IT’S ABOUT TIME: THE TEMPORAL IMPACTS OF INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) ON GROUPS

by

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August 4, 2008
(date) _______________________

*We also certify that written approval has been obtained for any proprietary material contained therein.
To my son, Kai Kai, who was born while I was writing the dissertation.
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It’s about Time: the Temporal Impacts of Information and Communication Technology (ICT) on Groups

Abstract

By

ZIXING SHEN

The widespread use of information and communication technology (ICT) at work impinges upon time in organizations. This dissertation examines the temporal impacts of ICT on groups. I first construct a conceptualization of time, which characterizes time to have both structural and interpretive dimensions. Structural dimension describes the objective and external aspects of time, and interpretive dimension characterizes the subjective and internal aspects of time.

Next, guided by such conceptualization, I assess how time has been studied in the IS literature on ICT-mediated groups. My analysis reveals that the knowledge on the temporal impacts of ICT on groups is very fragmented. They are only studied from the structural dimension. The impacts of ICT on structural time are only recognized in how ICT modifies the temporal conditions under which groups operate. The impacts of ICT on interpretive time are largely un-researched.

I then conduct a case study of three groups of IT professionals to advance the empirical understanding of the temporal impacts of ICT on groups. The empirical investigation finds that ICT impacts both structural and interpretive time. ICT shifts the temporal location, frequency, duration, and sequence of tasks and events, and furthers constant prioritizing, flexible scheduling, and concurrent executing of tasks. Temporal values and temporal norms are shaped by changes, occasioned by ICT, in structural time. ICT
directly impinges upon senses of time and blurs temporal boundary between work and non-work. Structural and interpretive time, as shaped by ICT, in turn contribute to procrastination of work on new development, improved efficiency, and better understanding and communication in groups.
CHAPTER 1
INTRODUCTION

Time, ubiquitous and experienced by all, is fundamental to organizational life (Bulter, 1995). It is implicitly or explicitly assumed in many management thoughts and theories about change, decision making and performance, and is widely studied in organization research. The significance of time also has been emphasized recently by an increasing number of studies about time in organizations (e.g., special issues in Academy of Management Journal, 2002; Academy of Management Review, 2001; Work and Occupations, 2001). The vast amount of research on time has generated numerous and divergent notions, concepts, and ideas about time.

Information and communication technology (ICT) is the one of the major players shaping the contemporary organizations. ICT is defined in this research to cover any digital technologies that enable and support the storage, transmission, processing and representation of digital information. ICT has functions and capabilities that have direct links to time (Failla & Bagnara, 1992; Jaureguiberry, 2000; Lee & Sawyer, 2002; Shen et al., 2006). For example, the automation capabilities of ICT enable the same actions to be performed quickly (Mendelson & Pillai, 1999). Decision support and business intelligence applications provide simultaneous display or sharing ideas and concurrent solicitation of input (DeSanctis & Gallupe, 1987). Electronic communication tools such as email facilitate asynchronous exchange of information and message (Ellis et al., 1991). These technological features of ICT impact the characteristics of tasks and activities (Lee & Liebenau, 2000b), the parameters of
behaviors and actions (Green 2002,), the dynamics of interactions and communication (Rennecker & Godwin, 2005) and outcome and performance (McLeod, 1992).

The temporal impacts are also related to the timing of tasks and events that are shifted by ICT. For example, Barley (1988) found that computerized radiology equipment changed the sequence, duration, temporal location and rate of recurrence of daily events of radiologists’ work. These changes made radiologists to subscribe to a new pattern of work arrangements that were temporally more similar to that of supporting technicians. As temporal organizations of radiologists’ and technicians’ work flowed more in parallel, conflicts between the two groups decreased. A similar finding was observed while a time-flex program enabled by ICT was adopted at a major hotel chain. The new program allowed managers to become more flexible in their work times. Such changed patterns of working led to happier employees and shifted the emphasis from hours worked to work accomplished and thus increased productivity (Munck, 2001).

The temporal impacts of ICT have been studied at the organization, process, group, and individual levels. At the organization level, ICT has been observed to speed up work and thereby to “save” organization’s time (Stalk, 1988). At the process level, ICT changes temporal attributes like deadlines, cycles and rhythm (Lee & Liebenau, 2000a). At the group level, ICT makes work monochronic (i.e., doing one thing during a period of time), which reduces the conflicts between groups (Barley, 1988). At the individual level, ICT affects individual’s temporal work patterns (Failla & Bagnara, 1992). Variations in how time is structured within individual’s work or business processes affect, among others, organizational flexibility (Lucas & Olson, 1994).
Recent advances in ICT, spurred up by the Internet, mobile communications, instant messaging and so on offer new technological capabilities, enhance existing functions, and shift further the temporal trajectories of tasks and events. For example, mobile technology enables anytime access of information and service and real-time responses to behaviors at distance. The Internet supports simultaneous access to and exchange of rich information. Instant messaging allows constant and spontaneous communication. These ICT features redefine temporal prerequisites of organizational work (Kakihara & Sorensen, 2002), provide organizations and their members with opportunities to perform tasks and coordinate activities (Failla & Bagnara, 1992; Lee & Sawyer, 2002), and affect the perception, consumption, management and discipline of time in organizations (Green, 2002; Lee & Sawyer, 2002; Jaureguiberry, 2000). Newer technological developments present research opportunities and intensify the need to study more systematically the temporal impacts of ICT.

This dissertation answers for the call for research on temporal impacts of ICT. Specifically, its focus is on the group level. Groups are defined in this research as small collections of people who are organized to achieve common goals (Friedlander, 1987). Time has been widely considered an important element affecting group behavior and cognition and has received intense attention and in-depth investigation in group research. Group research has examined how time affects group process and outcome (e.g., Gersick, 1988; Okhuysen & Waller, 2002), and how social, organizational and environmental factors influence time in group (e.g., Dubinskas, 1988a; Lawrence & Lorsch, 1967). Research on time in group, as represented by the time, interaction and performance (TIP) theory (McGrath, 1991) and the punctuated equilibrium model (Gersick, 1988), has made important theoretical contributions to the understanding of group phenomena.
The use of ICT in groups has been extensively studied under such rubrics as group support systems (GSS), computer-mediated communication, and virtual teams. In these IS research streams, time has been the research topic of some studies (e.g., Dennis et al, 1999; Massey et al, 2003), and the passing interest of others (e.g., Jarvenpaa & Leidner, 1999; Maznevski & Chudoba, 2001; Yoo & Alavi, 2004). Yet, the majority of these studies analyze one ICT tool (e.g., email, GSS). This is an unfortunate simplification of the complexity of the use of ICT in organizations which, in actuality, utilize a large array of ICT tools with varying capabilities and functions. As a result, the richness of temporal impacts of ICT in groups is not well articulated. When multiple ICT tools were studied, the attention was only given to the more conventional ICT tools such as email, computer conferencing systems and GSS. The newer technological developments like mobile technology, instant messaging are largely under-researched.

In addition, the majority of these studies separate groups from the temporal structures to which groups are subscribed. They either assume that groups operated in one temporal condition (e.g., one deadline to complete one task) or do not take into consideration the temporal characteristics of group work at all. Such treatment of time is not able to capture the interactions between ICT and time in groups. Subsequently, the intricacies of temporal impacts of ICT in groups are largely missing.

This dissertation intends to enhance conceptual understanding as well as empirical knowledge on the temporal impacts of ICT on groups. To this end, I conduct three pieces of work. First, I synthesize research on time and construct a conceptual framework of time. I conceptualize that time has both structural and interpretive dimensions. Structural dimension describes the objective and external aspects of time that can be described more or less
reliably by an independent observer (Hassard, 1991; Sahay, 1997). It is manifested in the
temporal characteristics of tasks and events (i.e., temporal context) and the temporal
organizing and behaviors of organizational members (i.e., temporal enactment). Interpretive
dimension, on the other hand, characterizes the subjective and internal aspects of time
(Bluedorn & Denhardt, 1988; Parkes & Thrift, 1978). It is embodied in perceptions and
experiences of, values towards, and norms about structural time. This theoretical foundation
guides literature survey and empirical investigation of temporal impacts of ICT on groups.

Secondly, I assess how time has been studied by surveying ICT-mediated group
research, published in major IS journals in the last two decades. There are several reviews
and meta-analyses of ICT mediated groups (Benbasat & Lim, 1993; Dennis et al., 2001;
Fjermestad & Hiltz, 1998-1999; Hertal et al., 2005; Kraemer & King, 1988; McLeod, 1992;
Powell et al., 2004). These studies draw upon general behavioral frameworks like the
lifecycle model (Hertal et al., 2005), input-process-output model (Benbasat & Lim, 1993;
Powell et al., 2004), and fit-appropriation model (Dennis et al., 2001) to synthesize the use of
ICT in groups. My review complements these studies as I examine the ICT-mediated group
research from a temporal perspective. It delineates how time has been studied, and provides a
basis for research on the temporal impacts of ICT on groups.

My survey reveals that most studies reduce time into a single environmental factor
that moderates group process and outcome or treat time as a proxy of other variables (e.g.,
group effectiveness and performance). While recognizing the effects of ICT on the temporal
context under which groups operate, the literature largely overlooks how ICT impacts
temporal enactment and interpretive time in groups and how time as shaped by ICT
influences group process and outcome. Overall, the review shows that the existing research
has produced very fragmented knowledge about the impingement of ICT upon time, both structural and interpretive.

Last but not least, to take up the research challenge identified in the literature survey, I carry out an empirical study of three groups of IT professionals. I treat time explicitly as a variable of interest, and examine how ICT impinges upon time. I also tap into newer ICT artifacts and capabilities (e.g., mobile phone, instant messaging) that become increasingly popular at workplace. The overarching research question of the empirical study is how ICT shapes structural and interpretive time in groups and how structural and interpretive time, as shaped by ICT, subsequently influence group behavior, cognition and performance?

The results of the study further evidence the impacts of ICT on temporal context of group work as identified in earlier research. They also demonstrate the impingement of ICT on group temporal enactment. In addition, the study shows that ICT affects experience of time, temporal values and norms in groups. Such effects can be direct or mediated by temporal enactment. More interestingly, interactions are found between temporal context and temporal enactment, between structural time and interpretive time. Structural time and interpretive time, as shaped by ICT, are found to influence task execution, communication, efficiency in groups. Furthermore, the study finds that the temporal impacts of ICT are same in certain aspects and vary in other aspects across groups.

This dissertation is significant in several ways. First, it directs academic researchers’ attention from a narrow view of temporal conditions induced by ICT to a broader appreciation of the intricacies in temporal impacts of ICT on groups. This research not only sustains efforts in studying how ICT affects temporal context under which groups operate, but also stimulates interest in examining how groups react to and internalize shifts in
temporal context of their work. Systematic approach to the behavioral and experiential parameters of temporality in group work, as advocated by this dissertation, can help better theorize in the future the relationships between ICT and work groups. This research also is of practical significance, as ICT is increasingly penetrating group work in organizations. Its empirical finding can help understand the complexity in using ICT in group work, formulate guidelines to implement ICT artifacts and capabilities, and design better ICT functionalities and configurations to streamline cooperation and collaboration under varying circumstances. Thirdly, this dissertation is implicated with other research on time in organizations (e.g., Blyton et al., 1989). For example, the new possibilities, created by ICT, to access information and computing services anytime anywhere, relates to studies on working life (e.g., see special issue in Work and Occupations, 2001). The research on the temporal impacts of ICT on groups provides cross-disciplinary research potential with organizational behavior and social psychology.

The rest of the dissertation is organized as follows: Chapter 2 describes the conceptualization of time adopted by the research. Chapter 3 surveys IS literature on ICT-mediated groups from a temporal perspective. Based on the literature review, Chapter 4 raises the research questions and details the research method. Chapter 5 presents and Chapter 6 discusses the empirical findings, respectively. Finally, Chapter 7 concludes this dissertation research.
CHAPTER 2
THEORETICAL BACKGROUNDS

This chapter delineates the theoretical foundation that directs the literature survey and empirical investigation of this dissertation research. I first discuss how time is approached in the management studies. Then, based on a synthesis of literature, I construct a conceptualization of time that guides this research.

2.1 Time in Management Studies

Time has been an ongoing research topic in many fields of social science including sociology (e.g., Durkheim, 1965), anthropology (e.g., Dubinskas, 1988a; Hall, 1983), and psychology (e.g., McGrath, 1991; Schriber & Gutek, 1987). The interest in time in management studies can be traced back to Taylor’s time and motion studies at the turn of the 20th century. Recently, there is a resurgence of research on time as evidenced in several journal special issues on time (e.g., Academy of Management Journal, 2002; Academy of Management Review, 2001; Work and Occupations, 2001), and publications in major business journals (e.g., Dennis et al., 1999; Orlikowski & Yates, 2002; Perlow, 1999; Staudenmayer et al., 2002; Yakura, 2002).

Traditionally, in the management studies, time has been characterized as homogenous and divisible in structure, linear and uniform in its flow, and objective and absolute in its meaning. In this tradition, time is treated as singular, quantifiable element that exists independently of objects and events (Hassard, 1989) and it is viewed as a resource that can be spent, saved, possessed and budgeted. Time serves as an essential background against
which movement of objects and evolutions of phenomena are accounted. Time is also reified into a fixed measure, which holds invariant for every organizational actor (Das, 1990). This clock time underpins the notions of productivity, efficiency, absorptive capacity, agility and the like.

In the past two decades, an increasing number of organizational scholars have argued that the clock view of time oversimplifies how time affects organizational life and action (Bluedorn & Denhardt, 1988; Orlikowski & Yates, 2002; Whipp, 1994). Empirical research reveals that time is not constant for organizational actors. It adopts a plurality of forms that vary within and between groups as indicated in concepts like improvisation, flow and the like. For instance, Ballard and Seibold (2000) found that groups differed in how they valued time as a scarce resource and how they consequently sought to control it. Similarly, Dubinskas (1988b) found that different task demands led to contrasting view of time among scientists and managers. The job of scientists – development of new engineering principles – made scientists to work with an extended and highly unpredictable time horizon. The coordination tasks of managers covered significantly shorter temporal horizons and demanded tight control over one’s and other’s time. This made managers to orient towards the present. To summarize, multiple organizational studies show that time is socially constructed, experienced, interpreted and shared and these constructions vary across social worlds (Adams, 1990; Clark, 1995).

2.2 Conceptualization of Time

Drawing on these two intellectual traditions, I conceptualize time as having both structural and interpretive dimensions. Next, I describe this conceptualization in details.
2.2.1 Structural Dimension

The structural dimension of time, building upon the clock concept, characterizes time in quantitative terms. Time is couched in standardized measures such as uniform seconds, minutes, and hours. Past research illustrates that temporal context and enactment are two distinct aspects of structural time (Ballard & Seibold, 2003). Temporal context embodies contours of external events and tasks, as reflected in many temporal attributes of tasks and events: sequences in which tasks occur, durations of tasks (i.e. how long they last), temporal locations of events or tasks (i.e., when they occur), and frequency of tasks and events (Zerubavel, 1981). Temporal context is also manifested in space zoning of temporally ordered tasks (locales): where the events and tasks take place at certain times. This is reflected in complex trajectories of temporal and spatial organization of daily events and tasks (Giddens, 1984).

Temporal enactment, on the other hand, refers to how individuals draw on time as resources and rules in their agency while organizing their practices. It is about regularized patterns of temporal behaviors. Temporal enactment includes activities like scheduling, synchronizing, allocating (McGrath, 1991). These are further reflected in other temporal attributes like pace, rhythm, entrainment, etc. Past studies show that temporal enactments within any given context are diverse. For example, Ancona and Chong (1996) showed that different organizational units work under different cycles (e.g., fiscal year or quarterly sales cycles), and their daily rhythms were shaped differently by these broader economic, and institutional cycles. Likewise, Gersick’s (1988) punctuated equilibrium model illustrated how a deadline (temporal context) affects a group’s pace of activities (temporal enactment). In
summary, temporal context and temporal enactment compose the structural dimension of
time in organizational life.

2.2.2 Interpretive Dimension

The interpretive dimension of time is about the phenomenology of time. It is
constituted by the perceptions and experiences of the structural time. Interpretive time then is
manifested in temporal attributes like time horizon (short vs. long), temporal orientation
(past, present or future), or urgency. For example, Lawrence and Lorsch’s classic study
(1967) found that the length of time period prior receiving feedback determined whether
groups operated with a short- or a long-time horizon. The sales group had the shortest time
horizon, followed by the production group. Not surprisingly, the basic research group had the
longest time horizon. Thus, groups’ sense of time was derived from, and varied on the basis
of, the duration of their feedback cycles. Likewise, the sense of urgency relates, but is
different, from the structural time (Ballard & Seibold, 2003): when people accelerate work
pace to cope with increased environmental stimuli, they are likely to construe time as urgent.
But it remains a mood that relates to the experience of time - not the features of the pace
itself. Urgency reflects thus an evaluation of experienced time driven by a pace of activities
that is triggered by an approaching deadline.

The interpretive dimension of time is embodied in temporal values that differ between
cultures as observed in analyses of monochronism and polychronism (Hall, 1983). The pair
of monochronism and polychronism conveys attitudes towards the use of time in performing
tasks in different cultures. In some cultures individuals focus on one task at a time
(monochronic behavior). In other cultures, individuals perform multiple activities in parallel
(polychronic behavior) (Leidner & Kayworth, 2006). The difference centers largely on
whether one values time as scarce and linear (Ballard & Seibold, 2000) or as situational and varying. Monochronism values time as a quantifiable, tangible resource, and emphasizes its control. In polychronism, a particular time point (e.g., ten o’clock in the morning) is not the primary regulator of activities. Instead, activities are determined by contextual events which unfold naturally. Therefore, polychronism is marked by a higher level of unpredictability in temporal work arrangements and loose evaluations of how time is organized.

Norms about time are a critical part of interpretive time. Norms concerning the uses and meanings of structural time emerge in organizations. Accordingly, temporal norms (e.g. it is good to conform to a schedule, deadline, and work pace) echo group membership, identify group members’ values and predict patterns of behavior (Doob, 1971). One example of temporal norms is punctuality: when one is expected to come to work, or how precisely “on schedule” the activities are expected to be. Another is separation, which indicates the degree to which extraneous factors are eliminated or allowed to intervene in the completion of a task (Ballard & Seibold, 2000; Hall, 1983). For example, organizational members can close their doors to protect from interruptions, while others adopt “open-door” policies to communicate that they are less restricted by spatio-temporal norms.

Finally, the experience of time is inherently intertwined with and inseparable from the experience of space (Carlstein, 1982; Giddens, 1984). Individuals organize their activities in ways where specific activities are associated with particular time and space zones (locales). Such time-space regionalization (i.e., the zoning of time-space in relation to routinized activities (Giddens, 1984)) has been studied to some extent. For example, Nandhakumar (2002) observed that activities within development teams were spatially and temporally
differentiated into distinct locales such as an office or a foyer. Each locale served as a venue for particular group activities at particular times of the day, or the week.

