \text{ sec.})

As mentioned earlier, data is collated into an Excel spreadsheet (SS). One source of metrics is accessed via internal and external websites (Browser). One website reports statistics on the Windows file space. Robert also consults an external website, whose services Audite enlists, to analyze and reports any needed security updates for the servers: this security “level” is added as part of the metrics.

2. (a) \([\text{Email} \rightarrow \text{Email} \rightarrow \text{SS}] \quad (d_1 = 7 \text{ sec.}, \ d_2 = 48 \text{ sec.})

(b) \([\text{SS} \rightarrow \text{Email} \rightarrow \text{Email} \rightarrow \text{SS}] \quad (d_1 = 31 \text{ sec.}, \ d_2 = 98 \text{ sec.})

(c) \([\text{SS} \rightarrow \text{Email} \rightarrow \text{Email}] \quad (d_1 = 17 \text{ sec.}, \ d_2 = 84 \text{ sec.})

(d) \([\text{Email} \rightarrow \text{SS} \rightarrow \text{Email}] \quad (d_1 = 10 \text{ sec.}, \ d_2 = 15 \text{ sec.})

(e) \([\text{Email} \rightarrow \text{SS}] \quad (d_1 = 5 \text{ sec.}, \ d_2 = 45 \text{ sec.})

(f) \([\text{Email} \rightarrow \text{SS} \rightarrow \text{Email} \rightarrow \text{Browser}] \quad (d_1 = 427 \text{ sec.}, \ d_2 = 437 \text{ sec.})

(g) \([\text{SS} \rightarrow \text{Email} \rightarrow \text{SS}] \quad (d_1 = 17 \text{ sec.}, \ d_2 = 161 \text{ sec.})

(h) \([\text{Email} \rightarrow \text{SS} \rightarrow \text{Email}] \quad (d_1 = 18 \text{ sec.}, \ d_2 = 83 \text{ sec.})
These T-patterns involve email. Again, this is another source from which the data come. Robert goes to a folder where automatically generated email reports come in (presumably from a server script): they list numbers such as total mailbox size and server snapshot sizes. In one instance, an email arrives from one of Robert’s subordinates regarding an earlier problem with one of the internal web pages that reports what OS people are using inside Audite. This email lets Robert know that the problem has been fixed, so he continues with the WS by going to web page and editing the spreadsheet. These patterns have a relatively variable temporal distance; although Robert knows what folder the emails are located in, he actually uses Microsoft Outlook to search and browse within the folder to find the correct emails that have the metrics in a specific time period. The larger number of T-patterns in this and the previous group reflect that all these sequences are very significant and interdependent.

Robert also navigates to Audite’s telecommunications provider’s webpage (Browser) for telephone statistics. This data is provided in PDF form. He views the PDFs in Adobe Acrobat Reader (App) and pastes the appropriate data into the spreadsheet. There is also an instance of using the Calculator software (App) to sum up file sizes reported by an internal web page.
(b) \([\text{OS} \rightarrow \text{SS} \rightarrow \text{SS}] (d_1 = 77\text{ sec.}, d_2 = 115\text{ sec.})\)

(c) \([\text{OS} \rightarrow \text{Browser}] (d_1 = 9\text{ sec.}, d_2 = 18\text{ sec.})\)

Robert also uses Windows Explorer’s (\textit{OS}) functionality to determine server hard disk space. He also does some meta work such as rearranging (\textit{OS}) the windows to allow him to better work on the WS and re-logging (\textit{OS}) into his laptop.

5. (a) \([\text{WP} \rightarrow \text{SS}] (d_1 = 51\text{ sec.}, d_2 = 75\text{ sec.})\)

This T-pattern is an interesting case of using Microsoft Word (\textit{WP}) as a text file formatter. Robert knows that the data copied from one source uses multiple space character as a delimiter between elements. So, he copies and pastes the text into Word, replaces all spaces by one space, and then replaces all spaces by tabs. This allows Robert to paste the data, properly formatted, into the table of his Excel “helper” spreadsheet (see Figure 6.5), which even further formats the data by converting units.

Work on this WS was spread out throughout the entire day. Robert utilizes a large array of T-patterns, each instance of which can vary in temporal distances. Thus, unlike Cluster 2 (cf. Section 6.5.2), the T-patterns here account for much of events of the WS, rather than just the transitional phases. It is not dominated by a single sort of pattern, but rather involves utilizing multiple routine tasks for each metric type, formating it, and arranging it into a single spreadsheet. There are some specific strategies that Robert uses to ensure that he can recall his patterns: (1) He leaves direct links (see Figure 6.6) to the server shares on the Excel spreadsheet itself; (2) His email folders serve as a site for work; and (3) has created “helper” spreadsheets (and a “helper” Word pattern to remove spaces) that, while not part of the final product, allow him to quickly format the data “programming” by spreadsheet.
Figure 6.5: Robert carrying out a T-pattern of pasting storage metrics from a website to a “helper” spreadsheet. Note the explicit instructions he’s written to remind himself (in the red rectangle).
Figure 6.6: The storage portion of the final metrics stats (others include staff). Note that the stats from previous months are easily viewable so that Robert can quickly predict which resources might need addressing. Links to websites and network shares in the spreadsheet facilitate T-pattern execution.
6.5.2 Cluster 2: High proportion of media T-patterns are significant.
Low # of classes and instances of T-patterns.

Cluster Characteristics: Cluster 2 contains WSs with a high proportion of media patterns that are significant. On average, each WS has 96% of its T-patterns being significant. In other words, most media events are part of a real temporal pattern of media usage. On the other hand, the number of T-pattern classes (≈ 3) and instances of each type is low (≈ 2). Our regressions suggest that days consisting of WSs with a high ratio of T-patterns have higher autonomy. A low $N_T$ and $X_T$ are related to higher workload with higher productivity. Days with such WSs are linked with greater levels of extraversion.

Exemplar WS: [Check Payments: $N_T = 12, X_T = 2.25, Ratio_T = 0.94, D_T = 45.59, \sqrt{VarD_T} = 39.40$] In this exemplar, we have a WS carried out by Juno who works in accounting. Carried out each week, Juno must verify and issue checks for Audite’s invoice payments. This involves matching invoices with their check and verifying (by looking for a signature) that the employee at Audite has in fact received the product/service. She stuffs the original check in an envelope and staples the invoice and check together for backup. Purchases greater than $5,000 need to be authorized by her supervisor. The T-patterns in this WS are:

1. (a) $[\text{Self} \rightarrow \text{Hardware}](d_1 = 18 \text{ sec.}, d_2 = 23 \text{ sec.})$
   
   (b) $[\text{Self} \rightarrow \text{Hardware} \rightarrow \text{Stationery}](d_1 = 18 \text{ sec.}, d_2 = 23 \text{ sec.})$

   (c) $[\text{Self} \rightarrow \text{Hardware} \rightarrow \text{Self}](d_1 = 18 \text{ sec.}, d_2 = 19 \text{ sec.})$

   (d) $[\text{Hardware} \rightarrow \text{Self} \rightarrow \text{Stationery}](d_1 = 37 \text{ sec.}, d_2 = 39 \text{ sec.})$

These T-patterns reflect the usage of a shared space amongst the accounting staff. This shared space is a storage room where financial documents are stored along with various equipment. In this WS, T-pattern (a) represents when Juno:
• Walks (*Self*) to the storage area to use the automatic stapler (*Hardware*) for a particularly large pile of invoices and checks.

• Walks to the storage area to make a Xerox copy (*Hardware*) of a signature an employee signed on the wrong form (remittance instead of invoice).

• Walks to the storage area to use the hole puncher (*Hardware*) for the final stack of payment backups.

T-pattern (b) and (c) represent media events following T-pattern (a). T-pattern (b) occurs when Juno continues processing the *Stationery* related to the WS: checks, invoices, and binders. T-pattern (c) occurs when Juno walks (*Self*) back to her office from the storage area. T-pattern (d), on the other hand, demonstrates that there is a temporal sequence *starting* with hardware followed by walking back and processing papers.

2. (a) [OS→Browser](\(d_1 = 39\) sec., \(d_2 = 44\) sec.)

   (b) [Browser→SS→SS](\(d_1 = 15\) sec., \(d_2 = 73\) sec.)

   (c) [OS→Browser→SS](\(d_1 = 58\) sec., \(d_2 = 108\) sec.)

   (d) [Browser→Stationery](\(d_1 = 10\) sec., \(d_2 = 16\) sec.)

These T-patterns represent utilization of online web applications to authorize Audite’s bank to pay the checks. T-pattern (a) and (b) shows Juno using Windows Explorer (*OS*) to browse to the location where she stores her spreadsheet templates (*SS*) for this particular WS. Her actions are quick—after double clicking the spreadsheets, she immediately starts the web application process (*Browser*), knowing that the spreadsheet will open in the background. She knows where to go folder-wise and these templates allow her to quickly conclude the WS (when she has finished processing all the checks) with the appropriate material. T-pattern (c) is recognized because Juno uses more than one spreadsheet (*SS*) in this phase of the WS: those gen-
erated from the web application and those handcrafted from her templates. Lastly, T-pattern (d) notes

3. (a) [Self→F2F→Self](d₁ = 149 sec., d₂ = 152 sec.)

(b) [F2F→Self→Stationery](d₁ = 108 sec., d₂ = 109 sec.)

(c) [F2F→Self](d₁ = 31 sec., d₂ = 94 sec.)

These T-patterns surround face to face conversations in the WS. Juno walks (Self) to shipping and receiving to mail the checks out for payment. She speaks (F2F) with the staff in the shipping department and also speaks (F2F) with human resources to drop off checks for travel reimbursements. As before, the T-patterns analysis determines a statistically significant pattern for Juno walking back to the office and continuing her paper processing for the WS after her face to face talks.

4. [Stationery→App](d₁ = 23 sec., d₂ = 29 sec.)

Here, Juno runs Audite’s internal accounting software (App) to look up payment information.

As demonstrated, this WS was unproblematic and nearly all patterns with identical patterns to the T-pattern’s media pattern were statistically significant. Interestingly, although the bulk of the WS consisted simply of looking at invoices and checks, this was not recognized as a T-pattern (which would’ve been [Stationery→Stationery]). Rather, the patterns in this particular case reflected the transitional phases of the WS: moving to the storage area, mailing out the checks, and submitting the payments online to the bank. Additionally, the low temporal distance between events in this WS reflect the relatively unperturbed nature of the WS; it was carried out largely sequentially with minimal switching to another WS (i.e., interruptions).

From our observations, we felt Juno had little need to hurry on this WS and simply did what she always does at her own pace (higher autonomy). Moreover, there were very few face
to face interactions (interruptions), supporting our proposed relationship of having lower extraversion and higher ratios with such WSs. It should be noted that the $N_T$ here is larger than the average for this cluster, perhaps indicating that the WS had a lower productivity but a high workload.

6.5.3 Cluster 3: High Temporal Distance & Variability in T-patterns

**Cluster Characteristics:** WSs in this cluster are distinguished by high $D_T$ ($\approx 5$ min.) and $VarD_T$ ($\approx 9$ min.). In other words, the T-patterns have media events happening after some time of each other, and this time period itself is variable. A large distance suggests that the T-patterns themselves are lengthy or composed of many media events. We found that people reported greater workload when experiencing such WSs. Also, people on the lower end of extraversion and agreeableness were related to having such WSs.

**Exemplar WS:** *Report to Funding Agency: $N_T = 8, X_T = 2.75, Ratio_T = 0.79, D_T = 187.9, \sqrt{VarD_T} = 23.03* Ada works as a research manager in Audite. Every month, she must assemble and submit a status report to her funding agency regarding a large-scale project her lab is conducting. Figure 6.7 illustrates Ada’s execution of many of these T-patterns.

1. (a) [OS→WP→WP→Phone] ($d_1 = 1825$ sec., $d_2 = 1835$ sec.)

As manager of a lab, Ada must gently coax her subordinates to submit their own status reports to her. Ada uses the *Phone* to ask her coworker John for clarifications on his report. The left-hand monitor shows the working draft of the final status report (*WP*); each section of the report is constructed by cutting, pasting, and editing other people’s reports (*WP*). The *OS* event is simply the use of Windows Explorer to open up documents. This T-pattern has a large temporal distance due to usage of a
communicative medium, the phone.

2.  
   (a) [Email→WP→Email] \( (d_1 = 24 \text{ sec.}, d_2 = 25 \text{ sec.}) \)

   (b) [PP→WP] \( (d_1 = 4 \text{ sec.}, d_2 = 22 \text{ sec.}) \)

   (c) [WP→PP→PP] \( (d_1 = 83 \text{ sec.}, d_2 = 267 \text{ sec.}) \)

   (d) [SS→WP] \( (d_1 = 34 \text{ sec.}, d_2 = 38 \text{ sec.}) \)

   (e) [App→WP] \( (d_1 = 3 \text{ sec.}, d_2 = 55 \text{ sec.}) \)

   (f) [Email→WP] \( (d_1 = 7 \text{ sec.}, d_2 = 18 \text{ sec.}) \)

Most of the reports arrive via Email. Ada opens up the word document attachments (WP). When she cuts and pastes figures from these reports, Ada has found in her experience that the figures always need some pre-adjustment before pasting, so she uses PowerPoint (PP) as an intermediary working area to modify graphics that will end up in the final report to the funding agency. Unlike the “helper” spreadsheet in Cluster 1’s exemplar WS, usage of the PowerPoint “helper” here is more variable (T-pattern (c)) because Ada must edit each image from each of her subordinates’ reports in a nuanced way to achieve her presentation goals (to the funding agency).

This WS exhibits temporal distance of large magnitude and variability. This exemplar shows the effect of temporal patterns that depend on human input. Ada cannot proceed with her final report without consulting each of her subordinates to both 1) remind them to send their reports, and 2) to ask questions about the reports. Additionally, the editing of figures in PowerPoint is not entirely routine.

According to our regression model, days with WSs with high \( D_T \) are related to higher extraversion and agreeableness for a particular informant. On the other hand, having a high \( VarD_T \) is also associated with low extraversion, agreeableness, and a higher workload coupled with lower autonomy. If we account for effect size, the regression suggests leaning
towards slightly greater extraversion and a great deal less agreeableness. While we can only conjecture the relationship between this particular WS and personality traits, we can note that in our observations, Ada’s role as a manager requires her to delicately remind her subordinates several times to submit their reports (something seen as a bureaucratic task that takes time away from researchers to do research)—a task requiring good social skills; however, the task itself deals little with cooperation, it is largely one sided (her asking others to carry out tasks).
Figure 6.7: The top video capture shows Ada asking John via the phone to clarify some numeric units of his report. The bottom capture shows Ada finding the figure (inside the red rectangle) from John’s report to be askew, so she is now editing it in PowerPoint.
6.5.4 Cluster 4: Average Routineness

Cluster Characteristics: The WSs in this cluster lie in the middle of the spectrum (refer to the last row of Table 6.3 for comparison). However, the ratio of media patterns that are significant is less (0.69 versus 0.80) and the variability of $d_1$ is less (1 min. 31 sec. versus 2 min. 12 sec.).

Exemplar WS: [Expired Wireless Certificate: $T_N = 19, X_T = 3.63, \text{Ratio}_T = 0.80, D_T = 64.19, \sqrt{\text{Var}D_T} = 92.13$] In this exemplar WS, we have a cluster executed by Betty, an administrative assistant of a department in Audite. She does much of the housekeeping for the department: inventory, office space, travel reimbursements, etc. In this particular WS, Betty is contacted from IT regarding computers whose wireless certificate have expired.

1. (a) [Email→Browser→SS→Email]$(d_1 = 291 \text{ sec.}, d_2 = 292 \text{ sec.})$
   
   (b) [Email→SS→SS→Email]$(d_1 = 291 \text{ sec.}, d_2 = 292 \text{ sec.})$

   (c) [Email→SS→Browser]$(d_1 = 39 \text{ sec.}, d_2 = 51 \text{ sec.})$

   (d) [SS→Email]$(d_1 = 14 \text{ sec.}, d_2 = 28 \text{ sec.})$

Betty needs to check if some of the machines are truly defunct; some of the machines she knows off the “top of my head” that they are obsolete. Unlike the previous WS where each data source was fetched via a small number of media events, Betty must use lengthy T-patterns to find a machine’s status. These T-patterns reflect switching between the email from IT and a spreadsheet (SS) Betty maintains that contains an inventory of all the machines used by her department. She also checks IT’s internal machine inventory website (Browser) because she is concerned as to why IT is asking her about some machines that (to her) have been defunct for awhile. Indeed, if a PC is decommissioned it must be removed from the accounting books for tax purposes. Figure 6.8 shows one example of a T-pattern being executed.
These T-patterns reflect the search and use of disposition of assets papers. These forms are filled out when computers are decommissioned. She opens a cabinet (Hardware) up and searches through her papers (Stationery) to find the disposition form for employees’ computers. A great deal of variability occurs because she searches several places for one particular person’s disposition form: in the cabinet drawer, above the cabinet, and in her shelves. Betty thinks she knows where the form is but is mistaken and has to thusly search several possible locations. Betty also uses paper (Stationery) to write down computers she will need to hunt for manually in the storage room. (Stationery).

The T-patterns of this WS reflect on Betty’s expertise on where to get information from various sources: inventory spreadsheet, IT browser, cabinets, etc. Yet, it also highlights
that the location of data is not always known with precision. Figure 6.8 shows that some measure of tacit knowledge, knowledge not encoded in a database, is necessary to accomplish her WS. Moreover, Betty must search through several data sources (e.g., paper piles) to find a particular computer’s disposition form due to her incomplete recollection of its location.
Figure 6.8: On the right-hand monitor, Betty has the IT Email which initiated the WS regarding expired certificates. Betty is now examining each computer in the email to see whether it belongs to her group, and if so, what its current status is. She uses the left-hand monitor to search and browse various sources. She looks up one of the computers called “Clive,” on Audite’s internal IT website (Browser) remarking, “Clive... [types in computer name]...Clive used to be a...pool laptop but I know I gave Clive to someone.” She switches to the spreadsheet, “It’s amazing how you remember stuff <laughs>. The things you remember.” The spreadsheet (SS) says it is in storage, so she writes on her paper notes (Stationery) that she will have to physically look for the computer as apparently she doesn’t know who currently has the laptop.
6.5.5 Comments

Through cluster analysis, we have described temporal archetypes of WSs that have been graded according to our routineness measures. Namely:

1. Working spheres that contain many significant T-pattern classes and the subsequent instantiation of such classes. (Stereotypical routines)

2. Working spheres that have nearly all T-patterns detected to be significant, but relatively few T-pattern classes and instances. (Transitional phase routines)

3. Working spheres with significant T-patterns of high temporal distance and variability. (Human (interaction) dependent routines)

4. Working spheres with middle of the road routineness. (Mixture of routine patterns coupled with expected exception handling)

Indeed, if researchers seek to facilitate users in tasks, one might ask, “What kinds of tasks are people seeking to model or adapt to?” Cluster 1 and 2 are perhaps closest to what people typically perceive routine tasks to be. They may be the easiest to facilitate. However, Cluster 2 contains T-patterns that are more indicative of shifting from one phase to another in a WS, whereas Cluster 1 contains T-patterns that reflect the content of the routine WS: the repetitious execution of numerous media patterns to extract data from sources to a target. Stress-wise (examining the workload component), Cluster 1 seems “better.” Cluster 3, on the other hand has a great deal of variability partially due to the unpredictable nature of WS that have communication as an integral component. T-patterns here are indicative of using a variety of communication media patterns to accomplish work. Finally, Cluster 4 may be the trickiest to assist with information technologies. While some T-patterns represent the use of “routines” to accomplish goals, others reflect instead the use of routine patterns to handle exceptions. In other words, the main content of the WS is not composed of regular patterns,
but instead contains exceptions that are routinely handled. It reflects here how people subtly handle incomplete and incorrect knowledge in their heads to accomplish work effectively. The example given for Cluster 4 is more like an off-the-cuff WS—something unplanned, and initiated by a communication and requiring one to use general well-honed T-patterns. Such T-patterns are probably not endemic to one particular WS (as opposed to Cluster 1 T-patterns, for example). It should be noted that the exemplar WSs given in this section were all specifically pointed out as “routine” tasks by the informants in their pre-interviews, except for Cluster 4’s WS.

The media patterns the T-pattern analysis has extracted are reflective of the skillful selection from a repertoire of possible media patterns. As we discussed in our review of ethnomethodological approaches (Section 2.3.1), the patterns show how people strategically choose what they think is the best media pattern for the moment. Perhaps in WSs from Clusters 1 and 2 the choice is often clear and correct. In Cluster 3, work often reflects more of the improvisatory choreography described by Whalen et al. (2002) is often clear and correct. In WSs from Cluster 4, the choice may less clear, but then the informant moves on to try the next media pattern to solve his/her problem. In sum, we found T-pattern analyses to be a useful tool in extracting what sorts of temporal patterns of action happen with our informants in the course of doing their projects.

6.6 Limitations with T-patterns

To some extent the patterns generated by the T-pattern detection algorithm is dependent on the parameters set, in particular the minimum significance value; we believe the settings are appropriate since 0.05 is a commonly accepted threshold.
6.7 Discussion & Conclusion

In his exposition of computer-mediated communication, Whittaker (2003a) notes a need to expand on task taxonomies:

> We have repeatedly observed that the effects of various technologies and their underlying affordances on communication depends on the task. The major differences occur between social and cognitive tasks...however, we need to move beyond this simple distinction, and provide a richer task taxonomy.

Ancona et al. (2001) advocated using time as a new research lens, instead of focusing on the three traditional lens in organizational science (culture, politics, and strategic design): “the temporal lens puts time and timing front and center.” A temporal lens allows us to examine the pace, cycles, rhythms, flow, temporal orientation, and symbolic meanings of time. The authors note that there is a general dearth of literature focusing on an organization’s temporal characteristics. They note that 1) fieldwork often does not allow capture of timed events over a prolonged period of time, 2) experimental work is biased towards short-term tasks, and 3) temporal work is simply difficult to do. The later point has to do in part with the proficiencies of the researchers themselves: “although we are skilled at detecting linear patterns and even quadratic forms, we are not yet able to readily detect spirals that increase and decrease over time...we are not experienced enough to know how to choose temporal variables.”