Summarized in Table 1 is the conceptualization of time developed by this research. The list of temporal attributes is not exhaustive, but seeks to integrate several analyses of time as reflected in the pertinent literature. It is important to note that although structural time and interpretive time are treated here theoretically and conceptually distinct, they are not orthogonal in organizational practices as they intimately interrelated. Instead, these attributes are separated here only for analytical purposes. For example, if temporal locations of a series of events can not be determined, their scheduling become impossible, and the temporal experience is likely to be viewed chaotic in a monochromic culture. Next, I detail how the conceptualization of time as presented in Table 1 guides the survey of IS research on ICT-mediated groups.
Table 1. Conceptualization of Time

<table>
<thead>
<tr>
<th>Temporal Dimension</th>
<th>Temporal Sub-Dimension</th>
<th>Temporal Attribute</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Structural time</td>
<td>Temporal Context - temporal structure and organization of events and tasks</td>
<td>Sequence</td>
<td>The order in which an event or a task takes place (Zerubavel, 1981)</td>
</tr>
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<td></td>
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<td>Duration</td>
<td>The amount of time spent on completing a task or an activity (Lee &amp; Liebenau, 2000a)</td>
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<td></td>
<td></td>
<td>Temporal location</td>
<td>The location of a task or an activity at a particular point over a continuum of time, i.e., when a task or an activity takes place in time (Zerubavel, 1981)</td>
</tr>
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<td></td>
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<td>Speed</td>
<td>How fast an event or an activity is, i.e., the ratio of the size of the task and the duration of the time (Schriber &amp; Gutek, 1987)</td>
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<td>Frequency</td>
<td>How often an event or an activity takes place (Zerubavel, 1981)</td>
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<td></td>
<td></td>
<td>Cycle</td>
<td>The periodic regularity in which an event or an activity repeats itself (Lee &amp; Liebenau, 2000a)</td>
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<td>Deadline</td>
<td>The fixed time by when a task or an activity is to be done (Lee &amp; Liebenau, 2000a)</td>
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<td></td>
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<td>Temporal buffer/slack</td>
<td>Unspecified amount of time built into schedules to allow for the uncertainty in predicting deadlines (Schriber &amp; Gutek, 1987)</td>
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<tr>
<td></td>
<td>Temporal Enactment - the way people do time through regularized patterns of behavior</td>
<td>Scheduling</td>
<td>Determine the temporal location of activities and tasks at particular points over the continuum of time (McGrath, 1991)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Synchronizing</td>
<td>Manage and coordinate the performance of more than one task simultaneously (McGrath, 1991)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Allocating</td>
<td>Devote a certain amount to time to a task or an activity (McGrath, 1991)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pace</td>
<td>The rate at which activities can be accomplished, i.e., measure the speed of activity or the number of activities that can be done within a given interval of time (Schriber &amp; Gutek, 1987)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rhythm</td>
<td>The alternation in the intensity of being busy (Schriber &amp; Gutek, 1987)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Entrainment</td>
<td>Adjust temporal locations of activities and pace to match with those of external events (Ancona &amp; Chong, 1996)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Routinization</td>
<td>Integrate fully activities into sequences (the work flow) over time (Schriber &amp; Gutek, 1987)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Temporal flexibility</td>
<td>The level of rigidity in accommodating changes in the task environment, i.e., the capability to allocate, synchronize and schedule with higher variance (Ballard &amp; Seibold, 2003)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Temporal linearity</td>
<td>Carry out tasks or activities in successive time frames (linear task execution), or engage in a number of different tasks or jobs concurrently (non-linear task execution) (Ballard &amp; Seibold, 2003)</td>
</tr>
</tbody>
</table>
### Table 1. Conceptualizations of Time - continued

<table>
<thead>
<tr>
<th>Temporal Dimension</th>
<th>Temporal Sub-Dimension</th>
<th>Temporal Attribute</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interpreted time</td>
<td>Experience of time - perceptions / phenomenology of structural time</td>
<td>Time horizon</td>
<td>The time frame in which an individual orients towards future and present (e.g., short vs. long term) (Ballard &amp; Seibold, 2003)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Time orientation</td>
<td>Temporal perspective adopted towards past, present or future (Ballard &amp; Seibold, 2003)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Temporal urgency</td>
<td>Attitude adopted towards deadline, pace or rhythm (Ballard &amp; Seibold, 2003)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Temporal scarcity</td>
<td>Construal of time as being limited and exhaustible resource (Ballard &amp; Seibold, 2003)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Temporal autonomy</td>
<td>Perceived control over the use of one’s time (Schriber &amp; Gutek, 1987)</td>
</tr>
<tr>
<td></td>
<td>Temporal boundary</td>
<td></td>
<td>Perceived boundaries created by the differences in the use and meaning of time in different task contexts or locales (Schriber &amp; Gutek, 1987)</td>
</tr>
<tr>
<td></td>
<td>Temporal values - attitudes towards doing time in performing tasks</td>
<td>Monochronism</td>
<td>Attitude towards the use of time in performing tasks by focusing on one task at a time with a sense of a deadline (Leidner &amp; Kayworth, 2006)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Polychronism</td>
<td>Attitude towards the use of time in performing tasks by focusing on several tasks in parallel and often without a sense of a deadline (Leidner &amp; Kayworth, 2006)</td>
</tr>
<tr>
<td></td>
<td>Temporal norms - norms concerning the use and meaning of temporal attributes in temporal context and enactment</td>
<td>Punctuality</td>
<td>The degree of rigidity to which deadlines need to be adhered (Ballard &amp; Seibold, 2003)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Separation</td>
<td>The degree to which extraneous factors can be eliminated or integrated while sequencing, allocating or synchronizing during task completion (Ballard &amp; Seibold, 2003)</td>
</tr>
<tr>
<td></td>
<td>Spatial experience of time - perceptions of ways people organize time through their actions and motions in the space around them</td>
<td>Regionalization</td>
<td>The zoning of time-space in relation to routinized practice (Giddens, 1984)</td>
</tr>
</tbody>
</table>
CHAPTER 3
LITERATURE SURVEY

This chapter describes a survey of IS research on ICT-mediated groups based on the conceptualization of time developed in Chapter 2. The survey is a comprehensive analysis of how time has been studied in existing IS literature on ICT-mediated groups, and complements earlier reviews and meta-analysis of ICT-mediated group research. The survey’s findings not only motivate this thesis research’s field study, but also lay a foundation for more extensive empirical investigations of the temporal impacts of ICT in groups. Therefore, the survey makes conceptual contributions to IS group research literature.

In this chapter, I first describe the sampling and coding procedures. Then I presented the findings of the survey and analyze the findings to identify gaps in research on temporal impacts of ICT on groups.

3.1 Sampling

I sampled in six major IS journals (Computer Supported Cooperative Work (CSCW), European Journal of Information Systems (EJIS), Information Systems Journal (ISJ), Information Systems Research (ISR), Journal of Management Information Systems (JMIS), and Management Information Systems Quarterly (MISQ)) and two leading management journals that publish IS research (Management Science (MS) and Organization Science (OS)). I felt that these eight journals would provide a representative sample of the mainstream IS research on ICT-mediated groups. Bearing in mind that multiple group-focused research streams, such as group decision support system (GDSS) or group support
system (GSS), computer-mediated communication, and virtual teams, have emerged and
developed over the last two decades, I used twelve key words (group, team, group decision
support system, group support system, electronic meeting, virtual, virtual team, computer,
computer mediated communication, computer supported collaboration, information
technology, information and communication technology) to search the Business Source
Premier Database for articles published in the these journals from their inception to October
2005. I queried CSCW, which is not available in the Business Source Premier Database, on
its own website. I examined hard copies of the earlier issues of CSCW, EJIS and ISJ, which
are not electronically available. My initial search revealed 850 potential studies (84 from
CSCW, 95 from EJIS, 114 from ISJ, 55 from ISR, 173 from JMIS, 117 from MISQ, 86 from
MS, and 126 from OS).

Out of 850 papers, 113 (12 from CSCW, 4 from EJIS, 3 from ISJ, 18 from ISR, 40
from JMIS, 22 from MISQ, 6 from MS, and 8 from OS) were selected for analysis based on
the criterion that the article reported an empirical study on ICT-mediated groups where
research design included constructs focusing on group process and/or outcome. Accordingly,
the following categories of papers were excluded from analysis: (1) non-empirical work
including conceptual and theoretical papers (e.g., DeSanctis & Gallupe, 1987); (2) meta-
analyses (e.g., Dennis et al., 2001) as articles in these meta-analyses would be included as
separate articles; (3) empirical research on implementation, acceptance and adoption which
did not study group process and outcome (e.g., Dennis & Reinicke, 2004); (4) design
research about ICT features to support group work (e.g., Bordesky & Mark, 2000); (5)
construct and measurement development (e.g., Salisbury et al., 2002); (6) empirical research
on groups without tasks such as online discussion groups (e.g., Jones et al., 2004); (7)
empirical research on groups not explicitly mediated by ICT (e.g., Faraj & Sproull, 2000); and (8) empirical research on dyads as they do not qualify as groups (e.g., Dennis & Kinney, 1998). I read the full text of each paper paying particular attention to theory, research design and finding sections to find out how temporal constructs were covered in the study. My reading revealed that 60 papers did not include temporal constructs. Time was mentioned only in phrases like “on the day of experiment”, “during the meeting session”, and “soon after the session”. As time was not treated as an important element in these papers, I dropped them from further analysis. The final sample included 53 papers (7 from CSCW, 1 from EJIS, 6 from ISR, 20 from JMIS, 11 from MISQ, 2 from MS, and 6 from OS), which are indicated by asterisk in the references.

3.2 Coding Procedure

For each paper, I coded three pieces of information: temporal content, aspect of group process and outcome covered that were related to temporal content, and ICT capability. See Appendix A for the coding of 53 papers analyzed for their temporal contents. I applied open coding (Strauss & Corbin, 1990) to categorize different treatments of time and how they had been framed in relation to group process and outcome. For temporal content, I did not code anything that only implicitly referred to time, assessed time-related findings in previous studies, or speculated about temporal behaviors. For example, I coded the temporal contents for Cramton’s (2001) paper as follows:

(1) Teams spanned over a period of 7 weeks (period of use);
(2) Team members accessed information via ICT at different frequencies (frequency of use);
(3) Speed of electronic transmission differed across team members (speed of information exchange);
(4) Rate of communications differed in different parts of teams (rate of communication);
(5) Feedback lags existed in team communication (speed of feedback communications).
I then repeatedly read the open-ended coding (Agar, 1980). The readings showed five patterns in temporal treatment: (1) changes in a group’s properties over time, (2) ICT capabilities related to time and space, (3) a group’s temporal condition, (4) a group’s outcomes measured in time, and (5) a group’s temporal enactment. Only five papers (Cramton, 2001; Miranda & Saunders, 2003; Massey et al., 2003; Maznevski & Chudoba, 2000; Sarker & Sahay, 2004) dealt with more than one category. I classified them into one of the five categories based on principal temporal category covered in the paper. Because only 5 papers covered two or more temporal categories, the potential bias introduced by choosing only one temporal category was deemed to be minimal. To illustrate, Cramton’s (2001) article includes five temporal attributes where one related to observing group properties over time (a period of use), and two to group temporal condition (speed of information exchange and speed of feedback communication), and two to group temporal enactment (frequency of use and rate of communication). As the temporal enactment was stressed over temporal condition throughout the paper, I classified it into the category “group temporal enactment”.

Next, I examined the temporal content covered in each paper as to code how they were related to group process and outcome. Again, for Cramton’s (2001) paper, the codes generated for group process and outcome that were associated empirically with temporal contents included:

1. Variance in frequencies and speeds in accessing information led team members to communicate at different rates which lengthened feedback cycles within teams;
2. Varying rates of communicating eventually contributed to the failure of building mutual knowledge in dispersed (over space) group collaboration;
3. Feedback lags amplified the problems of information exchange and interpretation.

I then developed a list of ICT artifacts (capabilities) covered in the 53 papers. The list included GSS, GDSS, GroupSystems, SAMM, CaptureLab, electronic meeting system,
electronic brainstorm system, electronic mail, listserv, computer conferencing system, audio conferencing, desk-top video conferencing, news-system, non-simultaneous computer conferencing, electronic communication technologies, among others. A generic term was allocated to multiple terms that denoted a similar ICT capability. For example, I classified GDSS, GroupSystems, SAMM, CaptureLab, electronic meeting system, electronic brainstorm system into a more generic term of GSS. I identified three generic families of ICT capabilities: GSS, email, and computer conferencing systems, which are represented in more detail in Table 2. I coded papers that examined a combination of different types of ICT capabilities into the hybrid ICT category.

<table>
<thead>
<tr>
<th>ICT Capability</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSS</td>
<td>Support for processing, storage, representation and transmission of information among meeting participants in a group either at the same place or in a distributed meeting (e.g., DeSanctis &amp; Gallupe, 1987; Kraemer &amp; King, 1988). Main focus is on simultaneous input, processing and presentation of meeting information.</td>
</tr>
<tr>
<td>Email</td>
<td>Support for fast asynchronous information transmission between individuals or groups (mailing lists) over distance. Additional support for storage (archiving), processing (filtering, indexing) and integration with other processing and presentation tools (word processing, spreadsheets) (e.g., Yates et al., 1999)</td>
</tr>
<tr>
<td>Computer conferencing systems</td>
<td>Support for synchronous transmission of mainly textual digital information for storage, search and manipulation shared by potentially large user groups over distance (e.g., Hiltz et al., 1991; Yoo &amp; Alavi, 2001)</td>
</tr>
</tbody>
</table>
Table 3: Temporal Contents Related to Group Process and Outcome

<table>
<thead>
<tr>
<th>Treatment of Time</th>
<th>N</th>
<th>%</th>
<th>Temporal Contents</th>
<th>Group Process and Outcome Related to Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Changes in group properties over time</td>
<td>30</td>
<td>57</td>
<td>Groups took time to adjust and develop</td>
<td>• Certain variables (e.g., group attitudes, communication effectiveness, group outcomes, group cohesion, and conflict management) improved over time, while others (e.g., social presence, communication interface) did not develop over time in electronic groups.</td>
</tr>
<tr>
<td>Groups changed over time</td>
<td></td>
<td></td>
<td>• Certain variables (e.g., leadership, work processes, trust, strategy setting, and technology use) changed over time in electronic groups.</td>
<td>• Sources of trust had different effects on trust in electronic groups over time.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• There was a clear decay in the generation of ideas and high quality ideas as the brainstorming task proceeded.</td>
<td></td>
</tr>
<tr>
<td>Group history</td>
<td></td>
<td></td>
<td></td>
<td>• In electronic groups, group history was related to group cohesion and accuracy of attribution of authorship of technically anonymous comments, and affected group information sharing, decision quality and satisfaction.</td>
</tr>
<tr>
<td>ICT features related to time and space</td>
<td>17</td>
<td></td>
<td>Asynchronous vs. synchronous communication</td>
<td>• In synchronous computer conferences, designated leadership improved agreement levels; statistical feedback improved level of agreement slightly in the absence of a leader; characteristics of individuals and groups were associated with variations in outcomes.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Asynchronous computer conferencing groups shared less information, were less comprehensive in considering all aspects of the decision-making task, made less progress toward the perceived decision goal, and were significantly less effective than face-to-face groups in solving problem.</td>
<td></td>
</tr>
<tr>
<td>Parallel processing (simultaneous access)</td>
<td></td>
<td></td>
<td></td>
<td>• Parallel processing contributed to information overload, and negatively affected reciprocity in group communication.</td>
</tr>
<tr>
<td>Feedback immediacy</td>
<td></td>
<td></td>
<td></td>
<td>• Parallel communication freed brainstorm participants from turn-taking.</td>
</tr>
<tr>
<td>Speed of electronic media</td>
<td></td>
<td></td>
<td></td>
<td>• In electronic groups, delayed feedback reduced the credibility of new information, and amplified the problems of information exchange (e.g., delay in electronic communication impacted the ability of conversational participants to create shared meaning by engendering some kind of trouble, which disrupted the turn-taking system and made the participants unable to identify the true source of the trouble) and interpretation (e.g., silence of unexpected delays in replying by remote members tended to be interpreted negatively, with attributions of incompetence and a lack of commitment).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Feedback immediacy, together with cue multiplicity, of electronic media negatively affected the groups’ social perception, message clarity and evaluation of others, which, in turn, decreased the groups’ decision quality.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Differences in speed of electronic transmissions led to team members communicating at different rates, and the lengthening of feedback cycles.</td>
</tr>
</tbody>
</table>
Table 3: Temporal Contents Related to Group Process and Outcome - Continued

<table>
<thead>
<tr>
<th>Treatment of Time</th>
<th>N</th>
<th>%</th>
<th>Temporal Contents</th>
<th>Group Process and Outcome Related to Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group temporal</td>
<td>8</td>
<td>15</td>
<td>Temporal differences (different rhythms and time zones)</td>
<td>• Lack of vigilance in the differences in group rhythms led to unattended synchronous meetings or missed deadlines, which, in turn, got interpreted as a lack of seriousness or commitment.</td>
</tr>
<tr>
<td>condition</td>
<td></td>
<td></td>
<td></td>
<td>• Significant time differences among virtual team members made it difficult to work in parallel. Members experienced unproductive waits.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Team members needed to sort through and make sense of messages originating in different local times and address concerns that were either past or future for the other side.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Team members took advantage of the time difference between different locations to extend the usual daytime working.</td>
</tr>
<tr>
<td>Manipulated</td>
<td>4</td>
<td>7</td>
<td>Manipulated temporal structure (i.e., time period for idea generation, pace of group activities, how often electronic groups were given a prompt, temporal coordination mechanism)</td>
<td>• Time constraints increased the rate of idea generation.</td>
</tr>
<tr>
<td>temporal structure</td>
<td></td>
<td></td>
<td></td>
<td>• Controlling the duration of brainstorm did not affect the number and quality of ideas generated electronically in groups.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• When the pace was set by GSS regulator, more ideas were organized, more categories were created, and more ideas were repeated. But group members also found using the regulator tool to be harder, since the mental workload was higher.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Temporal coordination mechanisms improved group performance under deadline.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• When a prompt was given every 2 minutes for 40 minutes, groups generated more solutions with higher creativity ratings, produced solutions with higher average creativity ratings, and produced higher concentrations of creative solutions than did groups using free-brainstorming.</td>
</tr>
<tr>
<td>Group outcomes</td>
<td>4</td>
<td>7</td>
<td>Time to complete tasks</td>
<td>• Compared with non-GSS groups, GSS groups were less efficient with respect to the time and number of messages it took to converge to a final solution.</td>
</tr>
<tr>
<td>measured in time</td>
<td></td>
<td></td>
<td></td>
<td>• Compared with non-GSS groups, it took GSS groups no more time to reach decisions when there was a distinct majority/minority, but more time to reach decisions when there was no majority preference.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Well coordinated groups spent less time on completing a writing task than poorly coordinated groups in a computer meeting supported environment.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• GSS altered the way the groups spent their time on different activities in the writing process, but did not change the time spent on completing the task.</td>
</tr>
<tr>
<td>Group temporal</td>
<td>2</td>
<td>4</td>
<td>Rhythm</td>
<td>• Effective global virtual teams exhibited rhythms in teams' interactions.</td>
</tr>
<tr>
<td>enactment</td>
<td></td>
<td></td>
<td>Frequency in accessing information and communication</td>
<td>• Different frequencies in accessing information led to team members communicating at different rates, and the lengthening of feedback cycles in teams.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Different rates of communicating eventually contributed to the failure of mutual knowledge in dispersed group collaboration.</td>
</tr>
</tbody>
</table>
Changes in Group Properties over Time

Studies in this category (Ahuja et al., 2003; Alavi et al., 1995; Berdahl & Craig, 1996; Bouas & Arrow, 1996; Cunnings et al., 1996; Easley et al., 2003; Galegher & Kraut, 1994; Huysman et al., 2003; Jarvenpaa et al., 1998; Jarvenpaa et al., 2004; Kayworth & Leidner, 2001-2002; Lebie et al., 1996; Malhotra et al., 2001; Piccoli & Ives, 2003; Potter & Balthazard, 2004; Reinig & Shin, 2002; Rhoades & O'Connor, 1996; Zigurs et al., 1991) followed typically longitudinal research designs by examining changes over time in group behaviors and processes in ICT-mediated groups. The temporal effects were observed in three ways. First, ICT-mediated groups evolved while interacting with ICT (Burke & Chidambaram, 1999; Chidambaram, 1996; Chidambaram et al., 1990-1991; Walther, 1995). While earlier studies (Daft & Lengel, 1986; Sproull & Kiesler, 1986) reported that ICT-mediated groups, compared with traditional face-to-face groups, were inferior in exchanging relational information and performing equivocal tasks, recent studies found an interaction effect of time on group process and outcome: time positively moderated the effect of ICT use on group processes and outcomes. Differences between face-to-face and ICT-mediated groups reduced in chosen outcome dimensions as time goes by.