This chapter seeks to move towards redressing these limitations. By focusing on the temporal aspects of routines in a working sphere, we hoped to determine facets of routineness which go beyond simple discrete characterizations of routines that have dominated the literature. To achieve this, we advocated the usage of a statistical technique for analyzing time, T-pattern detection. Routineness is not just about the mere repetition of a sequential
pattern of elements, but the temporal distance between such elements that can be crucial.

To validate our approach, we took a two-pronged mixed-methods approach combining deep ethnographic investigation with quantitative, statistical analyses. Firstly, we examined the psychological effects of T-patterns in WSs. If the temporal patterns we are detecting indeed are indicative of a true social construct called “routineness,” we speculated that there should be affects on mental states of workers who exhibit different degrees of routineness. WSs proved a useful framework to analyze routineness in terms of tasks/projects. Secondly, assisted by clustering techniques, we delved into our qualitative data to identify the different temporal facets routine WSs exhibit.

Our results revealed significant relationships between our facets of routineness and work/psychological profiles of employees. Little work has been done on how routines affect people mentally, and our work has shown that routines are a nuanced temporal construct containing different ramifications. For example, an increased number of T-patterns genres is associated with decreased workload, yet such an increase may be detrimental to productivity.

Our qualitative unpacking identified archetypes of routines that suggest information systems (e.g., adaptive systems) may need to be tailored depending on what sort of routines one regularly encounters. For example, some routines are routine in the sense that they are composed of repetitious media patterns to accomplish goals, whereas other routines contain media patterns instinctively utilized for exception handling. Thus, one must be careful when claiming to talk about “routines” in the workplace and what facet of a routine one is seeking to assist.

We note that in the current self-improvement environment of today’s workplace, many organizations employ surveys like the Big-5. While the focus of this paper has not been on creating systems that automatically detect routines, we note that the deployment of psychometric measures may prove useful (also see work by Goren-Bar et al. (2006)) in
estimating the suitability of people’s routines (or a class of job positions) for particular types of adaptive systems.

Additionally, a priori analyses of tasks based on less tedious data collection methods such as logging data may allow us to determine what a person’s “routineness profile” is, advancing intelligent system design. The utility of a routineness scale lies in its adaptability to multiple domains. That is, according to the domain, we envision people using different cutoff points to delineate between non-routineness and routineness (if such a dichotomy is desired). With this, task-management systems can offer support via semi-automation of actions, facilitating task recovery, or simply representing the patterns of one’s work day for reflection and future planning.

Time plays a fundamental role in describing and measuring routineness. Routineness is not just about the mere production of a pattern, but it is the temporal structure, the distance between the elements of a pattern, that is important to understanding how time shapes our mental states. While previous work has focused on the purely sequential aspects (including our own work in Chapter 5), this chapter introduces a statistical technique that takes time between elements in a pattern into account. Our work contributes to the multitasking literature by noting that while people do rapidly switch between working spheres, these patterns are themselves not as significant as the switching within working spheres. People who do actually have many patterns of switching between working spheres have stress, but the relative productivity and autonomy is more determined by the patterns within the working sphere. We have shown that these temporal patterns of media usage in a working sphere do have repercussions in mental workload state and inherent personality types. The relationships we found to mental states can implicitly point to how certain temporal patterns can lead one to better accomplish their working spheres.

In sum, while acknowledging that routines are indeed filled with exceptions, we hope that the introduction of routineness scales derived from T-pattern detection can move us to-
wards systems that can properly gauge when routines really are worth calling “routine” and amenable to facilitation. The routineness metrics which we have derived provide a means of parsing out the link between various phenomena and the temporal structures in one’s work.

In the next chapter, rather than focusing on the fragmented projects that we routinely work on everyday, we will now take a step back and examine the commonalities of media patterns across the day in its entirety. In other words, what sorts of days do people have in terms of temporally structuring media patterns?
Chapter 7

Working Across The Day: The Importance of Lunch

7.1 Introduction

To succeed in today’s workforce, a certain deftness in managing and controlling one’s communication across a wide range of mediums and contexts is required. The so-called “information worker” has become a catch-all phrase for such people. The heavy penetration of information technologies from telephones to instant messaging for everyday communication in the organization has heavily influenced the creation of the modern, high-paced office (Yates, 1993).

With this influx of new responsibilities, it might be said that multitasking has become a defining strategy of work. Recent literature has examined the cost of multitasking (e.g., Mark et al. (2008)) but relatively little work has examined exactly what the temporal patterns of multitasking are. Because work is structured in days, it might be fruitful to see what are the temporal structures that reflect different kinds of multitasking behavior. Orlikowski
and Yates (2003) note that people enact these structures in the course of their everyday practices:

Temporal structures simultaneously constrain and enable. For example, by following office schedules or academic calendars we restrict our activity to certain times or days, and by viewing our careers in terms of particular milestones we reinforce a certain evaluation of our activities that precludes other interpretations.

To this end, this chapter focuses on what sort of days people have with respect to multitasking among their communication mediums and solitary work. We contrast this with previous work that has used rhythms as a unit of analysis for media usage in the workplace. We also ask to what degree does a person’s preference for the multitasking strategy reflect on his/her temporal structures. Our results reveal how the midday, or lunchtime, is often suggestive of a person’s multitasking habits.

### 7.2 Data Collection

The dataset in this chapter combines all data from Loquor and Audite (30 employees). However, we required that each day be a “full” day (at least 6 hours long). Thus, three informants were excluded because their workday ended earlier than expected due to unforeseen circumstances (e.g., family-related errands).

For this chapter, the pertinent activities we recorded were face-to-face (ad-hoc, unplanned conversations), meetings (planned), email, instant messaging (IM), and phone. For instance, the start and end times of an email being composed to someone were recorded and considered a communicative act. Other work-related activities were classified as solitary.
work (e.g., PowerPoint usage). Events like movement, bathroom breaks, and lunch are not included. All recruited informants deal with information-based services and extensively use IT. As stated before, each informant was shadowed for three whole workdays; informants were asked to choose days that were “typical”–e.g., avoiding days with unusual events like company-wide gatherings.

We will utilize both the JCQ and polychronicity scores measures in our analyses here. A high JCQ and polychronicity score indicates more stress and preference/belief in multitasking. In our dataset, the mean polychronicity score was 4.35 (MED=4.50, SD = 1.00) and the theoretical max was 7; the mean JCQ score was 0.78 (MED=0.74, SD = 0.25) and the theoretical max was 1.

7.3 Methodology

Our goal was to approach the problem of discerning the patterns of workdays across informants’ days. For this, we take a two-step exploratory approach: we use hierarchical clustering to aid us in discerning temporal patterns and then refer back to our qualitative data sources, aided by visualizations of the temporal data, to examine the resultant dendrograms.

To prepare data for analyses, we create a feature vector for each informant’s workday. First, we split each person’s day into 20 equal slots (e.g., 1st 5% of the day, 2nd 5% of the day, etc.) Moreover, each time slot itself consists of three data points: 1) the percentage of time spent in that hour doing face-to-face (F2F)/phone conversations, 2) computer-mediated communication (instant messaging and email), and 3) solitary work. Meetings were excluded because they are generally not under the control of informants. F2F and phone were combined due to the primacy of speech (Whittaker, 2003b) in these mediums.
This essentially creates a multivariate (F2F/phone, CMC, solitary work) time series of a workday with an hour-by-hour scale. Finally, we ran divisive hierarchical clustering on the multivariate time series data. Unlike standard agglomerative hierarchical clustering, divisive clustering starts with one large cluster and continues to divide each cluster recursively (Kaufman and Rousseeuw, 1990). To reiterate, the hierarchical clustering uses the euclidean metric to calculate the distance between any two time series. We utilized R to conduct all statistical analyses: divisive clustering was done via the diana method in the cluster (see chapter 6 of Kaufman and Rousseeuw (1990) for full details of diana).

7.4 Temporal Media Patterns of the Workday

The resultant dendrogram from hierarchical clustering is illustrated in Figure 7.1. Each node is one person’s day (i.e., the time series data described in the previous section); e.g., "MG0" represents day 0 (the first day) observations of the informant Max. Note that informants from Loquor have no day 0 (half days were not included) and instead always start from day 1. The bottom barplots represent the labeled clusters we will be examin-
ing for temporal patterns of multitasking. Note that the left-hand cluster is comprised of three deep clusters, while the right-hand cluster is composed of two deep clusters. With the top-level clusters, we wanted to see whether the left-hand and right-hand clusters perhaps represented overall days from people who have different preferences for multitasking, i.e., polychronicity.

Our hypotheses was that the clusters would reveal a relationship between how informants differed in their preference/belief in the multitasking strategy (as defined by polychronicity) and the multitasking (as defined by the media percentages in each time slot over the day) among media and solitary work. To perform this analysis we assigned each day to the particular informants’ polychronicity score. For example, if a particular cluster had two of Max’s days, it would be weighted by two of Max’s polychronicity scores. Based on this cluster assignment, we found significant differences in both polychronicity and job strain. Informants assigned to the right-hand cluster ($N = 27, M = 3.84, SD = 1.14$) reported a significantly lower polychronicity than those in the left-hand cluster ($N = 53, M = 4.56, SD = 0.66$), $t(78) = 3.58, p < 0.001$. On the other hand, informants assigned to the right-hand cluster ($M = 0.85, SD = 0.33$) reported a significantly higher JCQ (job strain) index than those in the left-hand cluster ($M = 0.73, SD = 0.20$), $t(78) = −2.00, p < 0.05$. This results seems at odds with previous work that found increased multitasking lead to greater stress (Mark et al., 2008). Thus, the right-hand cluster has days by informants who reported a lower preference for multitasking, yet described their job as having a greater level of stress. On the other hand, it may be the case that such days were deemed as stressful, burdensome because informants were forced to have greater multitasking despite their preference for less multitasking. Let us turn to examining visualizations of the multitasking activity for the left and right hand clusters. What kinds of multitasking of media are occurring?
7.5 Visualizations of Clusters

Figure 7.2: Visualization of media usage and solitary work for the left-hand cluster. The x-axis is the 1st 5% of the day, the 2nd 5%, etc. This cluster has higher polychronicity.

Figure 7.3: Visualization of media usage and solitary work for the right-hand cluster. This cluster has higher job strain.

Figure 7.2 shows the averaged F2F/Phone, CMC (computer-mediated communication), Solitary work for the days in the left-hand cluster of the dendrogram. For simplicity’s sake, we will refer to timeslots of the day as TS0, TS5, TS10, etc. for the first 5%, second 5%, third 5%, etc. of the day. The visualization of the clusters represents the percent of time spent in each timeslot conducting work through F2F/Phone, CMC and Solitary work. Each day in the cluster is averaged and then visualized. For example, the amount of time each informant spent in the days of cluster 4 doing mediated communication in TS1 is averaged acrossed and the result is shown in Figure 7.3.
7.6 Left-hand & Right-hand Clusters: Lunch and Solitary Work

If we are to compare the left and right-hand clusters (Figure 7.3), the most striking contrast is the shape of solitary work.

For the left-hand cluster, solitary work begins at about 55%, dips nearly twice as much to 20% at lunchtime (TS45), and then rises back to around 55% by the end of the day for the informants’ times in these days. On the other hand, the right-hand cluster shows solitary work beginning at 50% and rising to above 70% by TS40. There is a large drop to 35% at TS60–TS65 (in the afternoon after lunchtime), followed by an immediate ramping up to nearly 60% by TS75. The dip in the right-hand cluster might be viewed as more gradual for the right-hand cluster, as opposed to the left-hand cluster’s dip at lunchtime.

With regards to communication, we see that the left-hand cluster has a relatively stable amount of F2F/Phone and Mediated communication. F2F does slightly spike up during lunchtime (TS40–TS45). On the other hand, the right-hand cluster has a marked dip in the middle of the day TS40 from 20% to below 5% at TS40. F2F/Phone remains on high levels–about 20% and then to 25% at TS65. Let us now examine the deeper-level clusters in the left-hand cluster.

7.7 Left-hand Cluster: Higher Polychronicity

Roughly, we can see that there are three deep level clusters in the left-hand, top-level cluster. Figure 7.4 shows the visualizations of each of these three deep level clusters. Each of the deep-level clusters show a marked drop at lunchtime as well. For example, both Cluster 1 and Cluster 2 show a drop at TS45. The amount of solitary work is rather high before the
Figure 7.4: Visualization of media usage and solitary work for clusters 1, 2, and 3. The x-axis is the 1st 5% of the day, the 2nd 5%, etc.

drop, but rises by three timeslots to even higher levels, above 70%. Cluster 1 and Cluster 2 differ in that Cluster 1 has a correspondingly large rise in face-to-face/phone interaction at around lunchtime. Whereas in Cluster 2, the amount of F2F/Phone largely hovers below 25% and in fact dips at lunchtime.

Finally, Cluster 3 shows a large dip at lunchtime from TS45 to TS75. F2F/Phone also shows a rise at about TS70.
7.8  Right-hand Cluster: Lower Polychronicity

The right-hand cluster can also be divided into two deep level clusters. The visualization of cluster 3 and 4 (Figure 7.5) shows an interaction between solitary work and face-to-face/mediated work. In some ways they are a mirror image of each other.

For example, for Cluster 4, the later half of the day from TS55–TS70, there is a dip in Solitary work to 25%, but a corresponding rise in F2F/Phone approximately 35%. Similarly, for Cluster 5, the early half of the day from TS15-TS30 has a drop in Solitary work to 35%, with a noticeable rise in F2F/Phone to 30%.
7.9 Examining Media Usage in each Cluster

We next compared the amount of solitary, mediated and F2F/Phone work done in the left-hand and right-hand clusters. We found that the right-hand cluster had significantly longer solitary work events. On average, solitary work events lasted 2 min. 4 sec. compared with 1 min. 45 sec. \((t(55.41) = -1.74, p < 0.10)\). We also found that the right-hand cluster had significantly longer mediated communication events. On average, mediated events lasted 1 min. 2 sec. compared with 51 sec. \((t(48.28) = -1.837, p < 0.10)\). We found no evidence of significant differences between F2F/Phone work done between the left and right-hand clusters. Finally, we found no evidence of differences in the total amount (as opposed to each event of the day) of solitary, mediated, and F2F/Phone work in the left-hand cluster days versus the right-hand cluster days.

7.10 Discussion

As mentioned before, the right-hand cluster primarily consists of days by people who reported lower polychronicity. How is this reflected in media activity of people’s days?

Here, we believe it useful to consider the significance of \textit{lunchtime} in multitasking. The midday, obviously, is when people often go to lunch. Many workers consider solitary work as a true measure of “accomplished” work (though acknowledging that building social capital is integral to career). People who embrace multitasking seem to be exhibiting a steady rate of media usage in their day. For example, they maintain a relatively steady rhythm of solitary work throughout the day. Although the midday is disruptive to the steady maintenance of solitary work, the bumps indicate a quick recovery or even preparation in anticipation of that midday disruption. To illustrate, contrast Cluster 1 & with Cluster 4. The day starts nearly 70% solitary work, but immediately declines to about 20% by
lunchtime, and then ramps back up to 70% by the end of the day. There is no such dramatic shift in Cluster 4.

The duration of the dip is also less on the right-hand clusters. In Cluster 4, the biggest dip occurs at TS60, but almost immediately starts climbing back up by TS65. The same occurs for Cluster 5 at TS65. In contrast, the left-hand clusters, especially Cluster 3, show a prolonged dip in Solitary work overall about lunchtime.

Looking back at our qualitative data, one simple reason lunch is not so jarring for the right-hand cluster is that many of the informants whose days primarily lie in this cluster either did not eat the traditional lunch or had very structured lunches. By traditional, we mean going out to eat with coworkers at the cafeteria or outside. For example, BR (whose days all lie in the right-hand cluster) always packed his lunch and did work while eating, thus maintaining his proportion of media usage.

Upon closer examination Cluster 2 has days where informants had unusually long lunches. This may explain the dip in F2F/Phone during the midday as opposed to Cluster 1, in which F2F/Phone goes high during the midday’s occurrence. To illustrate, in Cluster 2, AA went to a lunch function with several departments, complete with mojitos. CL went on a weekly exercise routine around the company’s vicinity during lunchtime. Nonetheless, even with such a large disruption to solitary work, both informants quickly resumed work.

The results here are somewhat surprising to us in that we expected that polychronicity would be associated with the sort of frenetic work that seems to characterize much of the hype around “information overload.” Instead, our data seemed to point towards the use of a multitasking strategy to balance solitary work with the expected dip during lunchtime.

As discussed, those who reported having more of a preference towards multitasking seemed to have days that are affected more greatly by lunchtime. To illustrate, Figure 7.6 shows day JC3 (Cluster 1), whose lunchtime began at 11:06AM— note the immediate rise of commu-
communication after the midday. As part of IT, after lunch JC had phone calls and emails arrive asking him to diagnose problems with an in-house application. In this case, the absence during lunch led to the subsequent spike in activity. These days were also characterized by a much higher percentage of solitary work.

In Cluster 2, we noticed many of the days had a good deal of F2F/Phone and CMC interactions which often lead to impending solitary work to be completed at the end of the day. The period after lunch was often the catalyst to start completing the work. DS worked in the legal department and the beginning of the day was often dominated by communication until after lunch in which he could get “real work” done. So, here we see not a sustained mixture of media types, but rather a sequential approach to work. Importantly, informants whose days lie here can structure their days to reactively act on events like lunch.

### 7.11 Conclusion

The famous “Banana Time” (Roy, 1959) article highlighted why seemingly non-work related activities have vital consequences for worker behavior. This chapter examines the temporal patterns that exist in media usage in modern organizations. We believe our work
is one of the first to longitudinally capture to-the-second empirical data of multiple media usage over a wide range of information workers. In particular, we have highlighted how one can view the day as one punctuated about lunchtime. Thus, we can view lunchtime as the ultimate interruption that needs to be handled and is an interruption shared by all workers, no matter what the position. We have showed empirical evidence based on the in situ shadowing of 27 informants that those who espouse multitasking have days that maintain a certain mixture of media switching throughout the day, despite a dip during lunchtime. Importantly, they view lunch as an integral part of the workday, and plan accordingly. At the same time, our results also indicated that those people reported their jobs as less stressful than their colleagues. It is perhaps the nature of their job that demands them to constantly multitask and balance their media usage throughout the day. Managers, for example, must be proactive in constantly communicating back-and-forth with colleagues, whereas engineers may be able to act more reactively or routinely in the day. This suggests that future approaches to designing systems for multitasking should consider a more bird’s eye view of the workday with respect to whether one brown bags it to work or not.
Chapter 8

Understanding Media Appropriation in Terms of Temporal Structures

8.1 Introduction

In this dissertation, we examined temporal structuring of media from four perspectives. We examined communication by analyzing 1) groups of people, 2) rapid fire interaction, 3) routinized patterns of media use, and 4) catalogs of workday patterns. In this chapter, we first summarize each of these phenomena and their theoretical contributions to the literature on media appropriation. Future work expanding on our contributions is also discussed. We then conclude by tying in how these phenomena all shed light on how we shape and are shaped by the temporal structures of media in information work.
8.2 Multitasking Among People

The working sphere construct sets itself apart from the usual nomenclature of “projects” by explicitly noting that people, or agency, is part of projects as well. Obviously, many different kinds of people are associated with projects. The workplace connectors we found indicated that indeed organizational boundaries provide, helpfully, much of the communicative opportunities that is found in information work.

However, we found that like solitary work, communication with people was fragmented. Especially with interactions in the groups “closest” to one’s self (e.g., work home), interactions are far more fleeting. The exemplar case is when informants act with office professionals. Usually if they have been hired for a period of time, the interaction between office professionals and their managers has become well-honed. We also found that the variety of media available to the informant allowed them to capably manage workplace connectors. It should be noted that the amount of time spent in certain connectors is not indicative of the importance of a particular workplace connector.

8.2.1 Theoretical Contributions

The workplace connector construct suggests that people use a variety of people just as people use a variety of media to get work done. Indeed, we noticed pairings of communication media with certain connectors. Certainly, with the private connector, computer-mediated communication was used a great deal. In some cases people since left an IM status message box open, showing their family and friends. Indeed, this supports the notion that people still need one foot in the door with their private communities, and that maintaining an “arsenal” of people to call upon is important to work in general.

Future work may expand on how important communication with certain connectors are.
Our qualitative analysis found that informants reported certain interactions as very important, even though they happened infrequently. For example, one informant at Audite would take a walking break, going to the basement of the company, and then converse with the staff in the mail room as well as the company’s receptionist. Indeed, one might question the utility of such an interaction. However, “touching” upon such interactions are important. Nardi et al. (2002a) noted the importance of managing “intensional” networks of people to call upon when work needs to be accomplished.

Thus, it may prove useful to derive an instrument to measure when vital communications occur. No doubt, much of interaction is fragmented across all connectors, yet not all interactions are equal. Fleeting interactions that are indicative of a well-oiled machine of conversation between people who regularly get work done together may not be as important as one-off interactions that occur rarely.

8.3 Chains: Rapid Fire Communication

We uncovered the properties of rapid fire communications, or communication chains. Here, we used the workplace connectors and analyze how certain characteristics of rapid fire communications can lead to greater stress. Notably, our chapter on connectors stated that interaction is fragmented. Yet, a certain type of fragmentation was found to be stressful. Specifically, switching among many different workplace connectors was found to be more significantly related to job strain. On the other hand, using a variety of different media types in communication chains were found to relate to less reported job strain.
8.3.1 Theoretical Contributions

Theoretically, the contributions of communication chains is to focus on the interdependent nature of temporal patterns. The rapid fire nature of communications happening one after another was found to be significantly related to how people perceive their job strain. It also highlights the usefulness of using workplace connectors to discern what kinds of people one multitasks with when conducting communication chains. This is the first work to establish how different temporal properties of chains are to some sense predictive of how the “rest” of the chain’s links will play out. This supports the notion that certain communications can “trigger” a domino effect of other communication types.

Future work may wish to expand on the “goodness” of chains. Job strain is not necessarily indicative of “bad” communications, nor does it answer the question of whether a particular communication chain was ineffective. Could one have used a “shorter” chain to achieve the same end result of a chain? Thus, work should be done on how to rate certain chains as effective or not. One possibility is to examine the so-called end result of a chain. Some chains may be indicative of handling a request (an interruption on the first link)—is that request handled by the end of the chain? Or is that chain further interrupted and later continued? Also, the relation between communication chains and solitary work was largely discarded. In this sense communication chains and solitary work belonging to the same working sphere may be a useful phenomena to look at. What working spheres consist of many chains? Are chains are better way of working?