Secondly, ICT-mediated groups changed over time (Dennis & Garfield, 2003; Jarvenpaa & Leidner, 1999; Majchrzak et al., 2000; Orlikowski et al. 1995) in terms of group properties including leadership, trust, scope of technology use, and work organization. Thirdly, group history influenced group properties like group cohesion (Yoo & Alavi, 2001), accuracy of attributing authorship of anonymous comments (Hayne et al., 2003), and level of information sharing, decision quality and satisfaction (Mennecke & Valacich, 1998).

ICT Features Related to Time and Space
This category dealt with how ICT features helped re-configured time and space boundaries of group work and how such features were intertwined with group process or outcome. Specifically, changes in two temporal attributes of temporal location and speed were observed. Temporal location was entailed in asynchronous/synchronous communication (Smith & Vancek, 1990; Hiltz et al., 1991) and parallel processing (Nunamaker et al., 1987; Nunamaker et al., 1991) as they were concerned with whether two or more activities take place at the same point of time. Feedback immediacy (Kahai & Cooper, 2003) and speed of electronic media (Cramton, 2001; Kahai & Cooper, 2003), the other two temporal features of ICT, were about speed. Overall, ICT-induced changes in temporal location and speed were found to negatively affect group communication (Cramton, 2001; Dennis, 1996; McLeod & Liker, 1992; Miranda & Saunders, 2003) information exchange and interpretation (Cramton, 2001; Ruhleder & Jordan, 2001; Sarker & Sahay, 2004), perception and valuation of others (Cramton, 2001; Sarker & Sahay, 2004), and to lead of poor decision quality and less efficient in decision-making (Kahai & Cooper, 2003; Smith & Vancek, 1990).

Group’s Temporal Condition

Studies in this category manipulated temporal conditions under which groups operated. Different rhythms (different physiological cycles and social activity schedules) and different time zones led to differences between or within groups working over distances (Majchrzak et al., 2005; Sarker & Sahay, 2004; Souren et al., 2004-2005). Such differences created problems in interpreting behaviors and understanding communications and resulted in unproductive waits. They also demanded group members to extend their daytime working (Sarker & Sahay, 2004).

In several studies, a single temporal condition was manipulated as an antecedent for effective group operation. For example, the time period allowed for brainstorming was controlled
to test its effects on outcomes of computer supported brainstorming. Time constraints increased the rate of idea generation (Dennis et al., 1996), but did not affect the number and quality of ideas generated (Dennis et al., 1999). Other studies used ICT tools to regulate the frequency of prompts signaled to groups (Santanen et al., 2004), the pace of group activities (Grise & Gallupe, 1992-1993), and groups’ temporal coordination mechanisms (Massey et al., 2003). Overall, increased temporal control was found to improve group performance.

*Group Outcomes Measured in Time*

Mixed results were found on how ICT affected the time for groups to complete tasks (e.g., Horton & Biolsi, 1993-1994). Some studies found that ICT-mediated groups spent more time on completing tasks than face-to-face groups (Barkhi, 2001-2002), and others showed that ICT had no effect at all (Horton et al., 1991-1992). Group composition (majority/minority composition) moderated the effect of ICT on task completion (Dennis et al., 1997-1998). Other group variables, such as task type, group size, group’s level of experience with ICT, may also explain the confounding effects of ICT on groups’ task completion.

*Group Temporal Enactment*

Finally, a couple of studies looked at temporal rhythm and frequency of information access and communication. Virtual teams enacted communications patterns with clearer rhythms in their interactions, and those which “danced” to a strong, repeating rhythm were more effective (Maznevski & Chudoba, 2000). Distributed groups were found to differ in how often they accessed information and communicated it to group members (e.g., some check email every day, and other once every few days). Different rates of information access and communication eventually contributed to the failure of building mutual knowledge in dispersed collaboration (Cramton, 2001).
3.3.2 Other Finding

Table 4 summarizes findings by ICT capabilities (their frequencies and relevant temporal contents). Research on GSS, the most widely studied ICT capability, covered all five temporal treatments except “Group Temporal Enactment”. Studies on computer conferencing analyzed its temporal features, and how its use changed over time. Email was only examined in terms of how it was used over time. Use of hybrid ICT received attention in all five treatments of time except in “Group Outcomes Measured in Time”.

<table>
<thead>
<tr>
<th>Type</th>
<th>N</th>
<th>%</th>
<th>Major Temporal Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSS</td>
<td>29</td>
<td>55</td>
<td>• It took time for groups to adjust to and develop relations in GSS environment, and group history affected group process and outcome.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• GSS supported parallel processing and simultaneous access.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• The manipulation of temporal conditions (e.g., pace of group activities, time span for idea generation) had mixed effects on group outcomes (e.g., quantity and quality of idea generated, output complexity).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• The use of GSS either had no effect on or increased/decreased groups’ decision time; and effective temporal coordination was important for efficient group work.</td>
</tr>
<tr>
<td>Email</td>
<td>4</td>
<td>7</td>
<td>• Trust changed over time in groups.</td>
</tr>
<tr>
<td>Computer conferencing</td>
<td>9</td>
<td>17</td>
<td>• It took time for groups to adjust to conferencing systems.</td>
</tr>
<tr>
<td>system</td>
<td></td>
<td></td>
<td>• Group history affected group process and outcome of conferencing systems mediated groups.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>• Conference systems supported both asynchronous and synchronous, and the same and different place communications.</td>
</tr>
<tr>
<td>Hybrid</td>
<td>11</td>
<td>21</td>
<td>• The process of adapting to technology changed over time in groups.</td>
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<td>• Groups changed over time while using ICT artifacts and this affected group process and outcome.</td>
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<td>• Groups differed in feedback immediacy, media speed, and rate of communication while using the set of technological configuration.</td>
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<td>• Groups operated in different time zones and with different temporal structure which affected the adoption and use of these technologies</td>
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<td>• Effective groups exhibited specific rhythms in group interactions that were supported by ICT.</td>
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3.4 Analysis and Summary
The five treatments of time, as identified by the survey, approach time exclusively from the structural dimension. Research in the “Changes in Group Properties over Time” conceives time as a structural attribute that simply ticks away, and thereby reduces time into an environmental factor. Research in “Group Outcomes Measured in Time” studies duration, treating time as a marker against which the group outcome is measured. Research in “ICT Features Related to Time and Space” examines temporal location which is entailed in asynchronous/synchronous communication and parallel processing as they were concerned with whether two or more activities take place at the same point of time, and speed which is feedback immediacy and speed of electronic media about. Structural temporal attributes of rhythm, frequency, deadline, and pace were examined by research in “Group Temporal Condition” and “Group Temporal Enactment”.

The survey produces following knowledge on structural time in ICT-mediated groups. Most notably, time moderates group process and outcome in ICT-mediated groups. Such moderating effect of time as found in the studies of “Changes in Group Properties over Time”, reverberate what is known in face-to-face groups. In addition, temporal characteristics of tasks and events affect group process and outcome in ICT-mediated groups. Research in “ICT Features Related to Time and Space” shows that ICT can shape temporal characteristics of tasks and events by adding new temporal possibilities (e.g., parallel processing, asynchronous vs. synchronous communication) or bringing in its own temporal logics (e.g., speed of electronic media). Studies in “Group Temporal Condition” manipulate temporal characteristics of tasks and events by ICT (e.g., using GSS to set pace of group work) or manually (e.g., giving groups a period of time to complete tasks). Moreover, temporal behaviors exhibited in ICT-mediated groups (e.g., rate of information access) influence group process and outcome, as indicated by
research in “Group Temporal Enactment”. Lastly, the use of ICT in groups is found to affect, positively or negatively, the time to complete tasks, as shown by research in “Group Outcome Measured in Time”.

Of the above knowledge, little is about the temporal impacts of ICT on groups. The differences, if any, between face-to-face groups and ICT-mediated groups, are the main interest of research in “Changes in Group Properties over Time” and “Group Temporal Condition”. Time is treated as a proxy of group outcome variables in research in “Group Outcomes Measured in Time”. Studies in “Group’s Temporal Enactment” reflect the patterns of temporal behaviors in distributed groups that rely on ICT for communication and interaction. They show how different patterns of temporal enactment are related to group process and outcome, but are not explicit on how temporal enactment is related to the use of ICT in groups. Only studies in “ICT Features Related to Time and Space” address how temporal context is shaped by ICT features of parallel processing and asynchronous/synchronous communication and how temporal context as shaped by ICT affect group process and outcome. In other words, the literature only shows effects of ICT on temporal context, and impingement of such effect on group process and outcome. Consequently, the understanding of how ICT impacts structural time is very limited. While recognizing the effects of ICT on temporal context, the literature largely overlooks the impacts of ICT on temporal enactment and interpretive time in groups and their influences on group process and outcome.

Overall, the review indicates that, while the literature on ICT-mediated groups has paid attention to time, the temporal impacts of ICT on groups are not well studied and, as a result, the understanding about the impingement of ICT upon time, both structural and interpretive, remains very fragmented. Extensive research is needed for coherent understanding. Next, I raise the
research questions drawing upon the survey results and justify the research method used to address the research questions.
CHAPTER 4
RESEARCH QUESTIONS AND METHODOLOGY

This chapter presents research questions and research methodology. First, I raise the questions that direct my empirical investigation in the light of the survey. I then describe the choice of case study, research site, case selection, unit of analysis, data collection, data analysis and interpretation, and reliability and validity.

4.1 Research Questions

The survey not only reveals how time has been studied in ICT-mediated groups, but also presents research opportunities. It shows what has been studied and what have not been studied in the temporal impacts of ICT, as illustrated in Figure 1. To address the issues identified in the survey, I raise two sets of research questions – one centered on structural time and the other dealing with interpretive time.
Solid line represents links that have been studied
Link A - ICT shapes temporal context under which ICT-mediated groups operate
Link B - Temporal context, shaped by ICT, influences group process and outcome

Dotted lines represents links that have not been studied
Link C - Temporal context, shaped by ICT, affects temporal enactment
Link D - Temporal enactment, affected by temporal context, influences group process and outcome
Link E - Structural time, impinged upon by ICT, affects interpretive time in ICT-mediated groups
Link F - Interpretive time, in turn, affects new rounds of temporal enactment
Link G - Interpretive time, shaped by structural time, affects group process and outcome

Figure 1: Research Framework of Temporal Impacts of ICT on Groups

Structural Time
Existing research has looked into how GSS, computer conferencing and email impinge upon temporal context by reconfiguring temporal location of activities and speed of information access (Link A in Figure 1). Recent advances in mobile and ubiquitous computing develop newer features with increasing mobility, connectivity and configurability. Because different ICT functions influence time differently (Failla & Bagnara, 1992), newer ICT capabilities (e.g., mobile phone, instant messaging) deserve careful studies to deepen the understanding of Link A.

Research Question 1a: How does ICT especially that is developed more recently shape temporal context of groups? (Link A)

Past studies show that temporal context has a direct influence on temporal enactment in face-to-face groups (Ancona & Chong, 1996; Gersick, 1988). This connection between temporal context and temporal enactment (Link C) has not been examined yet in research on ICT-mediated groups. How temporal context shifted by ICT alters temporal enactment in groups needs empirical investigations.

Research Question 1b: How does temporal context shifted by ICT affect temporal enactment of ICT-mediated groups? (Link C)

Existing research has found that temporal context as impinged upon by ICT affects group communication, information sharing, effectiveness in problem solving, and decision quality (Link B). As Link A is strengthened by recent technological developments, Link B should be further explored. Because temporal context affects temporal enactment (Ancona & Chong, 1996;
Gersick, 1988) and temporal enactment influences group process and outcome (as shown in research in “Group’s Temporal Enactment”), the connection between temporal enactment and group process and outcome (Link D) also merits research.

Research Question 1c: How does temporal context shaped by ICT especially that is developed more recently influence group process and outcome¹? (Link B)

Research Question 1d: How does temporal enactment which is affected by ICT-shaped temporal context influence group process and outcome? (Link D)

*Interpretive Time*

Interpretive time, as noted by the survey, has been largely neglected in the literature. On the basis of earlier research on time in face-to-face groups, I find interpretive time in ICT-mediated groups can be studied in following ways. First, the links between structural time and interpretive time can be researched in ICT-mediated groups. ICT shifts temporal context (Link A in Figure 1), and temporal context shifted by ICT can potentially affect temporal enactment (Link C). Little is known about how group members internalize the ICT-occasioned changes in structural time. Research is needed to study how the re-arranged structural time shapes group’s experience of, values towards, and norms about structural time (Link E).

Research Question 2a: How do ICT-occasioned changes in structural time affect interpretive time in groups? (Link E)

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¹ I don’t treat group process and outcome as two separate constructs (i.e., group process and group outcome). Instead, I only use group process and outcome as a general term to describe aspects of group dynamics other than those related to time.
Temporal interpretation leads to making sense, forming opinions and making assessments of structural time. Such interpretation can alter temporal enactment by rendering interpersonal negotiation of conduct and interactions in line as reflected in group schedules, project timelines and the like (e.g., Sarker & Sahay 2004). So far, research on the effects of temporal interpretation of ICT-shaped structural time on new rounds of temporal enactment in ICT-mediated groups (Link F) has been lacking.

Research Question 2b: How does temporal interpretation of ICT-shaped structural time guide new rounds of temporal enactment in ICT-mediated groups? (Link E)

Interpretive time continually calibrates dynamics in the course of group life and exerts influences on group process and outcome (Barley, 1988). The impacts of interpretive time on group process and outcome in ICT-mediated group (Link G) on group process and outcome remain largely un-researched.

Research Question 2c: How do the emergent experience of, norms about and attitudes towards time in ICT-mediated groups affect group process and outcome? (Link G)

4.2 Case Study
I used the case study method to answer my research questions. The case study method is more suited when “how” or “why” questions are being posed, when the investigator has little control over the events, and when the focus is on a contemporary phenomenon within some real-life context (Yin, 1994). According to Benbasat and associates (1987), the case study method presents three advantages for IS research. First, the case study method enables IS researchers to study information systems in a natural setting, and generate theory from practice. Second, the case study method allows the IS researcher to understand the nature and complexity of the processes taking place in work places. Third, the case study approach is an appropriate way to study an area in which few previous studies have been carried out.

My survey indicates that there was very little theorizing and empirical research on the temporal impacts of ICT on groups. This research looks into an important but largely unexplored research area which is still in its early, formative stages. A case study can offer rich insights into the temporality in ICT-mediated groups, and answer the “how” questions posed by this research. Therefore, the case study method is found appropriate.

4.3 Research Site

The research site was the Division of Information Technology Services (ITS)\(^2\) of a mid-sized private university (University) located in the Mid-Western United States. ITS manages the University’s information technology resources and provides information technology support within the University community. Headed by the University’s Chief Information Officer (CIO)\(^2\) The organizational structure of ITS changed after the study. Some members of the groups being studied have left and new members have joined. Presented here is information at the time of the study.
who is also a vice president of the University, ITS had six departments and about 105 employees at the time of this research. The six departments were Enterprise Application Services (EAS), Help Desk, Instructional Technology and Academic Computing (ITAC), Strategic Technology Alliance (STA), Technology Infrastructure Services (TIS), and University Archives.

Of the six departments, TIS and EAS were the two largest departments with about 40 and 35 information technology (IT) specialists respectively. They were at the core of ITS, responsible for the campus-wide information technology maintenance and development. ITAC was the third largest department with 21 members focusing on current and emerging technologies which enhance creative teaching, effective learning and other academic initiatives at the University. Each of the three departments had several groups. Figure 2 shows the organization chart of the research site.

Figure 2: Organization Chart of Research Site
I chose ITS as my research site two reasons. First, the work at ITS was ICT-intensive. It was enabled by the availability of powerful internet connections and affordable technology, and ITS employees used a variety of ICT, which included but were not limited to instant messaging (IM), mobile phone and email, to communicate and interact with each other. The extensive use of ICT presented itself an opportunity to address the research questions. Second, much of the work at ITS (e.g., trouble-shooting in day-to-day operation activities and brainstorming and problem-solving in development projects) was collaborative, and required frequent communication, interaction and coordination of group work. The intensive teamwork of IT professionals allowed me to examine the temporal issues related to ICT in groups.

4.4 Case Selection

According to Yin (1994), a case is about the unit of analysis of the phenomenon under study. It could be established concepts such as individuals and organizations or events or entities that are less well defined such as decisions, implementation process and program. The case is related to how the research questions are defined (Yin, 1994). Guided by my research questions, I chose group as the case of my field study.

Case study is not a specific method of data collection, but a research strategy by which researchers to achieve their research aims. According to Yin (1994), a primary distinction in designing case study is between single- and multiple-case designs. Single case designs are used when the case represents the critical case, an extreme or unique case, and the revelatory case. Multiple-case designs are employed on the basis of replication logic, which is analogous to that used in multiple experiments. In multiple case studies, each case is carefully selected so that it
either (1) predicts similar results (a literal replication) or (2) produces contrasting results but for predictable results (a theoretical replication) (Yin, 1994).

To better design the case study, I gathered information from several sources. I attended ITS meetings regularly, and accessed the ITS websites for information. I also interviewed directors and managers in ITS, and asked them questions about the use of ICT and the intensity of group activities in their work. Based on the information I gathered from the interviews, meetings and websites, I found that, although there were some variations, ITS groups were very similar in terms of the ICT artifacts in use and work activities. So a multiple case study was appropriate. I used the concept of literal replication (Yin, 1994), and selected three groups to obtain a broader base of data and reduce the likelihood of idiosyncratic findings. The three groups were the financials group in EAS, the network engineering group from TIS, and the instructional support group from ITAC, as highlighted in Figure 1. The three groups worked in different areas and interacted with different people both inside and outside ITS. But their work was all characterized by a combination of solitary concentration and active collaboration, and members in all groups used a variety of technologies in their communication and coordination of work.

The financials group, the network engineering group, and the instructional support group were functional groups within ITS. Members of the three groups worked in the same area, collaborated in their work, and met regularly as a group. They also worked with people from other functional areas on different projects. While these project teams had a limited life span, the three groups themselves were permanent. The focus of my field study was on the three groups, not on the project teams that the members of the three groups participated in. So the groups I
studied were different from those, which were temporary project teams or experiment groups, in the literature I surveyed in Chapter 3.

4.5 Unit of Analysis

Case study can employ either a unitary or multiple units of analysis. A holistic case study design uses only a single unit of analysis; an embedded case study design involves more than one unit of analysis (Yin, 1994). This research is a holistic case study that involves only one unit of analysis – the group.