8.4 Routinized Patterns of Media Usage

In this chapter, we combine the temporal perspective on routines with the working sphere construct. Here, utilizing a statistical technique called T-pattern analysis, we argue that
routineness can be looked upon less on a discrete scale, and more on a continuous scale. The routineness measures of the working spheres reveal relationships between personality types as well as the day’s workload.

8.4.1 Theoretical Contributions

This research contributes to the notion that people have an arsenal of regularized, media patterns they routinely utilize to get work done. Such an arsenal is employed to accomplish the goals of the working sphere. We found that reuse of T-pattern instances was significantly related to a decrease in the amount of workload perceived. Moreover, a reduction in the amount of T-pattern classes was related to decreased productivity. If people have media patterns that actually fluctuate a great deal in time spent to execute such patterns, then that was significantly related to greater workload. We showed that variability in temporal distance and personalities preferring social interaction were associated with T-patterns consisting of a communicative component.

Thus, one way to characterize the “deft” usage of media is to see how many media pattern classes are routinely reused. On one hand, having too many “weapons” in your arsenal can be counter productive, leading to too many choices and decreasing the regularity of media usage. On the other hand, the repeated reuse of certain weapons in your arsenal is good—leading to greater productivity.

Lastly, there are different sorts of routine media patterns employed in working spheres. For example, some media patterns are enacted to shift to one key phase of a working sphere to another. Such “phases” indicate lower level constructs in the working sphere notion. These working spheres are composed of many non-routine patterns but are peppered with routine patterns that shift phases. On the other hand, other working spheres seem to only reside on a top-level abstraction: having its content consisting only of mostly repetitive patterns.
The later is perhaps what many of us think of when imagining the canonical routine task.

Our work calls into question previous research that has taken as a given that certain tasks are simply “routine.” While a discrete categorization of tasks as routine or non-routine may be useful for systems, we believe that routineness itself is a subtle concept that is best thought of on a continuous scale. Thus this viewpoint on routines straddles both the ethnomethodological viewpoint and the cognitive science viewpoint. Both views are valid in that many people can seemingly identify certain tasks as “routine” such that the label routine is itself useful. However, ethnomethodologists have noted that, according to the “level” of magnification one does, routine tasks are anything but routine. Our work argues that the subtle exception handling of tasks itself may draw from a repertoire of media patterns and that these different media patterns are indicative of different kinds of routineness that have implications for a person’s psychological state (e.g., workload or personality types).

Finally, our method of analysis adds to work by Pentland and Rueter (1994) by creating an automated method of deriving the “grammars” of action that compose organizational routines. Our focus was on the media activities that information workers utilize to accomplish a wide range of working spheres. Unlike Pentland and Rueter we do not focus on a particular task (in their case a very routinized task, operators working in software support lines). In this sense their approach has some advantages in that they have many instances of the same working sphere. This allows the creation of decision trees which can further analyze a working sphere structure. We, on the other hand, have many working spheres but not as many instances. Nonetheless, the T-pattern analyses and the various routineness metrics can be calculated for any working sphere. Additionally, T-pattern analyses accomplishes through probabilistic methods what Pentland and Rueter had to do by hand, the automated detection of regular patterns among a sea of non-regular (“ungrammatical”) activities.
8.5 Workday Patterns: Looking at Lunchtime

Our final analyses combined both datasets from Loquor and Audite and attempted to discern what temporal patterns of solitary work, F2F/Phone, computer-mediated communication arise. Much past research on rhythms has posited that overall people often work in patterns, and that it may be useful to become aware of other’s patterns. This final analysis revealed that one pattern that has effects on the day is simply the effect of lunchtime. Conversely, it may also be true that one’s proclivity towards multitasking may influence the resultant media patterns in the day of how one handles lunch.

8.5.1 Theoretical Contributions

We found two distinct patterns of workdays, one in which lunchtime made a considerable dent in solitary work in the workday, and another in which there was no discernible dip in solitary work. For the latter, the dip was “shifted” either to the beginning half of the day or the later half of the day; consequently that shifted dip was shallower and did not last as long. Those whose days resided in that cluster reported lower polychronicity, or less of a preference and belief in multitasking as an optimal strategy for work. In addition, the informants whose days were in that same cluster (no dip at lunchtime) reported higher stress in the day. This right-hand cluster also reported a longer time for each solitary event and mediated communication event. Hence, those with lower polychronicity had no obvious break in work during lunchtime.

Thus, multitasking veers toward a trend of days with more rapid multitasking of individual media events, and less reported stress. On the other hand, those who have less preference for multitasking maintained a more sustained level of solitary work throughout the day and reported a more stressful day.
One might posit that those who multitask are able to better balance their days. For example, we found no difference in the total amount of solitary work accomplished between the left-hand and right-hand cluster. So neither group showed evidence of “accomplishing” more, yet days with informants who reported lower polychronicity have no marked dips during lunchtime. It may indeed be a vital signal that if a person takes noticeable lunches that reduce solitary work in the midday, the person is better able to multitask (e.g., related to their reported higher preference to multitasking) and accomplish his or her work. Alternatively, being forced to multitask may also force the person to take lunch (perhaps to take a break). Also, if we view lunch as an interruption, people who have high polychronicity might be able to manage/plan their workload so that even a dip in lunch is not a big disruption. Future work should tie in our visualizations and statistical correlations with qualitative data on why certain people on particular days take (or don’t take) lunch breaks.

8.6 Media Appropriation through Temporal Structuring

What is the theoretical drive to study the temporal structures we have discussed in this chapter? Underlying these temporal patterns of action is our belief that people gather and combine multiple forms of media to perform work. Taking a page out of Orlikowski and Yates (2003) [emphasis added]:

183
Individuals typically draw on (and thus shape and are shaped by) multiple temporal structures in their actions...our structuring lens sees this not so much as the existence of multiple times, but as the ongoing constitution of multiple temporal structures in people’s everyday practices. Engagement in such temporal multiplicity has important consequences for peoples’ experiences of time. That is, by enacting multiple and often interdependent temporal structures, actors engage with alternative, interacting, or contradictory expectations about how to temporally structure their activities.

We should note that our own notion of temporal structures goes beyond the normative definition. Orlikowski and Yates typically focus on a more macro-scaled and explicit view of temporal structures. For example, they examine temporal structures on a day (casual Fridays), season (academic deadlines), and month (calendar) scope. We focused on a more micro-scaled and implicit view of temporal structures and the attributes/effects of such structures in the workplace. For example, we are interested in temporal structures formed within intervals of seconds, not seasons; we are interested in temporal structures that do not necessarily have a tangible, explicit representation (e.g., paper calendars, timelines) but rather are subconsciously enacted, created, and maintained. In particular, our structures are based on the in situ data culled from shadowing. Thus they represent patterns of real, lived-in enacted structures that people utilize. For example, an initial phone call from someone (interruption) in a chain may cause the informant to adjust his or her temporal structure resulting in a chain of communication to handle that interruption. As another example, the archetypes of routines (redefined as having routine patterns of media usage that are picked opportunistically from an arsenal of patterns—T-pattern classes—to satisfy a working sphere’s goal) we found are characteristic of different contexts such as shifting from one phase of a working sphere to the next. Thus, in this dissertation we squarely focus
on the media patterns that form such structures, and how such media patterns shape us and are influenced by human agency.

One key contribution to analyzing the temporal structures in this dissertation is that a diverse set of media in temporal structures allows better control and management in multitasking:

1. In communication chains, we focused on the communication channels available to us. In particular, we examined the particular temporal structure where communication happens one after another in rapid succession. The particular form of media appropriation unpacked here demonstrated that a varied usage of multiple media types allows information workers to control multitasking among different groups of people (e.g., workplace connectors).

2. While the workplace connector provides a useful methodological tool, our analyses also reveals how media is appropriated to manage different people. The particular affordances of each media allows information workers to communicate with connectors in an (socially) appropriate and effective manner.

In particular, Orlikowski and Yates make the case for a practice-based perspective on temporal structures that focuses on

How the ongoing actions of members of a community shape and are shaped by a variety of temporal structures such as meeting schedules, project deadlines, and academic calendars and deadlines. Such temporal structuring occurs as people routinely schedule and attend departmental meetings, work towards project deadlines, and organize their lectures according to academic calendars. It is through such temporal structuring that time is made meaningful and consequential in organizational life.
Our analyses on the temporal patterns about lunch is sympathetic to this practice-based approach to time. The organizational norm of having lunch—the fact that it is around noon, most people eat around that time, and that lunchtime is not necessarily considered “worktime”—make lunch a temporal structure that inherently shapes how the day will play out. We found evidence that information workers structure their media patterns about the lunch temporal structure in different ways that were related to their polychronicity. Additionally, different archetypes of routines, based on our routineness metrics, reflect different strategies to regularized usage of media patterns.

Lastly, our work is one of the first to provide validation of our temporal structures through psychometric scales. By demonstrating that temporal structures have real effects on mental state, we can posit that these structures are socially constructed phenomena that are continually created, maintained, and destroyed. At the same time, we have shown how these temporal structures shape us; while we cannot say what are “beneficial” or “harmful” temporal structures, we can nonetheless state how different strategies of approaching media appropriation are related to differing personality types, multitasking preferences, job characteristics, etc.

Figure 8.1 lists the temporal structures we have analyzed to understand how media is appropriated by information workers and how they are related to our mental states. Four particular dimensions of our mental state are effected by the ways in which we conduct temporal structuring: stress (workload), control (decision latitude, autonomy), extraversion (agreeableness), and polychronicity.

With stress, we see how various characteristics of communication chains, routines, and workday patterns are associated with varying degrees of job strain. A higher degree of organizational switching via workplace connectors, the variability in the temporal distance of T-patterns, and having no lunch break are all significantly related to a higher perceived/reported stress level at work. On the other hand, a high degree of media switching,
T-pattern instances, and taking a lunch break are all significantly related to a higher account of stress.

The amount of control we have over our jobs—how we can dictate our own workflow processes—is correlated by the attributes of communication chains and the routineness of our working spheres. Experiencing chains with high degrees of media switching and having routines with media patterns that are mostly T-patterns was significantly related with a greater sense of control. On the other hand, having chains with a lot of workplace connector switching and T-patterns with high variable temporal distance gave evidence of a lower sense of control over work.

With regards to personality traits, extraversion (and to some degree agreeableness) was found to be significantly related to higher temporal distances in T-patterns, whereas those on the lower end of extraversion (more introverted) reported using more T-pattern classes and instances. A preference for multitasking was found to be significantly related to people who experience days with a marked dip in solitary work during lunch break, whereas those who stated that they do not believe in multitasking as a strategy for work had continued solitary work levels during lunch.

Each of these constructs gives us a variety of different perspectives into the issue of time. The temporal structuring of media appropriation couples with our perception of job stress, control, and autonomy as well as our personalities with regards to extraversion and poly-chronicity. The way in which we are shaped by the repertoire of media available to us, and the way such media shape us, do so in temporal ways. They also reveal that communication is a prime component of temporal structuring (e.g., communication in T-patterns) that is cognizantly experienced.

Finally, what is remarkable to us is how much can be learned through only the media we use in our daily work lives. Even our workplace connector construct was tied directly to

187
communicative media events. While a finer grained analyses will certainly contribute to a better understanding of media appropriation, the way we use media on a time line tells us a lot about how we go about doing work, and how it effects our own mental perspective on work.
Figure 8.1: Appropriating media through temporal structures.
Chapter 9

Conclusions

9.1 Introduction

This chapter will conclude this dissertation with a discussion of how our study goes beyond theoretical implications by contributing to methodology and future system design with a temporal lens. We begin by noting how the shadowing methodology, coupled with a pragmatic, Grounded Theory approach has allowed us to parse out the temporal phenomena of working and communicating in the modern organization. Our approach has contributed to providing future theoretical tools for others who seek a fine-grained viewpoint into the interactions of information workers. While the purpose of this dissertation has primarily been one that is descriptive—that is, describing the temporal structuring in the world, we will talk about how the theoretical aspects (Chapter 8) of our work can also inform system builders who seek to facilitate information work. Next, I describe the limitations of our study. This is followed by an exploration of possible alternative hypotheses that explain our analyses results (a warning on the causal implications discussed in this dissertation).
Finally, before closing the chapter, we have a section on the ethical implications of actually employing metrics (e.g., such as routineness) in companies to achieve organizational goals.

9.2 Standardizing the Shadowing Methodology

Our ethnographic investigation into temporal patterns of the workplace utilized the shadowing technique. We shadowed a total of 30 informants from two different field sites. These informants were deemed as information workers—workers who mainly consume and produce information. Positions included scientists, librarians, business directors, managers, accountants, and engineers. Each of the 30 informants was observed for at least three whole workdays. Pre-interview and post-interview protocols were conducted to ascertain the informants’ overall work roles and responsibilities. For one field site we also had the added value of video tape recordings and logs of computer activity.

Through the iterative process of shadowing, we have come up with various ontological groups to assist us in coding phenomena. One of our first questions was to expand on González’s (2006) thesis work by delving into particular temporal patterns that characterize work that go beyond simply descriptive statistics such as average communication event time in a day. The questions we asked were to instead view the analog of working spheres—to parse out the communicative aspects of multitasking from the working sphere construct.

In Chapter 4, we asked the question of what sorts of people do people interact with throughout the workday. This workplace connector construct was formed to provide a descriptive tool to analyze informants’ interactions. By using a protocol derived from the community membership literature (e.g., McMillan and Chavis (1986)), we formed a code set to statistically analyze whom people regularly interact with. The seven connectors we found were: work home, company, formal, professional, social, private, and common work role.
connectors. We believe this ontology, if you will, provides a useful framework for future “shadowers” of information technology.

Chapter 4 also outlined how connectors provides a viable alternative to other frameworks such as communities of practice or social networks. While other approaches are certainly useful, connectors offer a preciseness through their relative unambiguity when coding interactions. For example, it is relatively easy to code informants based on their organizational position (home and company connectors), but the connectors also take into account interactions that happen outside corporate boundaries such as private connectors.

We also outlined the exact media labels we utilized when coding each event line (Table 3.1). We believe these media events cover most of the micro-leveled interactions that can occur for information workers. These media codings were used throughout our analyses in Chapter’s 4–7 and have remained remarkably consistent through both field sites.

Certain adaptations in coding did have to occur because Loquor and Audite used a different suite of company-sanctioned productivity software. For example, Audite’s IT staff used a “support ticket” tracking service when customers requested service. At times, this software essentially served as an email program for Audite’s IT staff to communicate with Audite’s employees. So, while the program did not exactly fit the prototype of a typical email program such as Lotus Notes or Microsoft Outlook, we decided to call that particular support ticket tracking service an email client. Other adaptations include the use of specialized database programs used by employees at Loquor for tracking a team’s progress on a project. In such cases, we decided to label such media as SpreadSheet. The reader is advised to consider how different software may in fact fit into the categories we used for labeling media events.

As with Gonázlez’s dissertation, we also used a mixed methods approach, combining both qualitative (ethnography, Grounded Theory, participant observation, interviewing)
with quantitative techniques. This approach allowed us to triangulate results to give us a greater fidelity to our conclusions. For example, our work on communication chains utilized Markov models to predict chain outcome. This was combined with post-interviews that related how certain communications chains can sometimes provide respite from other kinds of communication chains: some informants use email to take a “break” from face-to-face communications. Thus, such a multipronged approach allows us to explore different methodologies to parse temporal data, without solely relying on one methodology to explain our conclusions. Perhaps the best example of using a mixed-methods approach is in Chapter 6 on routineness. Here, with the benefit of screenshots and video tape logs, we were able to use the statistical routineness measures to point us in the right direction of what qualitative data might be worth analyzing in detail. We could then “explain” what the routineness we are attempting to measure really looks like in practice. In our case, the T-pattern analyses program provided a direct link to the media event data. From there, we could directly scrub to the relevant section in the video analysis of people’s work patterns.

9.3 Design Implications

While the primary goal of this thesis is to uncover and discover the micro-scaled temporal structures involving communication and solitary work, we will now briefly reflect on the design implications of our work. A great deal of work has now been conducted on designing personal management systems. Many of these systems seek to augment operating systems by automating project, or working sphere, detected and catagorization. What does this mean for communication?

We must acknowledge that computers are still largely removed from many communication streams in the modern workforce. For example, face-to-face and telephone conversations are often not collected or stored on the computer. Notwithstanding the thorny privacy
issues, we might imagine that computers or sensors deployed in the environment could provide systems or algorithms with a person’s communication patterns. In such a future corporation, hardware and software might explicitly take into account the temporal structuring occurring among the employees.

Our results suggest that while there are many patterns that exist in communication, it is difficult to parse out what patterns can and should be automated. For example, if a system detects a routine pattern of media usage, should it attempt to automate this? This goes back to the problem outlined by Salvador and Anderson (2003) in that many of our actions are so deft, so subtle that any sort of automation, no matter how unobtrusive, would destroy that deftness. Indeed, the patterns we detected seem to confirm that many media actions have been honed to such a degree that automation seems unnecessary.

One possibility is to let people develop their own patterns as they have in the past, but have a system record and store a repository of such effective patterns in a central database. Then, it might be able to suggest an “alternative” pattern that would accomplish the same amount of work that the current pattern is doing. These patterns would help people understand and reflect on their own (and others’) patterns—in essence, becoming their own “shadowers.” Information workers could then take the appropriate action to improve upon themselves and give feedback to the system. This would of course require a system that is able to equate a series of activity events to the same goal (or working sphere). Such a community model of media patterns has been replicated through so-called “how-to” pages and wikis located in companies (Leshed et al., 2008), so it remains to be seen whether automated capture of media patterns would result in a list that is even browsable or understandable to laymen users.

We believe that another promising direction for systems to integrate temporal patterns is in creating a sense of “temporal history.” For example, if one knows that he or she is link number “10” in a communication chain, it may very well be indicative that the task
associated with the chain is an important one. One might imagine a phone augmented with a “link” indicator to emphasize how many communicative events have preceded a particular phone call. Another type of historically informed system might report dynamically the routineness of an event thus far. In other words, the running routineness of a working sphere at the moment. A manager may see a person is working on particular kind of routineness (a working sphere whose content consists of mostly routine media patterns, for example) and then deem it OK to interrupt the person for another, less routine task to handle. Systems could also alert coworkers or managers when an employee is exhibiting media patterns that are predictive of higher stress levels. Thus, an awareness of someone’s temporal history may be useful.

Aside from design implications of a purely software approach, many of our findings have implications for organizational policies. For example, companies that restrict so-called social networking sites such as Facebook may do well to reconsider what kinds of work is being accomplished with Facebook. Our findings indicate that a multiplicity of media is useful for handling multitasking among people and solitary work. Yet, Facebook itself may give undue priority to certain workplace connectors (e.g., private); such issues merit further examination to determine the extent to which information workers should be given the freedom and tools to manage and integrate new/old connectors.

Additionally, organizational policies that seek to formalize and standardize business flows (e.g., formal communities of practice, workflow systems) may be counterproductive. Each person has their own set of media patterns they have grown accustomed to, and policies that restrict or change people’s patterns may be counterproductive. This suggests that rather than having a few top management people decide what is the “best” procedure for accomplishing tasks, it may be worth first surveying the media patterns that exist and have slowly been fine-tuned over repeated use, and from there decide what is the most effective one out there in the “wild.”
9.3.1 The Ostensive and the Performative

Thus far, the structures we have outlined were derived in a partially automated fashion. It is useful to understand what it means to have a computer detect the regular patterns of work. To address this, we turn to Pentland and Feldman’s (2005) work on organizational routines (see Chapter 2). They note that routines can be ostensive and performative. Importantly however, routines are neither exclusively ostensive nor performative. Indeed, these descriptive terms may be best thought of as situated viewpoints.

Cohn et al. (2009) apply the concept to understanding software processes, calling the viewpoints different “modes of looking and reflecting.” At anytime, one can shift from one mode to another. The authors notes the case of signing off a document for software artifacts: “the writing of the signature foregrounds the performance, but the signature becomes a mark on the artifact which allows it to ostensively represent the system being built.”

A note on terminology: these modes coined by Pentland and Feldman are adjectives that describe routines. In this dissertation, we do not make explicit a distinction between routine as noun and routine as adjective. However, the focus on the temporal aspects of routines, and the different archetypes of routines show our emphasis and belief on viewing the routineness (adjective) of tasks. As evinced by our review of literature on routines (Chapter 2), we believe this continuous scale of routineness brings to the forefront an area that has been unduly ignored. It is by looking at routine tasks (nouns) that we can understand how routines are more or less routine.

Additionally, in our work on routineness, the R and Java programs that we developed to “mine” for patterns places the ostensive into the forefront. It codifies what patterns are deemed “noteworthy.” In this case, the program uses statistics to justify that such a pattern should be looked at, while others are not. Thus the privileging of certain patterns is done by an automaton, as opposed to human reflection. If we are to design systems that detect
patterns that others can cull from, to these workers, this database of patterns will be a warehouse for the ostensive.

At what point does the performative become privileged? Certainly, for every “run” of a working sphere (working on a project) on different days, the patterns detected will probably be slightly different. If we are to examine this variation, then the performative will become foregrounded.

Thus, we believe, it is important to consider, that while our data is grounded in the performative, the end results become indicative of the ostensive. Feldman and Pentland (2003) importantly emphasized the performative because it is often ignored; routines are often considered solely static entities. By considering both the ostensive and performative, we can view this continual enactment of media patterns as an ongoing process, a feedback loop.

Future design should consider that any sort of repository of patterns, chains, past behavior will necessarily shape and be shaped by organizational actors. Thus the codification of patterns will result in stability, and the enactment will result in destabilization, ad infinitum. As information workers use data from a system that mines patterns, this will introduce new (or modifications/refinements of old) patterns, and the cycle repeats. Here we can see both the ostensive and performative playing off each other. Informants will reflect upon and potentially change or add new patterns (performative) into their arsenal. These patterns will then be mined (ostensive), continuing the loop. Taking this dynamic philosophy on routines, or patterns of media activity, may prove useful in designing concrete systems that take a temporal lens in an automated, yet situated, fashion.
9.4 Study Limitations

As we mentioned, 30 information workers were shadowed from two field sites. This is a higher number observed than other in-depth workplace studies (Sproull, 1984; Perlow, 1999). As with any ethnographic account, the issue of generalizability is always an issue. However, we believe the informants we shadowed were representative of information/knowledge work that characterizes much of the modern workforce. By taking a wide range of job positions with high-technology and information communication use, our results will hopefully reflect real, in situ human behavior. Informants were chosen from Audite who reported conducting routine work. As such, people whose work is driven by temporal structures like monthly financial closing processes were shadowed. This may bias our results towards certain classes of working spheres, but we believe that all information work is characterized by deft usage of a repertoire of routine patterns, and the results show that informants at Audite do indeed encounter a wide variety of routines outside the stereotypical task that consists of mindless repetition.