I first started with individual group members - understood how they used and interacted with each other via an array of ICT artifacts and capabilities in their work practices, and how such usage and interaction affected the structural time and interpretive time in their work. I then analyzed the temporal impacts of ICT on individuals and attributed them to the group. Such attribution took place in the following ways. First, I accounted the temporal impacts of ICT that were mentioned by all group members as applicable to the group. For example, individuals in the instructional support group all told me that they did not feel disrupted by emails. As this was common across the group, I considered this as a group level impact as well. On the other hand, some of the temporal impacts of ICT were mentioned by some, not all, group members. I verified such temporal impacts of ICT with other group members who did not talk about them with me. Some of such temporal impacts were confirmed by other group members and others were not. For example, only Keith and Ruth initially talked about how the use of ICT blurred the temporal boundary of work and non-work. The other four network engineers – Chad, Clay, Denise and Ed, later confirmed such temporal impact, when I probed them, with examples. Accordingly, I treated this as a group level temporal impact. I did not categorize those with
individual differences as group level phenomena. For example, Kirk, a programmer in the
financials group, felt that the use of Instant Messaging (IM) speeded up his work as IM helped
him to get the information he needed faster. IM’s positive effect on speed, however, was not
supported by other programmers. When Beth, Cara, and Kay, the other three programmers, were
asked about the effect of IM on speed, they did not feel the use of IM had anything to do with the
speed of executing work. So I did not consider Kirk’s account representative of the financials
group.

4.6 Data Collection

Data were collected in a span of 14 months from November 2006 to December 2007. I
used observation and interview as the two primary data sources, and collected both subjective
data (i.e., interview data) and objective data (e.g., observation data)\(^3\). My interpretation is
grounded primarily in interviews and observation materials.

I shadowed each member of the three groups once or twice during the course of the
research. Each shadowing lasted about 4 hours. I spent approximately 100 hours on observing
everyday events, settings, interactions, conversations and the use of ICT artifacts in group
members’ work. I followed group members around in their offices/cubicles, in their field trips to
the customers’ site to solve problems, and in hallway conversations. While following each
individual around, I also asked him/her questions about the events, interactions, conversations
and the use of ICT artifacts to gain a better understanding of particulars of naturally occurring
behaviors. I recorded these observations in field notes. The field notes contained sequential
descriptions of action and interaction as well as context. To supplement the field notes, I

\(^3\) Objective or subjective data are relative to research participants.
photographed the settings of each group member’s work, which included the ICT artifacts in use, and the spatial organization of his/her office/cubicle. In addition to shadowing each group members, I also observed the three groups at work. I regularly attended their group meetings, and department meetings, and division meetings. In total, I spent approximately 30 hours on observing the groups in meetings.

As I observed and recorded the naturalistic behaviors but did not become a part of the unfolding events, I adopted the non-participant observation, which is especially useful in recording small group behaviors (Whiting & Whiting, 1970), person-object interactions scripted by taken-for-granted patterns (Langer, 1983). Shadowing group members generated details about their behaviors in real time, and observing groups at meetings provided information about the larger context of each group member’s work. In short, my observations focused on naturally occurring constellations of group member behaviors and provided a perspective in action that manifests internalized cultural norms, values, and beliefs (Gould et al., 1974; Snow & Anderson, 1987).

While observation data provides a perspective in action (Wallendorf & Arnould, 1991), they, however, do not provide direct access to the perceptions, values, and beliefs of informants and reveal little about informants' internal states. Because this research aimed to explain emic⁴ meanings and accounts of behavior as well as etically⁵ derived regularities, I combined observational data in building interpretations with interview data to account for the phenomenon of interest more thoroughly.

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⁴ Reflecting the consciously available perspective of individual informant
⁵ Reflecting the interpretation of the researcher
Interviews provide a perspective of action (Wallendorf & Arnould, 1991). This perspective of action is distinct from action observed as it is about how things are remembered. A series of semi-structured interviews were conducted with each member of the three groups. These interviews were taken place in the informant’s office, in the conference room, or wherever the informant felt comfortable. They were guided by general rather highly specific a priori topical structure (see Appendix B for the interview template) and allowed informants to provide interview content (Denzin, 1989; Fetterman, 1989; McCracken, 1988). Because these interviews were used to elicit emic meanings, I used open-ended probes in a way that built a conversation-like dialogue (Bitner et al., 1990; McCracken, 1988; Snow et al., 1982), rather than asked questions that imposed categorical frameworks on informants' understanding and experiences.

The number of interviews I had with each group member ranged from six to eight, and duration of an interview varied from half an hour to one hour and a half. I had approximately 150 hours of interviews in total. The interviews provided background information about the groups and their work, and allowed me to gain an understanding of group members’ perception of the temporal features of ICT, the temporal behavior and experience of their own as individuals and as groups.

Although interview data richly detail emic perspectives, they are unable to register actual behavior in context. Because of the inherent inconsistencies and ellipses in interview data, informants' responses about their behavior should be regarded and interpreted as situated, particularistic, and motivated. What informants report about their behavior is often, for a variety of reasons, not entirely consistent with what is observed by the researcher. Although both observational and interview data have their own limitations, together they enable to access different realms of experience that may diverge from each other, give voice to a particular
perspective on behavior, and come up with a credible account of the phenomenon of interest (Arnould & Wallendorf, 1994).

In addition to observation and interview, I gathered documents such as time report sheets, work activity schedule, and work manuals and had a couple of meetings with the director of each group that participated in this research. I also accessed the ITS’s website and listserv for information on group mission, service, and projects. These secondary data enabled me to better understand the work settings and procedure of the three groups. The use of multiple sources of data collection supplied more information and provided multiple perspectives on temporal dynamics in the three groups, and yielded a more comprehensive picture of how time was lived and experienced in the three groups.

4.7 Data Analysis and Interpretation

Because of the exploratory nature of the study, I maintained the overlap of data analysis with data collection. That is, I followed an iterative process of data collection and analysis, first developing hunches, then comparing those ideas to new data from the case, and further using the new data to decide whether to retain, revise, or discard inferences. Such interaction of data analysis and collection allowed me to take advantage of flexible data collection (Eisendardt, 1989). New theoretical ideas emerged from data analysis led to adjustment in the data collection instrument such as the addition of questions to an interview scheme.

A multi-step analysis process was used in data analysis. I first read the observational and interview data several times to become immersed in the data, which is a critical step in the analysis process (Eisendardt, 1989). After familiarizing myself with the data, I adopted an open-ended, generative approach to coding and analysis within each group, following the guidelines
suggested by Glaser and Strauss (1967) and Miles and Huberman (1984). I developed empirically grounded categories capturing how group members experienced and perceived time in their use of various ICT artifacts and capabilities, and identified relevant concepts based on the conceptualization of time as presented in Table 1. The iteration between data and concepts ended when enough categories and associated concepts have been defined to explain what have been observed at the three sites and when no additional data were being collected at the three sites to develop or add to the set of concepts and categories, a situation Glaser and Strauss (1967) refer to as “theoretical saturation”. Once all the data were examined for each group, I then pooled the data collected from the three groups to detect similarities and compare differences across the three groups. My data only enabled me to find the impacts of ICT on some, not all, temporal attributes listed in Table 1.

During the data analysis and interpretation building, I consciously made an iterative effort to accommodate or account for the variations between observational and interview data. I began the interpretation with the interview data and then turned to the observation data to check for disjunctures and convergences. I paid special attention to the disjunctures, the differences between the perspectives in action and the perspectives of action provided by observations and interviews, respectively (Arnould & Wallendorf, 1994). Next, I illustrate how I built interpretation when a disjuncture existed between interview accounts and observed behaviors.

After carefully examining the interview accounts, I found the recurrence of some absolute descriptors regarding what happened across informants. For example, most informants
used the words like “every” and “always” to recount the first thing they do in the morning as the
Reed⁶, the manager of the financials group, described how his work.

September 18, 2006 at Reed’s office (Reed, the manager of the financials group)
Me: I would just like you to tell me about the routine of your work —anything you would like to
talk about; please feel free to elaborate.

Reed: Well. I do different things everyday. Every Monday I have two weekly meetings, one with
my boss – Colleen, and the other with Colleen and other managers in the department. Every
Wednesday we have our weekly group meeting. I also have some monthly meetings with our end
users. In addition to meetings, I am responsible for preparing weekly status report for my
manager, upgrading computer systems related to Financials ……

Me: So now I know what you do in your work – your work activities, the hats you wear, and etc.
Is there any habitual way that you carry out your work activities?

Reed: Habitual way of work? Oh, OK. I come to work around 7:30 every morning before everyone
else is in. The first thing I do in the morning is always to check the calendar and email. I use the
Oracle calendar system a lot. It always tells me what meetings and/or activities I have scheduled
or I have been scheduled into, and so I have some kind of idea as of the organization of the day’s
work. Like for today, it’s Monday, (opened the calendar system to show me his schedule while
talking), here shows that I have a meeting with Colleen at 11am, and a peer meeting with Colleen
and other managers at 2:30pm. After checking calendar, I always check emails as often times
work activities originated from email messages. See, Kurt sent me an email this morning about the
user specification for one project (opened his email account and opened the email from Kurt while
talking). I asked Kurt to stop by my office around 3:30pm in my email back to him. I always reply
emails as I read them. This is always more efficient than logging back on and dealing with then
later. …….. [Italics added]

Reed’s description took the form of a conventionalized narrative describing his actual
behaviors. Yet the declarative tone and the words I have italicized cued me that Reed was
probably over-generalizing the incidence or prevalence of certain behaviors. The use of over-
generalizations about his behavior in his verbal account was confirmed by the recorded
behaviors in my observational notes, excerpt of which is shown as below.

September 25, 2006
Reed arrives at his office around 8:05am (He explains to me that his daughter is sick and so he is
in office later than he usually is.) When he sits down in front of his computer, Henry, the manager

⁶ Pseudonym is used to protect the privacy of the informant.
of the Human Resources group, knocks at the door. It is around 8:10am. Reed then chats with Henry about the peer meeting with Colleen in the afternoon about 10 minutes. After Henry leaves, Reed logs into his email account and checks emails. There are quite a few emails in the inbox. One of them is from Colleen about the individual meeting in the morning, a couple from his staff members, a few from end users, and others from the list-serves he belongs to. Reed replies to Colleen’s email first. Then he clicks on the emails from his staff members and the end users. He responds some, but does not reply others. (Reed explains to me that he replies those that he has the answer, and does not respond to those that he needs to do some research or extra work to find out the solution or answer.) He does not even check the emails from the list-serves at all. (Reed explains to me that these emails are typically not required immediate attention as they are mainly discussions of certain features of some software). Reed opens a new window to log on to the TeamTrack in order to understand the email questions from his staff member – Cara. It takes him a while looking up and down in TeamTrack about the project mentioned by Cara, but he still can not figure out Cara’s question. He picks up the phone and calls Cara at her office. But Cara does not answer. Realizing that Cara usually comes to work after 9am, Reed writes an email back to Cara and asks her to stop by and talk. One of emails Reed does not respond to is from an end user. (Reed explained to me that the end user had a service request, which was not well articulated. As the request did not seem very urgent and he is busy preparing for the Monday morning, he would like to deal with this email later today.) It was 8:50 when Rick is finished with emails.

After done with the first round of emailing, Reed turns to his desk and starts to prepare for his individual meeting with Colleen, which is at 11am. He closes his office door. (Reed explains to me that closing door protects him from those spontaneous visits from people – sometime when people see he is in his office, they just come in and have a chat, so that he can concentrate on preparing for his meeting with Colleen). While working on his meeting with Colleen, Reed’s office phone rings several times. Each time he screens the phone number, and only answers those he considers necessary. He has a brief phone conversation with his wife about his sick daughter, and with Kurt, his staff member, about scheduling a meeting with him about a project. Then at 9:50, Cara knocks at the door. Reed opens the door and has a meeting with her. It is almost 10:15 when Cara leaves. Reed closes the door and continues to work on his meetings with Colleen. It is 10:40 when Reed finishes working on the meetings. It is now 20 minutes away from the meeting.

Reed returns a couple of phone calls that he does not answer while working on the meeting with Colleen. He then checks emails again and finds a couple of new emails. He checks them out, and also reads those emails from the list-serves. Now it’s almost 11am – time to have the meeting with Colleen. ……

As the case with Reed shows, there were disjunctures between informants’ recurring verbal reports that they "always" do certain things at certain time and the observation of them prioritize, negotiate, improvise, and work around what to be done. Rather than viewed the informant as deceptive or inaccurate, I saw that disjunctures between observational and interview data provided me an opening for etic interpretation building that went beyond mere summaries of emic perspectives. I questioned the reasons for informants’ inclusion of such over-generalization in their interviews. In addition to the accuracy of the words, were there other reasons why
informants kept using them? If informants did not report everything that actually happened, why did so many of them choose to mention these absolutes? Why were these absolutes important to them? What were the more abstract cultural values or meanings that were contained in their references? Why were certain observed behaviors over-generalized and not others?

I developed answers to such interpretive questions not by speculation or projection but by looking at the full sets of field notes for informants to see what other behaviors were linked to the presence or absence of such overgeneralizations. I noted informants’ tendency to use absolute descriptors to stress the regularity of their work (e.g., the temporal context under which they operate, the temporal behavior that ICT artifacts introduced), and to express their desire to control their own time. I further noted numerous behaviors and activities that challenge or threaten the desired regularity and control. Inter-dependency between each other’s work, occurrence of emergency or things with higher priority, and interruptions from co-workers infuse uncertainty and unpredictability into daily work. The disjuncture between overgeneralizations in interviews and observations of variation in behavior could be explained by an ideal that guided, but did not perfectly predict, behavioral enactments. Etic interpretation of overgeneralizations indicated that in some cases a behavioral ideal was held so strongly that it prevented informants from critically considering their reports in light of their own behavior (Arnould, 1989). I concluded, therefore, that asserting the same thing was done at certain points of time proved ideals of regularity and control, while negotiation of temporal arrangement for the work activities accommodated the changing work environments of informants.

4.8 Reliability and Validity
Reliability refers to the degree of consistency with which instances are assigned to the same category by different observers or by the same observer on different occasions (Hammersley, 1992 cited in Silverman, 2001). Measures were taken to systematize field notes and ensure the reliability of the qualitative data collected. Following the guidelines suggested by Silverman (2001), several sets of field notes were taken for the observations. I took short notes while I was in the field, and expanded those notes right after each field session. I also kept a field journal to record problems and ideas that arose during the field work, and a running record of analysis and interpretation. To reduce the chances that informants misunderstood the interview questions, I pre-tested the semi-structured interview questions on few ITS employees who were not members of the three groups under study. Such pre-testing enhanced the reliability of interviews.

Validity refers to the truth interpreted as the extent to which an account accurately represents the social phenomenon to which it refers (Hammersley, 1990 cited in Silverman, 2001). Several data collection methods (e.g., observation, interviews, archival analysis) were used and different kinds of data – objective or subjective data - were collected. Comparisons of different kinds of data and different methods corroborated validity of my findings (Jick, 1979). In addition to triangulating data and methods, I used respondent validation (Silverman, 2001) to validate my findings. I took my findings back to the individual and the group being studied to see whether they confirm to their own experience as I discovered. By getting research subjects’ verification, I was more confident of the validity of my research findings. Next, I present the results of the case study.
CHAPTER 5
FINDINGS

This chapter presents findings from the empirical study. I first describe function, make-up, work and use of ICT of the three groups of IT professionals in Section 5.1. Next, I detail how the empirical study addresses the research questions raised in Chapter 4. Specifically, section 5.2 shows findings in structural time (research questions 1a, 1b, 1c and 1d), and section 5.3 findings in interpretive time (research questions 2a, 2b, 2c). Finally, section 5.4 summarizes findings in a table and shows how findings address research questions.

5.1 Group Descriptions

The general information of members of the three groups of IT professionals is shown in Table 5. In the following sub-sections, I describe each group in detail.
Table 5: Group Members’ Experiences and Working Hours

<table>
<thead>
<tr>
<th>Group</th>
<th>Group Member</th>
<th>Years on Current Job</th>
<th>Years in IT Field</th>
<th>Working Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financials</td>
<td>Reed</td>
<td>4</td>
<td>34</td>
<td>7:30am – 4:30pm – 4 days a week, 1 day (Tuesday) work at home</td>
</tr>
<tr>
<td></td>
<td>Beth</td>
<td>22</td>
<td>22</td>
<td>8am – 5pm – 5 days a week</td>
</tr>
<tr>
<td></td>
<td>Cara</td>
<td>19</td>
<td>19</td>
<td>9:30am – 6:30pm - 4 days a week, 1 day (Thursday) work at home</td>
</tr>
<tr>
<td></td>
<td>Kay</td>
<td>17</td>
<td>27</td>
<td>8am – 5pm – 4 days a week, 1 day (Thursday) work at home</td>
</tr>
<tr>
<td></td>
<td>Kirk</td>
<td>3</td>
<td>36</td>
<td>8am – 5pm – 4 days a week, 1 day (Tuesday) work at home</td>
</tr>
<tr>
<td>Network Engineering</td>
<td>Chad</td>
<td>17</td>
<td>17</td>
<td>8am – 6pm – 4 days a week, not work on Friday</td>
</tr>
<tr>
<td></td>
<td>Clay</td>
<td>4</td>
<td>8</td>
<td>8am – 5pm – 5 days a week</td>
</tr>
<tr>
<td></td>
<td>Ed</td>
<td>8</td>
<td>9</td>
<td>9am – 6pm – 5 days a week</td>
</tr>
<tr>
<td></td>
<td>Denise</td>
<td>3</td>
<td>22</td>
<td>10am – 9pm – 3 days a week, 1 day (Monday) work at home, not work on Friday</td>
</tr>
<tr>
<td></td>
<td>Keith</td>
<td>7</td>
<td>7</td>
<td>9:30am – 6:30pm – 5 days a week</td>
</tr>
<tr>
<td></td>
<td>Ruth</td>
<td>2</td>
<td>8</td>
<td>8:30am – 5:30pm – 5 days a week</td>
</tr>
<tr>
<td>Instructional Support</td>
<td>Mark</td>
<td>2</td>
<td>10</td>
<td>8:30am – 5pm - 5 days a week</td>
</tr>
<tr>
<td></td>
<td>Jenny</td>
<td>5</td>
<td>5</td>
<td>9am – 5:30pm - 5 days a week</td>
</tr>
<tr>
<td></td>
<td>Maria</td>
<td>3</td>
<td>7</td>
<td>8:30am – 5:30pm - 5 days a week</td>
</tr>
</tbody>
</table>

5.1.1 Financials Group

The financials group is a part of the Enterprise Applications Services (EAS) department, which provides development and production support for institutional based systems for academic and administrative areas of the University. It primarily supports the controller’s office, which includes general accounting, grants accounting, purchasing, and accounts payable, and works with the sub-systems of general ledger and interfaces, purchasing, accounts payable and grant in the financial module of PeopleSoft.

Headed by Reed, the financials group has four programmers – Kirk, Cara, Beth, and Kay. Each of the staff members is primarily responsible for one module or certain part(s) of one module, and provides secondary support for other module(s). For example, Beth works primarily
on General Ledger, and assists in Account Payable which is primarily taken care of by Kay when necessary. Cara and Beth share an office, and so do Kirk and Kay. Their offices are next to each other. The spatial layout of their offices is shown in Figure 3. Figure 4 shows Cara’s work desk, which is representative of those of the programmers. Reed has his own private office, which is three offices away from his staff members’. All group members work at home one day every week.

Figure 3: Office Layout of Programmers
The financials group primarily works with the vendor and the end users. The work of four programmers is a combination of production support, new development and overhead work. Production support keeps the financial sub-systems in PeopleSoft to function properly, and accounts for approximately 70%\textsuperscript{7} of their work time. It covers trouble-shooting of job failures, fixing technical problems, publishing reports, and tutoring end users. Taking up about 25% of their work hours, new development implements new applications and enhances the existing functions. Overhead work includes administrative things like weekly group meetings, quarterly department meeting, and reporting time, and staff training and development.