In addition, because of our focus on informal interactions, our data excluded meetings. Meetings are an important hub for communication. Spontaneous communication occurs before and after the meeting. Future research might further investigate how meetings may, for example, serve as catalysts for chains. While meetings are part and parcel of everyday work (and a central source for complaints), the focus of this dissertation was primarily on the temporal structuring of media. In this sense, we wanted to focus on human agency and not on events that were beyond an informants control. Of course, meetings are to a certain extent malleable—one can reschedule meetings, set agendas of meetings, or shape the discussion that occurs in a meeting. However, shadowing is particularly difficult during meetings because both informant’s and the observer’s actions are publicly viewable (by the meeting participants). Doing in-depth observations while a meeting is occurring (e.g., observing BlackBerry use of the informant during meetings) is often prohibitively
difficult and can potentially impede the informant from beneficially participating in the meeting itself. All events surrounding a meeting were analyzed (that is, the start and end time of a meeting were recorded, but not the events inside the meetings). However, because the actual actions *during* meetings one can carry out are typically limited (e.g., due to social conventions), we elected not to include them in our analyses.

Another limitation is the lack of consistent day-to-day psychometric measures for all the informants. Initially, we had planned on conducting research by comparing informants (as we did in Chapters 4 and 5). However, as we developed theories and methods from our grounded theory approach, it became apparent that day-to-day metrics of mental state would be useful, and we developed scales to deploy at Audite at the end of each day of observations.

With regards to psychometric measures, past influential work by Mischel (1968) pointed out that despite the prevailing notion that personality is invariant, he found evidence that personality is highly situational, i.e., dependent on the context. For example, one’s personality will differ in a party as opposed to a funeral. However, we believe for the short time interval of our observations (at most two months for each informant) it is reasonable to assume no drastic personality changes. Roberts and DelVecchio (2000) report that test-retest correlation coefficients showed *trait consistency* is .64 at age 30 and .74 between ages 50 and 70 and conclude that “traits are quite consistent over the life course” (pg. 20). Moreover, two traits of our study ensure that context is not widely varying: 1) all shadowing was in the workplace, and 2) we specifically asked informants to choose shadowing days that were “typical” and not “unusual” (e.g., all day seminars, special all-hands meetings).

The lunchtime patterns we visualized are highly dependent on the clustering algorithm used. It is possible that the patterns are not true patterns of work. Instead, it might be better to try several clustering algorithms to verify that the clusterings are in fact real.
Unlike work done on GOMS, grammars of action, and ostensive/performative routines (see Chapter 2), our focus was not on how a particular project or working sphere was completed. Thus while other approaches can explicitly map out the “standard operating procedure” of a task, or even chart out the various ostensive aspects of routines, we took a more general approach in simply understanding how the variety of tasks one encounters in a day is accomplished through temporal structuring of media. Thus the level of granularity as far as tasks were concerned was considerably more higher-level. We did not, for example, map out decision trees or the sequence of events in a task. Both approaches merit investigation and have negatives and positives. For example, our T-pattern approach gives a more general view of routineness in a day among informants, examining how many people do many tasks. However, an approach like narrative networks (Pentland and Feldman, 2007) would examine how a single task like airline reservations is done by many people. The latter approach may be useful for targeting a particular domain of patterned action. Nevertheless, it also requires a longitudinal effort of seeing many instances of a particular working sphere among many people. The shadowing approach we employed was best suited for capturing snapshots of people’s days and the tasks that interleave them.

Finally, the practice-based approach to temporal structures (Orlikowski and Yates, 2003) suggests a reflective phase for informants to understand the processes they themselves enact to get work done (and to subsequently create, delete, or refine the processes). Due to logistics, as outside researchers, the informants did not have a great deal of time to reflect upon our research results. One exception was our study on workplace connectors. Because we wanted to be sure our workplace connectors accurately captured the groups of people informants regularly interact with, we went back with a list of the people the informants communicated with during our shadowing and asked the informants to verify that the workplace connectors assigned to each person was reasonable. We also conducted interviews asking examples of interacting with particular workplace connectors and the perceived benefits/detriments of such connectors. Communication chain results were also
conveyed back to informants to ask them their opinions on why such chains occurred in their workday. However, overall, a limitation of this dissertation is that the amount of back and forth reflection/action between informants and researchers was inadequate to satisfy a true dialogue of reflection; this was simply due to the time frame and lack of sustained resources to conduct such a lengthy study.

9.5 Alternative Hypotheses

The oft-repeated phrase, “correlation does not imply causation,” is a wise one. All reported analyses stemming from statistical tests in this dissertation were significant; we also verified each dataset as falling under the requirements for each test (e.g., multicollinearity). However, there is always the possibility that our interpretations drawing from these correlations are incorrect and that, instead, the resultant correlations are due to some mediating or outside factor. We outline some possible alternative hypotheses for each of our temporal structures.

- **Communication Chains.** We reported that certain attributes of chains lead may be indicative of worker stress. However, an alternative hypotheses is that the individual communication mediums themselves cause stress and that the interdependent nature of mediums is only happening by coincidence.

- **Routineness.** The T-pattern analysis revealed several facets of routineness. It may be the case that routineness itself does not influence mental states, but instead routineness is indicating the degree to which one completes a working spheres (or makes progress towards completing), and that that itself is influencing measures like workload or productivity. It may also be the case that routineness is simply a strategy (like polychronicity) that is preferred by the informants we shadowed (who all are
involved in jobs that are usually considered to have a high degree of routine aspects) and that being routine leads the informants to report higher productivity, autonomy, and less workload.

- **Lunchtime Patterns.** The dip in lunchtime may not be reflective on the actual multitasking behaviors of the informants. It may be that informants who do not prefer multitasking are that way because they often have to work through lunch (which might be considered a form of multitasking). It may also be the case that people who do not prefer multitasking have less predictable days and thus must work during lunch. In effect, the causal direction (whether we shape our solitary work during lunch or whether we have to work during lunch due to uncontrollable circumstances) is unclear. A high degree of polychronicity may cause someone to manage lunchtime in a way that person feels productive, less stressful, as well. Finally an underlying covariate may better explain the association of lunchtime with polychronicity. For example, the organizational culture may contribute to social pressure to eat lunch. It may be that people who prefer polychronicity, or multitask often, are naturally in job positions with other people who often socially go out to lunch.

With all these studies, the extent to which the actual work in the detected temporal structures is in the informants control is unclear. So we can not state with 100% certainty that the hypotheses of people cognizantly appropriating media to accomplish work in temporal structures is true. However, we are confident that human agency is an important component to accomplishing work well.

It is important to note that while our theoretical explanations for the causal chain of mental states may be open to other interpretation, the predictive power remains. As we discussed in Section 9.3, this can be utilized in future systems that take temporal structuring into account.
9.6 Ethical Implications of a Routineness Metric

The exactness of metrics is certainly an attractive method for organizations to ascertain attributes of its individuals and groups. It potentially allows executives to identify “weak” spots and to “fix” them in an efficient matter. However, there are ethical and moral implications for using so-called performance measurements.

van Drongelen and Fisscher (2003) examine four empirical studies from a framework to understand the moral responsibilities of actors when performance metrics are involved. They note that “the effectiveness of performance measurement procedures in terms of, for example, more goal-directed behavior, better personnel motivation, or better decision-making, is not clear: both positive and negative effects have been reported.” In particular, tying a reward system to metrics can be unethical because “they convey social control over employees.” Moreover, “intrinsic motivation (someone’s internal drive to be successful in their tasks) is replaced by extrinsic motivation (motivation evoked by their rewards).”

Importantly, van Drongelen and Fisscher note that morality can be viewed from two perspectives, that of the evaluator and that of the evaluatees. For evaluators, they must design and deploy metrics responsibly. A routineness metric, for example, should it be deployed to ascertain employee stress or job characteristics must be deployed in a calculated manner. This includes clear communication on its motivation and the possible effects of a “low” or “high” routineness, for instance. Another issue is whether the evaluatee can ever realistically change his or her metric. Is it reasonable, given a job’s responsibilities, that someone can change his or her routineness? For example, accountants have repetitive T-patterns that are consistently done over and over to “close the books” for the month. On one hand, it may be the nature of the accountant’s job that certain working spheres are repetitive. However, this repetitiveness may reveal a certain kind of redundancy or inefficiency. In that case, it may be prudent to examine the T-pattern and then suggest a better T-pattern to
accomplish the work (i.e., a new class of T-pattern with potentially less instances). Thus, the evaluator must carefully choose why and whom such routineness metrics should be deployed to. Finally, the very collection of data to analyze routineness brings up issues of moral responsibility on the evaluator. What data can be collected and analyzed? Such data collection can be considered active monitoring, leading to decreased worker morality and an increased sense of constant surveillance (Foucault, 1995).

Evaluatees have their own set of moral issues. For example, people may try to “game” the system. They may perceive their job performance as “better” if they work more or less routinely. Thus, the evaluatees are providing inaccurate input for metric selection. Or, employees may attempt influence others such that their metric may change. Consider (an extreme case) that an employee may purposefully try to sabotage another person’s day drastically (e.g., interrupting them constantly) to distort the metrics that are derived.

In sum, van Drongelen and Fisscher note that performance measurement processes must fulfill three basic requirements (paraphrased):

1. The function of the metric must fit well with the organization’s circumstances at a specific point in time.

2. The format of the measurement procedures should be appropriate.

3. The functioning of the actors involved in the measurement process has to be ethical.

While it is outside the scope of this thesis to fully delve into the moral implications of metrics for such phenomena like routineness, chains, or even workplace connectors, suffice it to say, the design, planning, deployment, evaluation, and subsequent rewards/actions must be carefully considered in terms of the moral and ethical concerns of both the evaluatees and evaluators.
9.7 Concluding Remarks

We now live in a world surrounded by a cornucopia of communicative possibilities. Such an ecology (Foth et al., 2008; Tacchi et al., 2003) of communicative mediums poses challenges to information workers seeking to accomplish their work effectively and adeptly. Thus, workers have quickly become experts in utilizing certain patterns of media that take advantage of its’ affordances and contextual handling. While previous research has often focused on a single medium at a time, or rely on brief snapshots of the day or on artificial experimental settings, we set out to investigate how people deftly draw from their temporal structures of media to accomplish work in a variety of situations. We believe that the temporal dimension of work has been little examined, and, in particular, the temporal dependencies among different media has been ignored as well.

By taking a somewhat ecological approach to media usage (Nardi et al., 2002a), we may come to a better understanding of the relation of an object’s possible affordances (Norman, 1988; Gibson, 1986) in the environment with the task at hand. Of particular interest is how in Gibson’s definition of affordance (Gibson, 1986), we perceive only a subset of the total actions available with a medium. Nardi et al. (2002a) point out that key elements of media ecologies include 1) tasks, 2) relationships, and 3) temporal flow. We concentrate on aspect 3, but interleave it with 1 (solitary work) and 2 (workplace connectors).

Finally, the dataset itself provides a rich source for triangulation. Rather than relying on either purely qualitative or quantitative data, we obtained and combined data from multiple sources: shadowing, interviews, video tape, and computer logs. By taking a mixed-methods approach, we are better equipped to unpack the meaning of temporal patterns of communication the workplace: why people do them; when they do them; how effective are they; and the mental effects that time in organizations has on shaping us, just as we strive everyday to shape time itself in an increasingly media-inundated world.


### Bibliography


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Appendices

A Appendix A: Interview Protocols

A.1 Workplace Connectors Semi-structured Interview Protocols

Pre-interview Protocol

1. What is your work role at A Corporation?

2. How long have you been at A Corporation?

I’m going to ask you questions about communities. Communities have many meanings, but I am most interested in simply what you consider to be communities. For example, communities may include people sitting around you, your department, the people you regularly meet with at the water-cooler and A Corporation sanctioned communities. Community sizes may be as small as one person and as large as hundreds of thousands of people. Community members may also be geographically dispersed.

1. What communities do you interact with? In your opinion, what makes this a community?

2. Which communities do you consider yourself a member of?
3. For those communities that you are a member of, how did you become a member?

4. What is your role in these communities?

5. Can you briefly describe each of these communities?

6. For each community:

   (a) Tell me the time, location, participants and duration of your last interaction with them.

   (b) What did you do to prepare for the interaction?

   (c) Describe in as much detail as possible your last interaction.

   (d) What technologies did you employ to interact with this group?

   (e) What was typical or atypical about this interaction? Why do you feel this way?

   (f) What did you do after the interaction?

   (g) Tell me the time, location, participants and duration of your last official meeting with the community.

   (h) What did you do to prepare for the meeting?

   (i) Describe in as much detail as possible your last interaction.

   (j) What technologies did you employ to interact with the group?

   (k) What was typical or atypical about this interaction? Why do you feel this way?

   (l) Do you find that this community encourages a diversity of opinion and active participation? Why or why not?

   (m) What did you do after the meeting?

   (n) Do you feel like you have an equal status in this community? Why or why not?

7. What is your most important community? Why? What is your next important community? Why? Etc.
8. Does the work you do for these communities overlap? Can you describe to me a time when you had to interact with, do work with or manage several communities at once (or in rapid succession with each other)? How do you feel about this?

9. Aside from the interactions you’ve just described, can you describe your last collaboration?

   (a) Tell me the time, location, participants and duration of your last collaboration.

   (b) What did you do to prepare for the collaboration?

   (c) What technologies did you employ?

   (d) What was typical or atypical about this collaboration? Why do you feel this way?

   (e) What did you do after the collaboration?

**Post-interview Protocol**

1. *Ask for clarification of any events that transpired during the shadowing session.*

2. *Define to the informant the seven groups of people discovered by analyzing their data:* The 7 categories of people with whom we found you interacted with on a regular basis are:

   (a) Work Home Groups

   (b) Company Groups

   (c) Professional Groups

   (d) Social Groups

   (e) Private Groups

   (f) Common Workrole Groups
3. **For each group, give an example from their dataset of an interaction categorized into that group.**

4. Do you feel that these categorizations of people who you work with sufficiently describe your interactions at work? Conversely, do you find some of these categorizations inappropriate?

5. Which of these groups might you consider to be a “community?”

6. **Show the informant the percentage time, total time and average time spent in each workplace group.** How do you feel about this? Is this what you expected? Why or why not? (Do you feel that you should spend more or less time interacting with your X groups?)

7. **Explain the dimensions of each group.** Within your X groups, which of the following statements is most important for you to be true? Within yours X group, which of the following statements is least important for you to be true?

   (a) Shared Goal: I feel that people that are in my X groups share a common goal, interest, need or activity.

   (b) Reputation: I value the perceptions and opinions of other members in my X groups.

   (c) Common Ground: I feel that people that are in my X groups have similar or shared experiences, behaviors and discourses.

   (d) Identity: I value being identified as part of or associated with people in my X groups.

   (e) Support: People in my X groups provide me with support such as help or advice.
(f) Influence: I feel that people in my X groups value my opinion and that my opinion has the ability to influence others.

8. *Show the informant the technologies used in each workplace group.* Show the informant the percentage time/total time, average time and standard deviation of time spent using each technology with each workplace group. For each group, ask: How do you feel about this? Is this what you expected? Why or why not?

9. What technological problems do you encounter when interacting with X groups?

10. What function do X groups provide? For example, some groups can provide social or emotional support, while others may provide expert advice regarding your work.

11. Do you consider yourself at the core or periphery of these groups? Why?

12. Which groups are most effective in sharing knowledge? Which groups are least effective in sharing knowledge? Why do you feel this way?

13. Which of these groups are stressful for you? Why? Can you give me an example of a stressful time with X groups? Please rank the groups according to stress level. Why did you rank them this way?

14. Show the informant the communities described by the informant in the pre-interview.

15. In what group of people do you feel that community Y best belong in? If you feel that it belongs to more than one group, please rank them in order of best fit.

16. In our pre-interview, you ranked the communities in this order of importance. Is this still how you feel? If not, what should the ranking be and why has it changed?

### A.2 Routineness Semi-structured Pre-interview Protocol

1. What is your work role at X?
2. How long have you been at X?

3. The following questions will ask you about projects that you are involved in. Projects usually have a common motive or goal. You probably utilize a wide range of resources—documents, software tools, timelines, and physical objects—to accomplish a project. Projects also inevitably involve a circle of people who contribute to the goals of the project. You may or may not work directly with these people to finish the project. Of course, some projects only involve one person. What projects are you involved in currently?

4. For each project:

   (a) What is your role in the project?

   (b) Who else works on this project?

   (c) Tell me about the last time you worked on this project.

   (d) What technologies did you employ to work on this project?

   (e) Was this a typical or atypical example of working on this project?

   (f) Tell me about the last time you interacted with someone (or some people) from this project.

   (g) What technologies did you employ to interact?

   (h) Was this a typical or atypical example of interaction on this project?

   (i) Tell me about the last time you were frustrated with this project.

   (j) Do you consider the work you do for this project to be routine?

   (k) What resources do you typically utilize or gather for this project?

5. Are there other technologies or tools you use to get your work done not mentioned in your previous answers?
6. We are particularly interested in observing you when you do tasks that involve gathering, collating, and finding documents, information, and people from various sources to produce a final product. These tasks might be done on a routine basis (e.g., every month), but the work itself to produce this final product should not be entirely routine or automated. While these tasks may often span over multiple days, we would be interested in observing you in tasks that are typically started and ended on the same day (i.e., mostly accomplished in one day) and occur on a monthly basis.

7. Can you tell me what tasks you are currently working on that might fall into this category of work?

8. Tell me about the last time you worked on this task.

9. Was this a typical or atypical example of working on this task?

10. What technologies did you employ to work on this task?

11. Tell me about the last time you were frustrated with this task.

12. Under what project might this task fall under?

13. We would like to observe you doing these tasks. What days do you think you might be doing this task?

14. Can you recommend anyone else that might be amenable to participating in this study?

A.3 Post-interview Protocol

1. Was today a productive day? Why or why not?

2. Was today a stressful day? Why or why not?

3. Who else would you recommend to shadow?
B Appendix B: Survey Instruments

Here are a number of characteristics that may or may not apply to you. For example, do you agree that you are someone who likes to spend time with others? Please write a number next to each statement to indicate the extent to which you agree or disagree with that statement. (7-point Likert scale: Strongly disagree, Moderately disagree, Slightly disagree, Neither agree or disagree, Slight agree, Moderately agree, Strongly agree)

B.1 Personality Scales

I see myself as Someone Who...

1. Is talkative

2. Tends to find fault with others

3. Is original, comes up with new ideas

4. Is reserved

5. Is helpful and unselfish with others

6. Is curious about many different things

7. Is full of energy

8. Starts quarrels with others

9. Is ingenious, a deep thinker

10. Generates a lot of enthusiasm

11. Has a forgiving nature
12. Has an active imagination

13. Tends to be quiet

14. Is generally trusting

15. Is inventive

16. Has an assertive personality

17. Can be cold and aloof

18. Values artistic, aesthetic experiences

19. Is sometimes shy, inhibited

20. Is considerate and kind to almost everyone

21. Prefers work that is routine

22. Is outgoing, sociable

23. Is sometimes rude to others

24. Likes to reflect, play with ideas

25. Has few artistic interests

26. Likes to cooperate with others

27. Is sophisticated in art, music or literature

**B.2 Polychronicity Scale**

Please write a number next to each statement to indicate the extent to which you agree or disagree with that statement (7-point Likert scale).
1. I like to juggle several activities at the same time.

2. I would rather complete an entire project every day than complete parts of several projects.

3. I believe people should try to do many things at once.

4. When I work by myself, I usually work on one project at a time.

5. I prefer to do one thing at a time.

6. I believe people do their best work when they have many tasks to complete.

7. I believe it is best to complete one task before beginning another.

8. I believe it is best for people to be given several tasks and assignments to perform.

9. I seldom like to work on more than a single task or assignment at the same time.

10. I would rather complete parts of several projects every day than complete an entire project.

11. My job requires working very fast.

12. My job requires working very hard.

13. I am not asked to do an excessive amount of work.

14. I have enough time to get the job done.

15. I am free from conflicting demands others make.

**B.3 Job Content Questionnaire (JCQ)**

Please write a number next to each statement to indicate the extent to which you agree or disagree with that statement (7-point Likert scale).
1. My job requires that I learn new things.

2. My job involves a lot of repetitive work.

3. My job requires me to be creative.

4. My job allows me to make a lot of decisions on my own.

5. My job requires a high level of skill.

6. On my job, I am given a lot of freedom to decide how I do my work.

7. I get to do a variety of things on my job.

8. I have a lot to say about what happens on my job.

9. I have an opportunity to develop my own special abilities.

10. My job requires working very fast.

11. My job requires working very hard.

12. I am not asked to do an excessive amount of work.

13. I have enough time to get the job done.

14. I am free from conflicting demands others make.

**B.4 Daily Scales**

*These scales were deployed everyday at the Audite fieldsite. They use the NASA-TLX style check box for scoring (an ‘X’ mark on a scale, rather than a Likert scale format).*

Below we would like you to describe your work experience today. For each of the following statements, rate each question, marking an “X” in the box that reflects your answer.
1. Overall, how mentally demanding was your workday today?

2. Overall, how physically demanding was your workday today?

3. Overall, how successful were you in accomplishing your tasks today?

4. Overall, how hard did you have to work to accomplish your level of performance today?

5. Overall, how stressed were you today?

6. Overall, how much autonomy did you have today? That is, to what extent were you able to decide on your own how to go about doing your work today?

7. Overall, how much of your own personal initiative and judgment was carried out in your work today?

8. Overall, how much independence and freedom did you have in doing your work today?

The next set of questions asks you about how you felt about your work today. Rate each question with an “X”, where the extreme right reflects the highest level you think you could possibly achieve and the extreme left reflects the lowest level you have ever experienced at work.

1. How would you describe your EFFICIENCY today?

2. How would you describe the QUALITY of your work today?

3. How would you describe the OVERALL AMOUNT of work you did today?