Production support happens whenever such a need arises. It can be very quick – restoring a file, tutoring end users over the phone. It can also be time-consuming – fixing a bug from a prior development or program. When it takes more than four hours to finish a production support task, a project is created. A project is also created for a new development effort. Certain steps are followed to complete a project – specification, design, development, test, and production.

\textsuperscript{7} The percentage of work time was an estimate given by the informants themselves.
Production projects usually have higher priority over development projects as production projects have a direct impact on the existing day-to-day production of the ERP system. Project deadlines are usually flexible. A project is typically owned by one programmer who takes full responsibility of the project.

Reed, the group manager, is also involved in projects. He gathers project requests from the end users, prioritizes, assigns and coordinates projects, and provides support, either technical or non-technical, to his staff members. He also has such managerial and administrative duties such as staff review and development, regular meetings with his staff members, the department director, other managers in the department, and end users.

The group uses a variety of ICT tools, which can be classified into three categories: software development tools, project tracking tools, and communication and collaborative tools. Software development tools include Excel, Word for specification, Application Design, ChangeMan for development, and Rapid SQL, Data Mover for testing. TeamTrack is used to document and track changes in a project. Major communication and collaborative tools are email, instant messaging (IM), phone (cell phone, VOIP, Communite – an integrated online phone system), Oracle Calendar, conference call, and an online time-reporting system.

5.1.2 Network Engineering Group

The network engineering group is a part of the TIS department, and is responsible for the wired network infrastructure, the campus wireless network, network security, and basic network services including dial-up service and VPN. Headed by Chad, the group has four engineers – Clay, Ed, Keith, and Denise. Ruth, a field engineer from Sprint, works closely with this group, and is considered by the group as a group member as well. Each of the engineers is responsible
for one or more network areas/services. For example, Ed takes care of wired network, and Keith the wireless network and VPN. Though there is no overlap in their areas of responsibility, the engineers are well aware of each other’s work as changes in one area of the network affect other areas.

No members of the group shares an office – Chad, Clay, Ed and Debbie have their own private offices, Keith has his own cubicle in a larger office shared with three other people from the department, and Ruth has her own cubicle in an office shared with another Sprint engineer. Their offices scatter in the same floor, and the spatial layout of their offices is shown in Figure 5. Unlike the programmers who work primarily on one computer, the network engineers deal with multiple devices, as shown in Figure 6.

Figure 5: Office Layout of Network Engineers
The network engineering group works primarily with other ITS groups including the middleware services engineering group and the network operations and support group, and the Help Desk in ITS. The work of the network engineers is composed of production support, network maintenance, engineering development, and overhead work. Production support and network maintenance, the bulk of the engineers’ work, have high priority and account for approximately 70% of their time. Production support reacts to network problems (e.g., network emergencies, incidents, unable to use VPN, wireless network inaccessible), which come from the trouble tickets, management tools, and electronic and verbal messages from people. Network problems are expected to be solved as soon as possible. Production support also includes helping out in other people’s problem-solving by lending a hand to co-workers in the network engineering group and to those in different groups within TIS. Network maintenance covers monitoring the network status and condition and maintaining the already developed network deployment. Everyday, the network engineers read emails and messages from monitoring tools which send out dynamic alerts and generates reports periodically and look at network traffic.
graphs to prevent network problems. The network engineers also regularly upgrade network software and tools, and add, move, and change services on the network to make the network function better and work more smoothly.

Engineering development implements a new system or a service, add a new feature to the existing system or service, or removes something from the existing system of service. It takes in the form of project. Unlike the financials group’s projects which are primarily taken care of by one programmer, the projects in the network engineering group typically involve team work. The network engineer may participate in a project as a leader or as a team member. Project deadlines are usually not firm. To minimize the impacts of the change, the actually roll-out of a project usually takes place in summer when students are off-campus and network traffic is relatively low. The network engineers spend, on average, 25% of their time on engineering development.

Like the programmers, the network engineers have administrative overhead. On the weekly basis, they have two meetings – one group meeting, and the other one-to-one meeting with their manager, each lasting about one hour. They chart time and report status every week. In addition, they spend time on learning to keep up with technology and to get certifications. They also attend training courses, conferences and seminars. The overhead work takes up about 10% of their work time.

The work of Chad, the group’s manager, also involves himself in the four types of work as mentioned above. However, the bulk of his work is on management and coordination, which accounts for about 70% of his working hours. He implements decisions from the upper management and asks for resources and support for projects initiated by the group, coordinates and supervises the production support, network maintenance and engineering development.
The group uses four types of ICT tools: network design and documentation tools, network management and monitoring tools, REMEDY system, and communication and collaborative tools. VISIO is used to draw network diagram for the design purpose, and Excel to document IP allocations. Network management and monitoring tools oversee the entire network and verify the status and condition of network devices. These tools include Cisco Works, HP Open View, in-house developed scripts, and web-based graphing tool like MRTG. REMEDY system is a database for trouble tickets issued by the Help Desk for end user reported network problems. It shows the history of and the progress made on a trouble ticket and serves as a primary tool for exchanging information among end users, the Help Desk and the network engineering group. Like the programmers, the network engineers use email, instant messaging (IM), phone (cell phone, VOIP), Oracle Calendar, conference call, and an online time-reporting system for communication and collaboration. In addition, they also use wiki to disseminate information and notes within the group, websites to access network statistics.

5.1.3 Instructional Support Group

The instructional support group is a part of the ITAC department which assists the development of emerging technologies and supports current technologies that enhances teaching and learning at the University Community. The group works in the areas of emerging technology research and consultation, instructional design, teaching technology design and consultation, and education technology support. It has three instructional technologists – Mark, the manager, Maria, the instructional designer, and Jenny, the instructional technology coordinator. Mark, Maria and Jenny all have their private offices in the same hallway (see Figure 7 for the spatial
layout of their offices). Figure 8 shows Jenny’s work desk, which is quite similar to the other two instructional technologists in the group.

Figure 7: Office Layout of Instructional Technologists

Figure 8: Work Desk of an Instructional Technologist
The work of Maria and Jenny can be categorized into user support and training, student management, and project. Each of them supports some educational systems and technologies. For example, Jenny is responsible for BlackBoard and PACHYDERN system and Maria for Courseware system and clickers. User support provides information and/or answer to faculty and students requests/questions to help them to do what they want to do with the systems and technologies. User support takes place everyday in the forms of answering questions from emails and phone calls, face-to-face meetings, and documenting things that are important and frequently asked. Jenny and Maria also offer workshops to faculty on how to use the systems and technologies every four weeks, and training sessions to student workers once every the other week. Together, user support and training takes up 50-60% of their work hours. Jenny and Maria both supervise several student workers. They interact with students workers on daily basis, coordinating, clarifying and reassuring what students to do. They also have weekly meetings with the student supervisor (who is also a student), and monthly meetings with the students. Student management accounts for about 10% of their work time.

Project, the development of something new, is also an important part of the work of Maria and Jenny. As an instructional designer, Maria is active in projects on website development (i.e., creating websites for a faculty member, a research center, a project, etc) and emerging technology (e.g., creating a new technology product like the digital poster). Maria’s role in projects varies depending on projects’ needs. Jenny usually works with projects in the areas of assessment and Questions & Answers.
Mark’s work is research-oriented. He assesses the effectiveness of the technologies developed and maintained by ITAC, explores the use of emerging technologies (e.g., gaming technology) in educational settings, and examines how to use technology to enhance a particular learning method. He also assumes the role of the spoken-person of ITAC, communicating to the University community the services offered by ITAC.

The three instructional technologists use a variety software tools which include, but are not limited to, Dreamwaver, Photoshop, SPSS, Excel, VISIO, PowertPoint, in their design, development and support work. They also use a large set of communication and collaboration tools such as email, Oracle Calendar, website, and cell phone.

5.1.4 Summary

The work of the three groups can be characterized to have the following temporal features. First, the day-to-day work is punctuated by foreseeable schedules such as group meetings, project meetings, software updates, production reports, and trainings. These schedules are set at different frequencies – weekly, monthly, quarterly, etc., and group members manage their time around these schedules. Second, the intensity of the work oscillates with the cycles of the parties that the groups work with. For example, the instructional support group is busier at the beginning than at the end of each semester. The volume of work to keep existing developments working (i.e., production support) is lower in summer when most students are off-campus than in regular semesters. The financials group finds production support takes up more time at the end of each month when the accounting cycles end than at other times. Third, frequent interactions occur throughout the course of the work. These interactions are unpredictable, sporadic and of varying durations ranging from a quick chat to a lengthy
discussion. Fourth, production support has higher priority over new development effort. While problems in production support should be solved as soon as possible, new development projects usually don’t have firm deadlines. The everyday demand of production support directs the attention away from new developments. Fifth, group members work with changing priorities and deadlines and constantly prioritize. They constantly organize and re-organize their work according to the changes in their work environment. Sixth, group members have controls over how to organize their time on the condition that they perform their work. Seventh, group members, on average, work 40 hours a week, but it is quite flexible as to when to start and stop to work.

The ICT tools used by the three groups in their work can be broadly sorted into two categories - one for individual job performance, and the other for communication and collaboration with others. I call the first category work tools and the second category communication tools. Work tools include software suites (e.g., Microsoft Office) which are commonly used by all three groups as well as those which are used to meet each group’s specific work needs. For example, the financials group uses ChangeMan to keep track of changes in software, the network engineering group CiscoWork to monitor the network health, and the instructional support group Dreamweaver to carry out multi-media design. Communication tools, on the other hand, are very standard across the three groups. They include, but are not limited to, email, IM, Oracle Calendar, and cell phone. These ICT tools, with their own temporal features, are so embedded in work that they are woven into the fabric of the group members’ temporal

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8 The informants put the various ICT tools they use at work into the two categories, and I came up with the names of the two categories based on the informants’ descriptions.
structures, behaviors and experiences. Next, I present the research findings on how ICT tools impinge upon time in the three groups of IT professionals.

5.2 Findings on Structural Time

5.2.1 Temporal Context

My interpretation of the data discloses that ICT features impinge upon temporal location, sequence, frequency of tasks and events in the three groups. They increase superimposed activities, interruptions and disruption, and temporal ambiguity in temporal context (findings to research question 1a). In addition, my cross-group analysis further shows that while the effect of ICT on superimposed activities and temporal ambiguity remains the same, that on interruptions and disruptions varies across the three groups. Temporal disorganization increased by ICT contributes to group members’ procrastination of certain work (finding to research question 1c).

Temporal Location

My observations show that ICT tools support activities to be superimposed upon each other at the same point or span of time. Temporal location is entailed in superimposed activities, as they are concerned with whether two or more activities take place at the same temporal location. ICT tools enable superimposed activities primarily in two ways. First, automatic information processing capability of ICT provides with means to process two or more activities at the same time span. I observed many times that two or more activities running in parallel in informants’ work. For example, it is a common practice for the network engineers to work on trouble shooting on one computer while running network monitoring tools on another computer. Network monitoring tools, once configured and set up, generate automatically network statistics, which frees the network engineers from active efforts of watching and keeping track of network
health. As such, the network engineers can add a second activity (i.e., trouble shooting) on top of the initial activity (i.e., monitoring network). The network engineers not only work on trouble shooting but also keep an eye on network health from time to time by checking out the network statistics. In other words, they have two lines of activities going on concurrently - trouble shooting which stands at the center of their attention, and monitoring network which is up and running in the background.

Such superimposition of an active involvement with an activity upon a passive running of another activity is also evident in the work of the programmers and instructional technologists, as I witnessed numerous times in my observations. For example, the programmers always involve themselves with other activities on computer while it takes a while for the electronic tools to produce production reports or run tests. The instructional technologists always start a new thread of activities with the electronic tools while they wait for the completion of a download or an electronic file transfer, or the results of a database search. ICT tools allow informants to extricate themselves from one activity’s temporal constraint which leads to waiting time by giving them the opportunity to superimpose a second activity, without coming to collision with the initial activity.

Second, the use of multiple ICT tools make possible informants engaging actively in multiple activities simultaneously, as illustrated in Ruth’s account of an on-site trouble shooting.

October 5, 2006 a in the lounge of the first-floor in the building where Ruth works (Ruth, a network engineer)
Ruth and I talk about the use of electronic tools at work.

Ruth: Let me give you a recent example (of the use of electronic tools at work). It was a couple of weeks ago. I was in the Yost Hall trouble-shooting a reported device failure. I checked the device on my laptop, but could not figure out what’s going on. My hunch was it was related to the wired network, which is Ed’s area. So I sent an IM message to Ed for help. Ed IMed back immediately. We communicated on IM back and forth several times. At the same time, both of us worked on
our computers. Then Ed called me up at my cell phone. While we were on the cell phone, I IMed the messages I got from the diagnostic tools to Ed, and he IMed those from his to me. After several rounds of such verbal and text message exchanges, we finally found out where the problem was. It took us more than one hour to solve the problem.

Me: Do things like the example you just gave happen often?

Ruth: Oh, yeah. Quite often.

Me: How do you think about this (superimposed activities)?

Ruth: Mmm, this enables me to make time denser. I feel I can do more things, which is good.

The above interview excerpt exemplifies how multiple ICT tools support multiple lines of communication and interaction at the same time. Different ICT tools, which utilize different types of actions (e.g., seeing, talking, typing) enable informants to superimpose two or more actions at the same point or span of time. As informants are not just substituting one activity for another, or dealing with a task more quickly, ICT tools allow them to “make time denser” by better organizing the tasks at hand, in particular in situations of waiting and of real-time communication and interaction.

In addition to enabling execution of multiple activities at the same point or span of time, ICT tools render the temporal location of tasks and events more unpredictable. Specifically, the asynchronous communication supported by ICT applications like email facilitates the random arrival of tasks and events. As the occurrence of tasks and events becomes less pre-determined, temporal ambiguity, the uncertainty about when particular events or actions are going to occur or recur, and how long they will last (McGrath, 1991), in the work of the programmers, network engineers and instructional technologists increases. The following excerpt of an interview with Clay reflects increased temporal ambiguity experienced by members of all three groups.
October 2, 2006 at Clay’s office (Clay, a network engineer who is responsible for firewall administration)
Clay and I talk about his work.

Me: Now I would like to know the unfolding of your day of work. What’s the structure of your typical work day?

Clay: Well, everyday is different. But the first thing in the morning is always to check emails for operational requests and for answers to my own project requests. After that (checking emails), I check the Calendar to see what scheduled meetings I have for the day. I have a plan for what to do – continue to work on the things I did not finish the day before, respond to requests from operation support, attend scheduled meetings, take care of scheduled software upgrades, and things like these. But things never go as planned. Always get interrupted by operation needs.

Me: Can you expand on this?

Clay: Sure. As I told you earlier, operation support takes a lot of my working time. People come to me whenever they encounter firewall problems, which happen quite a few times a day. They also come to me when they suspect their problems have to do with firewall administration. These requests actually happen anytime during the day, and impossible to plan ahead. They have higher priority over some of my planned work, say engineering work, and take up the time for the planned work. Depending on the scope of the problems, it may take a few minutes to hours to handle them.

Me: Do you take some actions to protect your time for planned work?

Clay: Yes, sometimes I do. I close my door, especially when I need to focus on complex work or when I have a deadline to meet. This reduces the number of personal visits, but does not block the requests from electronic tools. They see my door closed, and send me emails or IMs or call me instead. I am always available anyway. It is not what we do here to shut ourselves down from others. We don’t keep people in need of help waiting too long. We need help from others as well. So I try my best to of take care of these firewall requests as soon as I can.

Frequency and Duration

In addition to temporal location, other two temporal attributes, duration and frequency, are contained in the concept of temporal ambiguity. As the above interview excerpt shows, asynchronous communication supported by ICT applications like email adds the unpredictability in the duration and frequency of tasks and events related to operation support, as well. The increased temporal ambiguity of unanticipated operation support makes plan ahead difficult, if not impossible. Because of their higher priority, tasks from operation support take time away from planned work, changing the course of the work. The procrastination of planned work, in
turn, adds temporal uncertainty about when planned work to be executed and completed. As described by Clay in the above interview, the use of electronic tools for interaction and communication increases temporal disorder of the three groups’ work.

Moreover, the norms in handling operational tasks delivered via electronic tools are found to enforce the effect of operational tasks on temporal ambiguity. The programmers, network engineers and instructional technologists all value being collaborative with colleagues and responsive to end users. As reflected in Clay’s interview, they are receptive and responsive to electronic queries and contacts, despite the fact that they can employ a variety of tactics (e.g., posting an “away” or “busy” indicator in IM or delaying checking emails for prolonged periods of time) to counter the imposition of operational tasks. Instead of exercising tight control over their work, they try their best to make themselves accessible to and accommodate the needs from operation support. In other words, they let their work to be regulated more by events and communication than by time on the clock. Accordingly, such low control over work flow tolerates intrusion of operational tasks and reinforces temporal ambiguity of tasks and events in their work.

My interpretation of the data indicates that electronic communication and interactions increase temporal disorganization as mapped in the more unpredictable temporal location, duration and frequency of events and tasks for the programmers, network engineers and instructional technologists. As result, their work flow even more in flux.

Sequence

The workplace situations in the three groups all involve many interruptions, which are defined as synchronous interactions which are not initiated by the recipients, are unscheduled, and result in the recipients’ discontinuing their current activity (O’Conaill & Frohlich, 1995).
Entailed in interruptions is the temporal attribute of sequence. Interruptions alter the order in which events or tasks take place (sequence). Phone calls and colleagues and end users dropping-in without appointments are two typical interruptions experienced by the programmers, network engineers and instructional technologists. There are electronic interruptions from email, cell phone and IM, as well. These interruptions may or may constitute disruptions, i.e., disrupt work flow or compromise task performance. The varying usages of electronic communication tools at work, task characteristics, and group variables lead to different patterns of interruptions and disruptions across the three groups, as shown in the following interview excerpts.

October 13, 2006 at Jenny’s office (Jenny, an instructional technologist)
Jenny and I talk about interruptions in her work.

Jenny: I get a lot of interruptions. As you just saw minutes ago, a student worker stopped by and asked me questions is an example of interruptions. The phone call I received from a professor earlier in our conversation is another example. Things like stop-bys and phone calls are very common.

Me: Do these interruptions break the flow of your work?

Jenny: Well, it depends how I am involved in the work at hand. If I am really into something, they are posed as disruptions. Otherwise, they are not disruptions but distractions. I think it also depends on the nature of interruptions. If I have a quick answer to the question, like in the student stop-by case you just saw, such interruption does not disrupt at all. But say, for example, Wendy (the department director) calls me up and tells me she wants a report by the end of today. I would probably drop the work I have at hand and start to prepare the report. In this case, the interruption disrupts the flow of my work.

Me: How about electronic tools? Are they sources of interruptions?

Jenny: I do a significant part of my work via emails, as you know I am also responsible for the BlackBoard email account. And I check emails regularly throughout the day. Emails deliver tasks. But most of the time, I don’t consider emails as interruptions.

Me: Why? Can you explain?

Jenny: I don’t know. I check emails the first thing in the morning. I finish easy ones. For those I don’t have answers right away, I will put them on my things-to-do list. I then work on them along with other things on my list. Then I am back with emails when I am not busy. Sometimes I do check emails from time to time when I am waiting for something from emails.

Me: OK, I see. Emails are not as intruding as phone calls and personal visits. Do they disrupt your work flow?
Jenny: Yeah, they are not very intruding. But sometimes they could be disrupting as well.

Me: Can you give me an example?

Jenny: For example, a task delivered by email may have a higher priority and change my plan of work. Like this morning, it was slow and I planned to do some statistical analysis for Mark. Then I got an email from a faculty who had problems in using the BlackBoard. I put the statistical analysis work on hold, and worked on the faculty’s problem. I called her up and found out what her problem really was. I felt it necessary to send a student worker over to her office to show her how to use. And I then checked the availability of my student workers, and called her back for a demo appointment. BlackBoard users email me all the time, and I try to help them out as soon as possible. Emails sometimes stop my work at hand or make changes to my plan. But as instructional support is the bulk of my job, I don’t think they are really disrupting. Anyway, it’s what I am supposed to do.

Me: How about the use of other electronic tools like IM and cell phone?

Jenny: I don’t use cell phone for the purpose of work. I seldom use IM. So I don’t see them as posing interruptions.

The instructional technologists often get interrupted in the course of their work. Interruptions are mainly from visits from student workers and colleagues who stop by to ask questions and have a quick exchange of information. Phone calls from end users such as faculty who need help in using the educational systems (e.g., the BlackBoard) also constitute interruptions. Email of end users of the educational systems is another source of interruptions. However, the instructional technologists typically do not consider tasks delivered via emails from end users disrupting because they usually have the control over when to check and respond to emails. More importantly, answering emails questions from end users is regarded as top priority not only in the work protocol but also in the work practice of the instructional technologists. As a result, the instructional technologists do not have much negative feeling towards being interrupted by emails from end users, as manifested in what Jenny says in the above interview excerpt “It’s what I am supposed to do”.
October 13, 2006 at Beth’s office (Beth, a programmer)
Beth and I talk about interruptions in her work.

Me: I know you get interrupted easily. Where are interruptions from?
Beth: Oh, they are from everywhere. Phone calls, colleagues’ visits, emails and IM messages.

Me: Can you give some examples of interruptions from electronic sources?
Beth: No problem. I find IM messages very interrupting. They can pop up literally anytime. Most of the messages I receive are from my colleagues in my group or my department. My end users don’t communicate with me using IM. They use phone calls or emails instead. Anyway, I try to be as responsive as possible; as I told you before that I don’t want to have a reputation of “not very helpful” among my colleagues. So when I see an IM window pops up, I stop the work at hand and take a look at the message.

Me: Do the IM messages disrupt your flow of work?
Beth: Not really. IM messages are used primarily for information or quick answers. So it usually does not take long to answer IM messages. I can easily go back to my work after dealing with them.

Me: How about emails?
Beth: Emails may be interrupting, but I don’t think they really disrupt my work. My end users from the accounting department use emails to report problems in the area I support. Sometimes, they also call me up. Fortunately, the system is very stable now. Most of the time, these problems are user problems – the users don’t know how to use the system. And user problems are easy to fix. I just email them back or call them up to give them instructions as how to use the system. Like in the case of IM messages, it is easy for me to switch back to my work at hand after dealing with emails. So I don’t see them disrupting. Occasionally, there are bugs in the program. Those are serious problems and for these serious problems, we create a project and follow the standard project procedure to proceed. Sometimes, Reed, our group manager, also assigns projects to us by email.

The work of the programmers, like that of the instructional technologists, is punctuated by interruptions, as well. IMs from colleagues and emails from end users of the financial systems are the two sources of electronic interruptions experienced by the programmers. The pop-up configuration of IM directs the attention of the programmers away from what they are working on, and is, therefore, is notably interrupting. The programmers, however, do not find the use of IM compromise their work at hand. This is related to the characteristics of interactions that the
programmers have with IM, which is used primarily for sharing simple information and seeking quick answers. The programmers are not expected to process a large amount of information to respond IMs. Because of the task simplicity, the programmers’ interactions with IM are short, and trains of thoughts are not discontinued from their original tasks despite the fact that their attention is temporarily away.

Similarly, answering emails from end users of financial systems does not take the programmers much time. In most cases, solutions to end users’ problems are on the top of the programmers’ head, and are readily available to be imparted to end users. Such task familiarity enables the programmers to switch easily back to their original tasks after addressing end users’ email questions. In a word, the simplicity of tasks delivered via colleagues’ IMs and the familiarity of tasks delivered via end users’ emails contribute to the negligible effect of electronic interruptions on the programmers’ performance on tasks at hand.

October 17, 2006 at Keith’s office (Keith, a network engineer)
Keith and I talk about interruptions in his work.

Keith: Yeah, my work is full of interruptions. Some of them are unpleasant interruptions. Trouble tickets from emails are unpleasant ones, especially when I need to spend time on searching information for them. Project-related interruptions from my colleagues are pleasant ones. There are also expected interruptions. Expected interruptions, I mean, expected breaks from the monitoring tools which send me emails and text messages to my cell phone.

Me: That’s very interesting categorization. What makes interruptions unpleasant or pleasant? Are expected interruptions unpleasant or pleasant?

Keith: You know, we are network engineers, but most work on trouble tickets are not engineering. It’s customer support, examining basic stuff like checking out if jacks are appropriately plugged. Things like that. It is not really what engineers are supposed to do. But we do a lot. Projects are engineering work we all enjoy. Expected interruptions are from things already in production. It is a part of our work to keep things in production going.

Me: Do interruptions disrupt your work flow?

Keith: Well, most of them do.

Me: Can you expand on this?
Keith: Well, trouble tickets need to be resolved within 2 days, that’s the goal set by Lev, you know, the head of ITS and CIO of the University. If a ticket falls in my area and I do not claim it soon enough, Chad (the group manager) will come and ask “What’s going on? There is a ticket for you!” Trouble tickets come in everyday, and I try not to do tickets all day long. Production support also happens on daily basis. Monitoring devices send me messages all the time, and I need to watch them from time to time. Very often, my colleagues from my own group and from other groups in the department ask me for help. They come to my cubicle, call, email or IM me. Though each of us has our own areas, different areas are connected to each other. Changes in one area may affect other areas. So we collaborate a lot and help each other a lot. We always trouble shoot together over the phone, emails and IM. I would like to lend a hand to my colleagues on their work, but I always end up with no time for my own project work. I always find myself in the situation that I do not do my project work as planned. I always feel being interrupted and disrupted.

Emails from end users of network infrastructure and services, text messages sent from network monitoring devices to cell phone, and IMs from colleagues can all break electronically the continuity of the work of the network engineers. Unlike the instructional technologists and programmers, the network engineers find electronic interruptions results in delays and procrastination of their engineering work, and are, therefore, very disruptive. This can be attributed to the characteristics of interruptions they experience. For example, tackling with trouble ticket emails from end users is not always straight forward as in the case of the programmers dealing with email questions. Instead, it involves a great deal of information processing and takes longer periods of time. In trouble-shooting a trouble ticket, the network engineers typically engage in several rounds of information exchange with the end user to understand the reported problem. It is quite normal for the network engineers to hold while waiting for the input from end users. Unlike the programmers who always get an email question answered in one shot, the network engineers have to go back and forth several times with a single trouble ticket during a period ranging from one to quite a few days. In addition, they always have several un-resolved trouble tickets at hand at the same time. As a result, the network
engineers feel that the “demands of trouble tickets keep popping up and seem never ending” (a quote from the interview with Clay on October 2, 2006). The lack of a sense of task closure makes the network engineers’ experience of being disrupted even more palpable.

The sheer volume of interruptions also contributes to the network engineers’ experience of being disrupted. One example is the multiple trouble ticket emails that the network engineers handle in a given time span, as mentioned in the previous paragraph. Dozens of text messages that the network engineers receive on the daily basis on their cell phone from network monitoring devices add to the disruptive effect of interruptions. The frequent text messages, as indicated by beeping or vibration of cell phone, need the network engineers’ immediate attention, and are very distracting especially when they are busy or in the middle of something complex, even though some of text messages serve to keep them aware of network status and require no actions from them (e.g., the network engineers can do nothing about the alert message that temperature of certain network devices is too high). They have to frequently shift their attention away from their task at hand, and find it difficult to concentrate under constant task switching. The random arrival of multiple interruptions from diverse electronic sources typical of the work day of the network engineers contribute to declines in task execution and organization. For them, the number and rate of interruption correspond with the magnitude of the negative effect of interruptions.

In addition to easy tasks such as seeking quick answers and simple information as the programmers use IM for, IM can be used for demanding tasks, as well. For example, the network engineers use IM in their collaboration to trouble shoot complicated network problems which involve network areas and other expertise than their owns, especially when they are off desk at the client’s site. While the programmers find negligible impact of IM interruptions on their
performance of original tasks (i.e., tasks being interrupted by IMs), the network engineers link IM interruptions to disruptions. This negative impact of IM interruptions has primarily to do with the complexity of interrupting tasks. Unlike the programmers who do not spend much time on IM interruptions, the network engineers input much time and effort in their IM interactions with colleagues. The longer and more frequently they are away from their original tasks as they interact with IM, the more fragmented their original tasks become, the more difficult for them to stay focused on their original tasks, and the longer the total time required to complete their original tasks. As a result, the network engineers feel delays in and deviations from the execution of the interrupting tasks. So the complexity of interrupting tasks also influences how interruptions impact their recipients.

Greater importance attached to engineering work than to operation support also explains why the network engineers experience interruptions from operation support as disruptions. Compared with operation support which keeps existing network running, engineering work in the form of projects is about design and implementing of news things into existing network infrastructure, is much more challenging and is considered by the network engineers more important in their own professional developments. As well summarized by Clay, “Projects give me a stronger sense of ownership and have a meaning for my own, for example, the areas I am responsible is better off. Unlike operation support which makes me feel cycling around, they give me a feeling of forward and progress. I learn more (from engineering work), enjoy much more (doing engineering work) and would like to do more engineering work. After all, we are network engineers.” (a quote from the interview with Clay on October 2, 2006). However, engineering work is always compromised by the popping-up demands of operation support which has higher priority. Such erosion frustrates the network engineers as their projects suffer
from constant delays and procrastination. The discrepancy between the operation support’s higher priority as specified in work protocol, and the importance of engineering work as psychologically valued by the network engineers furthers the network engineers’ experience that the interruptions from operation support disrupt engineering work. Particularly, trouble tickets are regarded very disrupting, because the network engineers, on the basis of the general industry practice, do not consider the customer support part of resolving trouble tickets (e.g., checking out basic stuffs such as whether jacks are appropriately plugged) what they are supposed to do.

5.2.2 Temporal Enactment

As presented above, ICT adds new complexity and features to the temporal dimension of tasks and events in the work of the programmers, network engineers and instructional technologists. To cope with the increasingly fluid task environment, the three groups all constantly prioritize, flexibly schedule, and concurrently execute tasks (finding to research question 1b). Temporal enactment, as shaped by temporal context, is found to affect group process and outcome (finding to research question 1d). For example, concurrent executing of tasks enabled by ICT leads to improved efficiency. Besides, my interpretation of the data suggests that the three groups use ICT to better organize, manage and regulate their work time.

Prioritizing

Electronic communication and interactions bring in more uncertainties to the work of the three groups. Along come tasks of varying levels of importance and urgency, which demand temporal commitments and compete for limited working hours. In response, the three groups regularly evaluate tasks, set goals and prioritize activities. The following field observation of
Keith, a network engineer, at work, embodies how the three groups control and manage activities by listing competing tasks in order of priority.

On December 8, 2006, I follow Keith, a network engineer, around while he works. He comes to work around 9:30 in the morning, and leaves his office around 6:30 in the afternoon. His plan for the day is to work on the Call-Manager project and the Access Control Service (ACS) project, and trouble tickets. Listed below in the table is what he does from 11:15am to 4:15pm, as I shadow him around and ask him questions.

<table>
<thead>
<tr>
<th>Time</th>
<th>Place</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>11:15am</td>
<td>KSL Building Basement</td>
<td>Work on ACS project, which is far behind the schedule Have done a part of the work as planned, and need do some research for next step</td>
</tr>
<tr>
<td>11:35am</td>
<td>Cubic</td>
<td>Back from KSL Building Check emails on the white computer Reply a few emails</td>
</tr>
<tr>
<td>11:44</td>
<td>Cubic</td>
<td>Trouble shoot a wireless problem reported by a trouble ticket email forward by REMEDY (the trouble ticket reporting system) Work on the trouble ticket and resolve it</td>
</tr>
<tr>
<td>12:25am</td>
<td>Cubic</td>
<td>Read documentation for ACS project</td>
</tr>
<tr>
<td>12:46</td>
<td>Cubic</td>
<td>Cell phone vibrates – a text message comes Check out the text message, an alert about abnormal traffic volume on the wireless network Move to the black computer (which is used for monitoring), check the network traffic graphs, and find the traffic becomes normal after experiencing a very short period of very high volume</td>
</tr>
<tr>
<td>12:50</td>
<td>Cubic</td>
<td>Get back to read ACS documentation</td>
</tr>
<tr>
<td>1:10pm</td>
<td>Cafeteria</td>
<td>Have lunch break</td>
</tr>
<tr>
<td>2:05pm</td>
<td>Cubic</td>
<td>Back to work from lunch break Check emails Go to the neighboring cubic and talk with co-worker about scheduling conference call, as requested by an email, and go back to cubic and reply the email</td>
</tr>
<tr>
<td>2:11</td>
<td>Cubic</td>
<td>Continue to work on emails Find some scripts not running Open a new window and check the status of these scripts</td>
</tr>
<tr>
<td>2:22pm</td>
<td>Cubic</td>
<td>Cell phone vibrates – a text message comes Check out the text message, a warning message about overheating of some network hardware</td>
</tr>
<tr>
<td>2:23 pm</td>
<td>Cubic</td>
<td>Continue to work on the scripts on the white computer Move to the black computer, and check the monitoring graphs of call manager, to which the non-working scripts are supposed to monitor Find out the root of the problem on scripts and fix it</td>
</tr>
<tr>
<td>2:35pm</td>
<td>Cubic</td>
<td>Move back to the white computer to check Remedy emails Pick a ticket about no connection to wireless network,</td>
</tr>
</tbody>
</table>
which is urgent as this affects the end user community
Trouble shoot the wireless connection problem (check wireless access points, etc) with multiple windows open

<table>
<thead>
<tr>
<th>Time</th>
<th>Location</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>2:55 pm</td>
<td>Ed’s office</td>
<td>Need Ed’s help on the wireless connection problem and go to Ed’s office, which is down the hallway. Discuss with Ed, check out computer programs and draw diagrams on the white board together with ED. Get some clue.</td>
</tr>
<tr>
<td>3:10 pm</td>
<td>Ruth’s cubic</td>
<td>Go to Ruth’s cubic, which is next door. Talk with Ruth about the wireless connection problem, and ask Ruth to check the hardware she is responsible for.</td>
</tr>
<tr>
<td>3:15 pm</td>
<td>Cubic</td>
<td>Back in cubic with some speculation about the cause of the wireless connection problem. Make some work around changes in the network, so the user can access the wireless network.</td>
</tr>
<tr>
<td>3:22 pm</td>
<td>Cubic</td>
<td>Get an IM from Jason, the Sprint on-site engineer, about an failure in the MAC system. Chat with Jason in IM about the failure problem, and trouble shoot it while exchange information with Jason on IM. Can not identify the cause of the failure, and consider it may be related to some other areas.</td>
</tr>
<tr>
<td>3:40 pm</td>
<td>Cubic</td>
<td>Call Ed about the wireless connection problem, but Ed does not answer the call. Email the changes made to the network to the email address that is used for archiving changes. Update the status of the trouble ticket in Remedy to “Pending.” Email the person who reported the problem to leave a trace of what has been done.</td>
</tr>
<tr>
<td>3:55 pm</td>
<td>Cubic</td>
<td>Pat, (the department secretary) comes in about books on the shelf in the room next, talk with her few minutes.</td>
</tr>
<tr>
<td>4:01</td>
<td>Cubic</td>
<td>Back to trouble shoot the failure problem. Check reference online for the failure problem. Ask Nate (a friend on campus) about the failure problem via IM, but does not get his response. Put the failure problem on hold.</td>
</tr>
<tr>
<td>4:15 pm</td>
<td>Cubic</td>
<td>Back to REMEDY emails and look through the trouble tickets.</td>
</tr>
</tbody>
</table>

After the observation, I ask Keith what he will do in the rest of the afternoon. He says that he will work on the trouble ticket at hand, and that he will continue to work on the ACS project if time permits. He also says that he will not be able to work on the Call Manager project as planned today.

Keith goes through a variety of activities in his work. He arranges activities based on their priority and allocates his working hours accordingly. Here my analyses focus on his
experience of constant prioritizing in dealing with electronic communication and interactions (i.e., emails, cell phone text message and IM). During the 4-hour period of my observation, Keith responds to one IM inquiry, receives two cell phone text messages, and works on three trouble ticket emails. In line with the group’s norm of cooperation and collaboration, Keith responds to the IM inquiry (the failure problem) immediately by discontinuing his work on the wireless connection problem. But he does not find the cause of the failure after spending about 40 minutes on and off on the problem. As this takes much time and efforts as well as the failure problem may be related to some other areas, Keith puts the un-resolved IM inquiry on hold, and switches back to working on the wireless connection problem.

The first cell phone text message, which signals a potential network problem, arrives when Keith is in the middle of the ACS project. Because of the greater urgency attached to the potential network problem than to the ACS project, Keith stops reading the ACS documentation and looks into the text message. The second cell phone text message, which warns high temperature of some network hardware, comes in while Keith is working on the scripts problem. With the knowledge that such overheating will be alleviated once the network traffic slows down, he continues to work on the scripts problem at hand. In other words, Keith does not take any actions due to this message’s negligible impact on network operation.

Keith checks emails as soon as he comes back to his cubic after spending approximately 2 hours working on the ACS project in the KSL Building basement. He still needs to work on the ACS project, but instead checks emails first. He explains to me “I enjoy doing project work and it is more challenging and meaningful. Project work can take me all day. So can the operation support. I need to keep a balance between the two. The ACS project is really far behind the schedule and needs a lot of work. So it’s the first thing I did this morning. I think now it’s the
time for me to take care of operation support.” Keith replies several emails very quickly before starts to work on trouble ticket emails. He feels that “I need to clear the way by finishing those simple ones first. They (those simple ones) do not take much time, just drop emails with a line or two. Then I can concentrate on those may be more time-consuming.” In the afternoon, Keith continues to work on trouble ticket emails.

Keith’s behavior of allocating work hours to competing tasks delivered electronically according to their priorities is observed across all members in the three groups. Keith’s behavior also illustrates how the programmers, network engineers and instructional technologists order their tasks from electronic sources on the basis of the task importance as defined in work protocols, the urgency and significance of the task as they perceive, group norm, or the time and efforts needed to address the task.

First, task priority is determined by its importance as defined in work protocols. Operation support, which keeps the existing IT infrastructure running, is more important than new development, which enhances the existing IT infrastructure. As in the above example of Keith, it is more important to check out the warning signal of a potential network problem than to work on the ACS project.

Secondly, task priority is estimated based on its perceived urgency and significance. For instance, Keith finds work on the ACS project, which is far behind its schedule, more urgent than trouble tickets which keep coming each and every day. As a result, he works on the project before turning his attention to trouble tickets. The greater significance of engineering work to network engineers’ professional development than that of operation support also matters when Keith decides what to do first.
Group norm is found to influence the direction of activities as well, as evidenced in the use of IM by the network engineers. Conforming to the group norm, Keith rates the IM inquiry higher in priority than his task at hand. Accordingly, he drops the wireless connection problem that he is working on when the IM inquiry from Jason pops up on his computer screen. In addition, individual work habit plays a role in determining priorities of tasks. For instance, Keith deals first with emails which are not very important but easy to complete, and leaves those which may take more concentrated time to complete for later. That is, he takes into consideration the efforts and time needed to address tasks from electronic sources when he lists tasks in order of priorities.

*Scheduling*

Electronic tools enable tasks, especially tasks related to operation support, to be delivered virtually any time, making the temporal characteristics (e.g., temporal location, duration, and sequence) of tasks and events less prearranged and more dynamic. It is less possible for the three groups to formalize the temporal location, duration and sequence of tasks and events and to follow a prescribed route of activities. Accordingly, they are spontaneous and open with regard to scheduling their work time to cope with the mandates of tasks and the demands from colleagues.

Such flexibility in scheduling is mainly manifested in terms of activities loosely formalized and schedules open to changes. First, the programmers, network engineers and instructional technologists loosely schedule their time with no specific boundaries regarding either when something must occur or how much time is allocated to complete it. Again, take Keith’s work, as presented in the previous sub-section, for an example. Keith plans to work on two projects and trouble tickets. He does not fix each with finite beginning and end points of
time (except for the scheduled meetings or appointments, which he does not have one on the day of the shadowing), but fits them into his schedule as the work day unfolds naturally. Here, clocks are not the primary regulator of activities. Activities are driven by events, not fixed with a particular “time” (e.g., eleven o’clock in the morning). Many of his activities are not determined by his resolve, but are largely determined by the mandates of tasks and the demands from colleagues.

Flexible scheduling addresses the spontaneity embedded in the three groups’ work, too. Rather than adhering rigidly to schedules, the three groups change their work plan easily and often to accommodate tasks and events that are temporally located in a relatively spontaneous manner. The ability to react to spontaneity and unpredictability requires the three groups to keep their schedule open to changes. As in the case of Keith, he keeps adjusting during the course of his work. For instance, Keith responds to a cell phone text message by putting his work on the ACS project on hold. He engages in an IM inquiry by postponing his work on a trouble ticket. He runs out of time and does not do anything on the Call Manager project as planned because trouble tickets and IM inquiry takes up too much of his time. In other words, the programmers, network engineers and instructional technologists regard the intended time commitments as tentative goals, and coordinate their activities contingently on task demands. They take a relaxed approach to work plan, maintain their schedules open to change as people and events require, and develop lowly-organized time structures which are flexible enough for them to meet their responsibilities as much as possible.

Temporal Linearity

In addition to constant prioritizing and flexible scheduling, the three groups also manage tasks and events from electronic sources by doing two or more tasks at the same time. The notion
of concurrently executing tasks is closely related to the idea of superimposed activities, which I present earlier in the findings on temporal context. While the idea of superimposed activities centers on the ICT artifacts enabled technological possibility, the notion of concurrently executing tasks emphasizes actual engagement in multiple tasks. My data show that the programmers, network engineers and instructional technologists do two or more activities literally at the same time” (i.e., simultaneously) as well as actively intersperse and dovetail several tasks within the same time period.

For instance, in my interview with Ruth, a network engineer, on October 5, 2006, Ruth describes that she is on cell phone with Ed, also a network engineer, while exchanging IMs with him and checking network monitoring graphs on laptop computer, in trouble shooting a network problem off desk at a remote site. That is, she is talking, typing and watching simultaneously in solving a problem. Similarly, in my shadowing around with Jenny, an instructional technologist, on November 27, 2006, I observe that Jenny are engaging in two activities at the same time in assisting a professor in the use of the BlackBoard. Jenny is talking on the phone what she is doing on the BlackBoard to the professor who is following Jenny’s instruction in using BlackBoard.

The three groups not only are actively involved with two or more activities on one task with the help from ICT tools as shown in the above examples, but also engage in different tasks in a given time span to adapt themselves to unplanned events and interruptions from electronic interactions and communication. The above example of Keith’s work illustrates how he manages several tasks at once during the course of his work day. Keith is working on the wireless connection problem from the REMEDY system when an IM inquiry pops up. He addresses the IM inquiry’s need immediately while leaving the wireless connection problem unfinished. After
working on the IM inquiry for a while, he switches back to the wireless connection problem without closing the IM inquiry. Instead of completing tasks one by one in successive time frames, Keith is engaged in a combination of tasks at once. Such interweaving of different tasks characterizes the temporal behaviors of the programmers, network engineers and instructional technologists who always juggle several tasks in the same time frame at work.

Routnization and Allocating

The three groups not only prioritize on a regular basis, make their schedules flexible and engage in different tasks and activities at the same time to react to temporal context shaped by ICT, but also utilize ICT artifacts actively to organize and manage their work time. Most noticeably, ICT artifacts, as the central communication structures at the workplace, are incorporated into work routines. For example, email is integrated into daily fabric of work, as in Reed’s description of his work routine “The first thing I do in the morning is always to check the calendar and email” (a quote from the interview with Reed, the financials group manager, on September 18, 2006). The three groups also check emails regularly to keep informed on tasks and events, as represented in above example of Keith’s work on December 8, 2006. Electronic communication tools are used on a regular basis and are well blended into work habits, despite the fact that the use of ICT artifacts does not occur in a pre-determined fashion (not following any fixed temporal order).

ICT artifacts play a significant role in facilitating the three groups to organize time, as well. The most salient in this respect is that ICT artifacts are used to make full use of time, as evidenced numerous times in my observation and interview data. For example, Reed, the financials group manager, is observed to use emails to kill dead time (in my shadowing around with Reed on September 25, 2006). Reed finishes preparation for the meeting with his manager
at 10:40am, 20 minutes earlier than the meeting which is scheduled at 11am. Instead of idling away the 20 minutes that he does not have any planned work, he replies a couple of simple emails and reads some emails from the list-serves. ICT tools are also used to fill up waiting time, as typified in Jenny’s (an instructional technologist) account of how she uses emails to turn waiting time into productive work time. “[w]hile I search databases and wait for results, I check my emails and respond to some emails to which I have quick answers. Instead of sitting there waiting, I do something in that a few minutes. I feel that I make a better use of my time.” (a quote from the interview with Jenny on October 20, 2006).

Besides, electronic tools provide the three groups with the means to better coordinate and protect their work time. The Calendar is found particularly useful in this regard. For example, the Calendar can avoid scheduling conflicts as it shows red sign for double booking a same period of time. The Calendar’s visual representation of time helps the planning of work (e.g., as Maries describes in the interview on October 25, 2006). Also, the programmers, network engineers and instructional technologists can use the Calendar to block time for their work (e.g., as mentioned in the interview with Mark on October 13, 2006, and the interview with Beth on October 13, 2006). As this is also significantly related to experience and norm of time, I will present relevant findings in greater details next.

5.3 Findings on Interpretive Time

My interpretation of the data shows that temporal context and temporal enactment, as shaped by ICT, influence temporal values and that temporal enactment affects temporal norms in the three groups (findings to research question 2a). It also finds that experience of time and temporal norms, in turn, shape temporal enactment (findings to research question 2b). Group
differences are observed in internalizing structural time. In addition, ICT is found to have a direct effect on the groups’ experience of time. The effects of interpretive time on group process and outcome is found in the groups’ better understanding and communication resulted from the sense of the past as enhanced by ICT (findings to research question 2c). In this section, I organize the findings by the sub-dimensions of interpretive time - experience of time, temporal values and temporal norms.

5.3.1 Experience of Time

The ICT tools’ most obvious binding with interpretative time lies in their capability of rendering time more visible, touchable and manipulatable. ICT tools enable the informants to visualize abstract time into meaningful blocks of events and activities. Kirk’s perception of time enhanced by the Calendar is typical across informants in the three groups. Figure 9 shows Kirk’s weekly Calendar page for the week October 23 – October 27, 2006 and cited below is an excerpt of the interview in which he explains how the Calendar shapes his sense of time.
October 26, 2006 at Kirk’s office (Kirk, a programmer)
Kirk and I talk about the use of electronic tools at his work. He mentions that the first thing he always does in the morning is to check the Calendar. (Italics added for emphasis)

Me: Can you show me what your Calendar looks like?

Kirk: Yeah, no problem. (Kirk logs into the Calendar system, and the page for the current week shows up. Kirk moves the mouse around to show me while talking with me). Let’s see. Here is the page for this week. See, here, today, Thursday, I am having a meeting with you from 9:45 to 10:45am, as you scheduled me into a couple of weeks ago. See this hour is marked as green. As for tomorrow, our department will have a monthly department meeting, and I will go, and so I also block the time from 1 to 2:30pm. Other than these two meetings, my schedules for today and tomorrow are open.

Me: So from this page you can tell what meetings you schedule or you are scheduled into.
Kirk: Yeah, that’s right. Like this morning when I opened up the Calendar, I knew you were coming, and so made no other commitment during this one hour. I knew I had no meeting obligations for the rest of the day. I also knew I had a deadline – staff notes due by 3pm. Seeing these meetings and deadlines help me organize my day. This is really a very nice thing the Calendar does for me. It helps me to see my time.

Me: What do you mean by “see my time”?

Kirk: I mean it helps me visualize time.

Me: Can you elaborate a bit more on this?

Kirk: Hmm, let me try. As you see, each block on this page stands for 15 minutes. When I book a meeting on it (the Calendar), it shows me that a certain amount of my time is committed. By looking at it (the Calendar), I have a pretty good sense of time – what slots I have already committed to, and what are still at my disposal. The Calendar’s graphic presentation (of time) makes time visible to me. Another nice thing (about the Calendar) is that my colleagues and I can view each other’s schedules (on the Calendar). See I was on vacation on Monday and I marked it on the Calendar. My colleagues knew I was not available. My time is visible to my colleagues as well as their (my colleagues’) time visible to me. For example, by looking at this page I know that Babic and Chen work at home and Afech is on vacation today.

The Calendar’s features, such as visual representation of time, color codes of committed time slots, reminder of deadlines, availability of colleagues’ time, as mentioned by Kirk, promote informants’ awareness of time associated with particular events and activities through the sense of seeing. The visualization of time makes time more palpable to informants, as reflected in Mark’s notion of “move time around”.

October 13, 2006 at Mark’s office (Mark, an instructional technologist)
Mark and I talk about his use of the Calendar, sitting in front of his computer with the Calendar open. (Italics added for emphasis)

Me: So you use the Calendar a lot in your work. What are the things you like or dislike in using it?

Mark: Well, I like the Calendar presents time in a visual fashion. It shows me vividly what things I need do at particular times. It is very intuitive, and makes it easier for me to move time around.

Me: What do you mean by “move time around”? Can you give an example to show me how you “move time around”?

Mark: Well, hmm, I can’t literally move time around (Smiling). What I mean is that the Calendar makes me feel easier to allocate my time. For example, I really need to do some research work for
a meeting which is about one week away. This morning, I looked at the Calendar to find a time (for this research work). I found out I have several meetings – staff meeting, project meetings, meeting with my manager, etc, next week. These meetings are not long, each taking about one to one and a half hour, but they fragment my time. I need a longer period of time (for the research work). The Calendar shows me that Wednesday afternoon is blank, which means I have no committed obligations on Wednesday afternoon. So I block the hours on Wednesday afternoon (for the research work). The Calendar shows intuitively my work hours into chunks of time, and by looking at these chunks of time, I have a better sense of time available to me, and I can manipulate these chunks of time to suit my needs. That’s what I mean by “move time around”. This (visual representation of time into chunks) really helps me plan and prioritize.

Informants’ working hours are fragmented into segments of time, large or small, by various events and activities. The Calendar’s graphically presenting temporal locations and durations of events and activities into chunks of time help informants to configure cognitively hours available, and map their activities into hours available. Such planning of work supported by the awareness of temporal locations and durations of activities and events is evidenced by informants across the three groups, as shown by the interview with Marie when she talks about her use of the Calendar (Figure 10 shows Marie’s monthly Calendar page for October 2006).
Figure 10: Marie’s Monthly Calendar Page

October 25, 2006 at Marie’s office (Marie, an instructional technologist) Marie mentions to me that she finds the Calendar’s monthly page is helpful. I ask her to show me a monthly page. Marie prints out the Calendar’s monthly page for October 2006 at my request.

(Italics added for emphasis)

Marie: Here is this month’s page. Here x indicates the meetings one does not attend, and v indicates those one attends. As you can see, I don’t go to every meeting I am scheduled into.

Me: Oh, I see. What do you use this kind of page for?

Marie: I use it mainly to plan my work. As I told you before, my work load varies, and I try my best to keep it as balanced as possible. The Calendar’s monthly page helps me in this regard.

Me: Can you elaborate on this?

Marie: Sure. As you already know, most of the meetings I attend are scheduled at least one or two weeks ahead, although sometimes I am given short notices. By looking at the monthly page, I can tell how many meetings I am gonna have in next a couple of weeks, and have an estimate of the
amount of time I need for those meetings. I have a better sense of the future. Then I can plan for my own time (time that is at my own disposal) for the non-meeting part of my work based on deadlines, priorities, availability of resources, and so forth.

The Calendar monthly page exposes informants to the meeting schedules. They can view their meeting obligations, estimate meeting-related work load, and plan for the rest of their work. The Calendar enables informants to have a better sense of the future in planning work. ICT tools not only present the future but also keep track of the past, as Cara talks about how a software tool – TeamTrack – renders the history of projects accessible.

October 17, 2006 in the lounge of the first-floor in the building where Cara works (Cara, a programmer)

I ask Cara how the electronic tools she uses in work are related to time. The first thing comes out of her is about TeamTrack, a software tool that keeps a project’s records – emails exchanged between the parties involved, changes and additions made to the PeopleSoft Financial system – during its lifespan. (Italics added for emphasis)

Cara: Everything about a project is in TeamTrack. It (TeamTrack) is like a depository, and you can find everything related to the project in it. Every email (related to the project) is there. I also periodically update the project information in TeamTrack. It (TeamTrack) keeps track of the progress of a project. It shows the history of a project, and makes the project flow visible.

Me: It shows the history of a project?

Cara: Yep. It shows a project from its inception to its completion. It shows what the user specifications are, the steps I go through, and all the time-stamps of the project. The whole life of the project is there.

Me: How useful is TeamTrack? I mean, why TeamTrack is used?

Cara: It is required by the department that we use TeamTrack to keep track of each project. It’s like an archival of projects. Personally, I find it very useful when I need information on some project I did before. I can always open the TeamTrack and see what have been done in the past. It helps my new projects. I also find it useful when my manager or end user inquires about the progress of a project. I can show him or her in TeamTrack what I have already done.
TeamTrack, a depository of projects, enables the programmers to trace back what they have done to the PeopleSoft Financial system. Similarly, REMEDY system, which stores information on trouble tickets (i.e., problems reported by the end users on IT infrastructures and services), is found to help “see the history of and progress made on a trouble ticket” (a quote from an interview with Edward from the network engineering group on September 28, 2006). The enhanced awareness of the past improves the understanding of and communication between parties involved in ongoing work. ICT tools, such as TeamTrack and REMEDY, facilitate a shared comprehension of history in teamwork.

In addition, my data also suggest that computer shapes the sense of the present in the three groups by helping them “keep the flow of work going” (a quote from the interview with Kirk on October 18, 2006). Computer, as a work tool and a communication tool, reduces informants’ moving around to gather information and receive services by making information and services readily available to them. Working continuously without leaving desks provides the programmers, network engineers and instructional technologists with opportunity to fully engage with their work. As their work engrosses them, informants feel “lose track of time” (a quote from the interview with Denise on October 26, 2006) and experience “a loss of the consciousness of time” (a quote form the interview with Mark on October 13, 2006). The following three interview excerpts offer the evidence of informants’ sense of the present as transformed by the use of computer.

Interview Excerpt 1
October 18, 2006 at Kirk’s office (Kirk, a programmer)
Me: You just told me that the electronic tools get trivial tasks done more quickly, minimize the length of interruption and the length of time on switching tasks. Is there anything else you would like to share with me?
Kirk: Umm. They (the electronic tools) also make it easier for me to keep things going on. I mean, I can do multiple things with my computer. Let me show you what I mean. (Kirk turns to his computer, which has several windows open.) This is the Application Designer window. Application Design is a code development tool supported by PeopleSoft. Before you came in, I was using it for coding. This is another window – Rapid SQL. I was using it for testing. After coding, I put the codes into test right away to see if they worked. Here is the Word window. I use Word as a specification tool. I checked the specifications before I started to code. That’s what I did this morning – understanding specification, coding and testing – before you were in. You see, I opened three windows. No actually five windows. The other two are Calendar and Email window. The multiple windows make it easier for me to switch between tasks. They also help keep things going on, I mean, keep the flow of work going.

Me: OK. That’s very interesting!

Kirk: Yeah. As I have all the tools I need in my computer, I always end up sitting in front of my computer for hours. Like this morning, I did not know it was almost 10 until you knocked on the door. Then I realized that it’s our meeting time and I have been working on the project for almost 2 hours!

Interview Excerpt 2
October 26, 2006 at Denise’s office (Denise, a network engineer)
Me: You just told me that the use of electronic tools both takes time from you and gives you more time. I want to know if the use of electronic tools has anything to do with your experience of time.

Denise: My experience of time?

Me: By your experience of time I mean your personal perception, understanding, feeling, thinking, sense of time.

Denise: Umm. My experience of time. Umm. I always feel I lose track of time working in front of my computer.

Me: Can elaborate on this?

Denise: All the information I need for work is there in the computer. I can monitor, configure and fix the network services, check out the trouble tickets in REMEDY, communicate with my colleagues, and do many other things with the computer. I can work in front of the computer with full attention. I feel I am sucked into the computer and unaware of the passage of time. Time passes quickly.

Interview Excerpt 3
October 13, 2006 at Mark’s office (Mark, an instructional technologist)
Mark: I find the use of ICT tools leads me to the flow state.

Me: What is the flow state? Can you give me an example?

Mark: The flow state refers to a mental state in which a person becomes absorbed in what he or she is doing. It is a term proposed by a famous psychologist, whose name starts with Csik, something like that. It’s very long, and I can’t remember. Anyway, I find the computer offers me the opportunity to focus and concentrate. This always happens when I search on the research databases. Say I am doing a search on the use of video-gaming in educational settings. After I type
in the keyword “video-gaming” and hit the Search button, many articles come up. Some of them may not be directly related to what I am searching for, but have something to do with other things I am interested in. So I check them out, and find additional something else interesting. And then I follow those links again. So you see, the hypertexts on the websites allow me to read by instant needs of being inquisitive. I am immersed in chasing the articles. Such high degree of concentration is like a current carrying me along and I experience a loss of the consciousness of time. Many times, I don’t realize it is noon until I feel hungry.

To some extent, the use of ICT distorts informants’ senses of time and alters their subjective experience of time by providing informants means to keep the flow of work going and become engrossed with their work,. So far, my analysis shows how ICT tools turn abstract time more visible and tangible, absolute time more personal and manipulatable. It also demonstrates that ICT tools play a role in strengthening people’s senses of the future and the past, and how the perceived awareness and understanding of time are intertwined with their experience of the present. While the three groups do not report any differences in their senses of time resulted from the use of ICT tools, the impingement of ICT tools on temporal boundary between work and non-work exhibits different patterns.

Cell phone is a critical tool for the network engineers. They use it not only for verbal exchanges with their colleagues, but also text communication with the network management and monitoring tools, which automatically send dozens of text messages to the network engineers on their cell phone. These messages report network traffic statistics, alerts and warnings, as well as network outages and failures in real time. The network engineers rely on these messages to monitor the network health and fix network problems, if any. They carry cell phone wherever they are – in office, in equipment rooms where network devices are physically installed, in trips, and at home, as vividly reflected in a remark made by one network engineer “I wear it (cell phone) all the time except when I am taking a shower.” (a quote from the interview with Denise
on October 5, 2006). They check out cell phone regularly to stay informed of network status and respond immediately to cell phone notification of network emergencies (i.e., network services are not working). The immediate response to network emergencies which could occur anytime, as required by the work protocol, puts the network engineers on call. Ed’s account of his experience with network emergency represents how cell phone penetrates into the network engineers’ after-work hours.

October 5, 2006 at Ed’s office (Ed, a network engineer)

Me: What kinds of messages the network monitoring and management tools send you via cell phone?

Ed: I receive many messages (on my cell phone) from them (the monitoring and management tools) every day. Most of these messages are about the network status – things like the traffic volumes, warnings of network devices with high temperature, alerts of abnormal network usage. I can’t do anything to many of these things. What can I do for over-heated devices? But I need to keep an eye on them. I usually check out these messages several times a day, typically when it not that busy. I also receive cell phone notification of network emergencies. By emergencies, we mean that the network is not working. Because network emergencies have direct impact on production, we need to address them as soon as possible to minimize their negative effects.

Me: Can you give an example of network emergencies?

Ed: Sure, I have a convenient example for you. Last night, actually around 2 this morning, while I was sleeping, my cell phone beeped. Then it beeped again. I knew something wrong, and got up. I checked the message out and found some part of the wired network was not working and needed a quick fix.

Me: What did you do then?

Ed: I pulled out my laptop, logged into the network, and began to trouble shoot. It took me about one hour and half to figure out what went wrong and fixed the problem. It was almost 3:40 when I went back to bed. This morning, I could not get up as usual, and it was about 11 when I came to work.

Me: What do you think about this experience?

Ed: Well, it’s a part of my job (to work anytime as demanded). The technologies give me the flexibility to work in places other than my office. But they make me to work at odd hours as well. I worked at home last night. But personally, I prefer working in regular hours in the office. Though incidents like last night’s do not happen quite often, thanks to the stable network, they do happen. They happened on weekend and even when I was on vacation. It’s not unbearable, but, you know, everyone likes to be off-work after work.
The network engineers all gave me examples of working when they are off-work. Clay’s narrative is another good example to show how the communication via cell phone invokes work activities in off-work hours.

October 23, 2006 at Clay’s office (Clay, a network engineer)
Me: Do you work after regular work hours?
Clay: Yeah, I do.
Me: Can you give me an example?
Clay: Actually, almost every morning before I come to work, I check email at home. This helps me plan for the day’s work. Usually, it does not take long, just a few minutes, to browse what are in my inbox. Maybe I should not call it work as I am not really engaged. Sometime I do real work (after regular work hours), because problems need to be fixed as soon as possible. A recent example was on Saturday afternoon. Chad, my manager, you know, called me at my cell phone while I was at my parents’ house. He told me that something in the wired network was wrong, and he was trouble shooting with Ed. They felt this might be related to the firewall, my area, you know, and wanted me to do something. I immediately drove home. I used my laptop and VPN to log into the firewall administration website. While I was working (on the firewall administration website), I was also on the cell phone discussing with Chad. It took a couple of hours for us to solve the problem together.
Me: What do you think about working after regular work hours?
Clay: Mmm. It is kind of intruding into my family life. I had to leave in the middle of a family get-together. But it’s something I have to do. It’s my job. I hope to keep a clear-cut line between work and non-work, but it’s hard (to do so). These technologies make me always available and able to work after regular work hours.

Mobile and pervasive ICT support stretches the network engineers’ work across temporal conditions and blurs the boundaries between their work and non-work hours (for similar findings also see Cousins & Robey, 2005). Because work takes place in time after work, the network engineers feel that time after work is not entirely at their own disposal. But the programmers and instructional technologists do not perceive such invasion of work into their personal lives. The
programmers are equipped with cell phone as well. But the frequency and purpose of cell phone usage for the programmers are quite different from those for the network engineers, as reflected in one interview with Beth.

October 6, 2006 at the conference room in the fifth floor of the building where Beth works (Beth, a programmer)
Me: Do you use cell phone a lot in your work?

Beth: Not really. Everyone in our group, actually everyone in our department, is given a cell phone. It is required to carry it at work. But I don’t use it often. I communicate with the end users using email and land phone. I am always at my desk, and they usually reach me by calling at my office phone or emailing me.

Me: So when do you use cell phone?

Beth: Most of my cell phone calls are from Reed, our manager. He calls me (at cell phone) if I am not answering my office phone. He does the same thing to everyone else in the group. He wants to know where we are. Sometimes, my daughter calls me at cell phone.

Cell phone for the financials group is not a frequently used communication tool, but instead serves as a management control tool. “Colleen (the department director) and Reed (the group manager) treat us as kindergarten kids. They want to see us sitting in front of our desk. If they don’t see us at desk, they call us at cell phone. I think there is a trust issue here. I know the network engineering group downstairs has a more friendly work environment. As long as they do their work, they are fine.” This comment made by Cara (a quote from the interview with Cara on October 23, 2006) typifies the programmers’ feeling towards the use of cell phone.

As cell phone is primarily used as a management control tool, the programmers report very limited cell phone usage after their regular work hours, and do not perceive cell phone’s intrusion into their time after work. They sometimes work after their regular work hours. But their work is not triggered by a pressing demand forwarded to them by some ICT tools (like cell
phone in the case of the network engineers). Instead, they choose to work in order to complete
their assigned work, as Kay explained in one of her interviews with me.

September 26, 2006 at Kay’s office (Kay, a programmer)
Me: Do you work after regular work hours?
Kay: I do, sometimes.
Me: Why? Please feel free to elaborate
Kay: I work (after the regular work hours) to complete the work assigned to me. Recently, I don’t
do that as often as I did several months ago when I took over Account Payable from Beth. There
were so many new things, and I had so many meetings that I could hardly work on my other
projects which had looming deadlines. Oh, that’s awful time! I had to work longer hours to catch
up. I worked more than 60 hours a week, but I did not get overtime pay.
Me: Does anything that you receive from electronic tools like cell phone, email prompt you to
work after the regular hours?
Kay: Not really. Usually, I don’t get phone calls after work. I do get emails, but they are not that
urgent that I have to work on them right away. I work (after the regular hours) because I myself
find that I have to in order to get my assigned work done on time.

Similarly, the use of ICT tools does not prompt the instructional technologists to work
after the regular work hours, either. In fact, the instructional technologists generally don’t work
after the regular work hours. Despite the fact that the communication with their end users may
continue electronically after their work hours, no expectation is set that the instructional
technologists need to resolve or answer the issues or questions reported in the after-hour
communication straightaway, as the most communication is not critical and needs their
immediate attention. Mark, the manager, is equipped with cell phone for work, and Marie and
Jenny have their own private cell phone for personal use. They all have access to ICT tools and
services such as laptops, high-speed internet, and emails, which enables them to work after the
regular hours. But they “[I] try not to open the emails at home” (a quote from the interview with
Marie on September 20, 2006) or “[I] don’t really work on the emails after checking them out at home” (a quote from the interview with Mark on September 29, 2006), because they would like not to “be overwhelmed by work at home” (a quote from the interview with Marie on September 20, 2006), but rather to “leave work at office and get the mind off work at home” (a quote from the interview with Mark on September 29, 2006). As a result, the instructional technologists maintain a clear boundary between work and non-work.

5.3.2 Temporal Values

The paired notions of monochronicity and polychronicity are related to both behaviors and attitudes. Behavioral monochronicity/polychronicity can be applied to two separate, though closely connected, domains – temporal behavior of tasks and events (temporal context) and temporal behavior of working (temporal enactment) (Lee, 1999). Temporal behavior of tasks and events is about the way in which tasks and events occur in a temporal sense. While some events and tasks take place in an unexpected way, i.e., irregularly, sporadically, unevenly and not following a fixed schedule, others come in an organized temporal way, i.e., regularly, following the pre-determined, or at least predictable, sequence. The former is polychronic and the latter monochronic temporal behavior of tasks and events.

Temporal behavior of working is concerned with the way of operating. While some people may deal with tasks and events spontaneously as they arise and may perform several things in any order during a period of time whether tasks and events occur regularly or not, others may conduct one thing at a time, designating some slots of time for specific tasks. The former is polychronic and the latter monochronic temporal behavior of working. The degrees of
behavioral monochronicity/polychronicity vary in the continuum from the end of extreme monochronicity to the other end of extreme polychronicity.

Attitudinal monochronicity/polychronicity reflects people’s evaluation of behavioral monochronicity/polychronicity. It shows the extent to which people feel positively or negatively about monochronical or polychronical behaviors of temporal context and of temporal enactment. It may lead to changes in monochronical or polychronical behaviors of temporal enactment.

The use of ICT tools, services and functions, as the interpretation I make based on the data indicates, reinforces behavioral polychronicity in all three groups. The evaluation of this increased behavioral polychronicity, however, exhibits individual variations. The programmers, network engineers and instructional technologists all report mixed feelings towards the increased behavioral polychronicity. Enhanced polychronic behaviors of temporal context and of temporal enactment may have a singular meaning in the minds of some informants, but for many others it appears that multiple meanings are created for behavioral polychronicity. Polychronic behavior is positively seen as an efficient way of make use of time, creating a sense achievement and accomplishment, and as a signal of the importance of the actor. Illustrative examples of each of these feelings are shown in the following.

**Efficiency.** Informants unanimously feel that engaging in two or more activities simultaneously in a given period of time, as enhanced by the use of ICT tools, makes them to work more efficiently. Improved efficiency is perceived as ICT tools help them turn waiting time into productive time, have more control over the pace of their work by minimizing person-to-person contacts, and maximize work time by reducing the amount of time spent on overhead related to work, as represented in the account of Jenny, an instructional technologist, of Keith, a network engineer, and of Kirk, a programmer.
Interview Excerpt 1
October 20, 2006 at Jenny’s office (Jenny, an instructional technologist)
Me: How do you feel about that electronic tools made it easier for you to manage a number of things at once?

Jenny: I think it helps me do more things in a given time. As in the example I just gave you, while I search databases and wait for results, I check my emails and respond to some emails to which I have quick answers. Instead of sitting there waiting, I do something in that a few minutes. I feel that I make a better use of my time. As I do more things in a certain block of time, I feel I am more effective in working. So I do engage in multi-tasking.

Interview Excerpt 2
October 17, 2006 at Keith’s cubicle (Keith, a network engineer)
Me: Electronic communication and interaction, that deliver information, ask for help and demand actions, can happen anytime, and many of them are not foreseeable at all. Events and tasks can happen literally anytime. How do you feel about this?

Keith: Yeah, it is true that electronic messages can happen anytime. They sometime re-direct our attention. But they don’t always dictate our work. We have certain control over what we do in response to electronic communication and interaction. For example, while I am working on a wireless network problem, an IM window pops up – someone is seeking help from me. If I am really into the problem, I can choose not to look at the IM message and continue my work at hand, although most of the time I do take a look (at the IM message). Even after checking out the (IM) message, I still have several options depending on how much time it takes (me) to respond (to the IM message). If it is just a simple “yes” or “no” question, I respond immediately (after reading the IM message). Anyway, it is not good to hold your colleagues’ work back. If it requires additional work, I can either ignore the message for the moment and finish my work at hand before making any other commitment, or drop my work at hand and start to work on the message, depending on which one of the two tasks has higher priority. I think electronic communication (compared with person-to-person contact) gives us more options (in how to respond). Suppose your colleague comes to your office for help. It will be so rude if your ignore him. No matter whether you get involved with his question or not, you need take your attention off your work and talk with him. I find electronic tools save me time by minimizing person-to-person contact and give me more control over when to respond. As I can work at my own pace more, I feel more productive.

Interview Excerpt 3
October 18, 2006 at Kirk’s office (Kirk, a programmer)
Me: I now understand how working with and switching among multiple windows make you feel time flies. What else do you feel about this way of doing your work?

Kirk: I think it also minimizes the down time.

Me: What do you mean by “down time”? Can you expand on it?

Kirk: Down time is time spent on things like getting up to talk with colleagues, switching between tasks. These things are not really about work, but you have to do them to get the work done. They are overhead related to work. ICT tools reduce the down time. For example, switching between tasks in the multiple windows work environment is just a click away. It is really takes no time to
switch back and forth among tasks. I feel I have more time for work, and can produce more. In fact, I always work with multiple windows open.

*Signal of importance*. Behavioral polychronicity can also mean “I am important”. The reasoning that informants offer is that polychronic behavior signifies multiple demands and multiple priorities. People whose temporal context and temporal enactment exhibit this type of behavior are needed by their colleagues and therefore are important in the organization. Ruth, a network engineer, and Reed, the manager of the financials group, perhaps best express this feeling.

**Interview Excerpt 1**
October 19, 2006 in the lounge of the first-floor in the building where Ruth works (Ruth, a network engineer)
Ruth: I enjoy my work. It’s not routine, and everyday I do different things. I am also responsible for many things. I always have different things going at once. When I’m doing things, my colleagues are IMing, emailing or calling me, and I am receiving text messages from all these monitoring devices. I feel a lot more responsible, I feel a lot more, um, involved I guess, needed or something, something like that.

**Interview Excerpt 2**
October 23, 2006 in Reed’s office (Reed, a programmer)
Reed: Electronic messages always pop up, and I don’t have much control over them. I have to use two or more senses at the same time. For example, while I am emailing, I am also talking over the cell phone. They (electronic messages that pop up) demand my time and attention. On the other hand, I see my end users, group members, peers and manager want my input, effort, advice, and expertise in their work, and I would be more than happy to help them out.

*Achievement and accomplishment*. As behavioral polychronicity means getting more things done in a given period of time and signals the importance of one’s work, it gives informants a sense of achievement and accomplishment. They feel that behavioral polychronity
supports them to attain their desired aims and to bring about their intended results, as described
by Jenny, an instructional technologist and Reed, the managers of the financials group.

Interview Excerpt 1
October 20, 2006 at Jenny’s office (Jenny, an instructional technologist)
Me: Anything else you can share with me about your feeling about that electronic tools made it
easier for you to manage a number of things at once?

Jenny: That’s pretty much what I have. I can work more effectively. This is always the aim I have
for myself. I feel I am getting there.

Interview Excerpt 2
October 23, 2006 in Reed’s office (Reed, a programmer)
Me: Anything else you can share with me about your feeling about the electronic pop-ups?

Reed: Yeah, I always feel positively about those pop-ups. They indicate that the people I work
with appreciate my values in this group and department. It always satisfies me after I help people
complete their tasks and fulfill their jobs.

Those positive feelings towards behavioral polychronicity reinforce informant’s
polychronic way of working. On the other hand, informants also see increased behavioral
polychronicity as a form of fragmentation, as a creator of stress and frustration, and a reason for
delays in new development effort. These negative feelings sometimes make informants shun
polychronic way of working.

*Fragmentation.* The constantly changing time demands of activities and tasks as
prompted by electronic communication and interaction bring more disorder to temporal context.
Juggling several activities and tasks as reinforced by electronic tools, services and functions
renders more disruptions to temporal enactment. Informants construe growing temporal disorder
and disruption as segmentation of work time and lacking focus on the job. As a result, they
equate polychronic behaviors with being fragmented. Beth’s following reflection is typical in this respect.

October 13, 2006 at Beth’s office (Beth, a programmer)
Beth: I always get interrupted in the middle of doing my work. Sometime interruptions are from personal visits, but most of the time from electronic tools. I try my best to accommodate (to interruptions), cause I don’t want to have a reputation of “not very helpful”. As I adapt myself to them (interruptions), I find my time is chopped into short segments. This is especially true when the work I am on requires intense involvement. This type of work needs my full attention and my train of thoughts to flow. But interruptions make me unable to focus. So sometimes I just block some time on the Calendar, turn my status on IM to Unavailable to reserve my own time.

Stress and frustration. For some informants, polychronic behaviors promoted by ICT tools also mean increasing stress and frustration. This is related to a more urgent feeling, created by behavioral polychronicity, which helps them to feel that their work is pressing, and a stronger sense of insecurity and dissatisfaction arising from unresolved problems or unfulfilled needs. The following vignette shows increased behavioral polychronicity, as Ruth, whom I discuss earlier in relation to the positive feeling of “signal of importance”, undergoes it, has not been a positive experience.

October 19, 2006 in the lounge of the first-floor in the building where Ruth works (Ruth, a network engineer)
Ruth: Sometimes it is crazy working on a number of things at once. Like this morning. I was working on OpenView (a project Ruth is primarily responsible for), and I got a warning message on my cell phone. Some switched failed in Yost Hall, and I had to address this immediately. So I put OpenView on hold, and started to prepare for the trip to Yost Hall. Then with my laptop I went to a SER (Satellite Emergency Room) in the basement of Yost Hall and checked the failed switches. While I was trouble-shooting, I communicated with Ed about the wired network information. We IMed each other, and also talked over cell phone. Finally, we found out the hardware devices were OK. Then I was back in my office and resumed my work on OpenView. Then my phone rang, and I started to answer questions and trouble shoot on the phone. So you see, I am doing something in the middle of something else. There were just a lot of different things. Then I get emails, and I’ve got to respond to those so it’s a little bit of everything really.

Me: How do you feel when that happens?
Ruth: I get bogged down. I can get kind of like ooohh, stressed out.

Similarly, Marie, an instructional technologist, regards behavioral polychronicity advanced by ICT tools as a source of stress as well as a force of frustration, as shown in following delineation.

September 20, 2006 in Marie’s office (Marie, an instructional technologist)
Marie: Email is my most used communication tool. I get most of the job requests from emails, and email can also deliver my job requests to other persons quickly. I check my emails regularly, usually once, twice in an hour, and sometimes even more frequently. I receive many, many emails each day. I don’t have enough time to respond them all, and so I choose to read only those with higher priority. Unread message in inbox leave me with some kind of frustration that I don’t have enough time.

Me: Do you switch tasks because of email delivery of jobs?

Marie: Yes, I do. I switch only if the incoming task has higher priority. Definitely I would do the most important first, I would rank them. I’m the type of person that if I’m doing something I have to finish that. I get really frustrated if I just start one and then the other. I’d rather just be done with one and then the next one and then the next one. I feel a little more stressed out if I have a bunch of things unfinished all at once. But you know, sometimes you have to approach your work by starting all the projects and working on all of them sort of simultaneously.

Delays in New Development Efforts. Some informants associate behavioral polychronicity increased by ICT tools with delays in new development efforts. For all three groups, compared with production/operation support which is related directly to running of existing services and programs, new development is lower in priority. While production/operation problems are expected to be solved as soon as possible, new development typically does not have a firm deadline. Deadlines set for new developments are usually estimated and can be negotiated. Production/operation support is ongoing everyday and much of it happens unplanned. Subsequently, some informants find their planned efforts for new
developments are always postponed. This is a particularly pronounced feeling in the network engineers, as shown next in the interview excerpt with Keith, whom I discuss earlier in relation to the positive feeling of “efficiency”.

October 17, 2006 at Keith’s cubicle (Keith, a network engineer)
Keith: Everyday, day-to-day operation takes up much of my time. Emails, IMs, phone calls and stop-bys all take time. Some of the problems in operation support are quickly fixed, but others can be really time-consuming. Many of them can’t be solved at one shot. Problems shown up in my areas may be actually problems in others’ areas. I need to trouble shoot together with my colleagues both inside and outside my group. And not everyone is always readily available when you need him. I always end up with a number of things going on in parallel, and I have to come to them from time to time. Yeah, I also need to work on trouble tickets in REMEDY, exchange emails and phone calls with end users or Help Desk people back and forth several times. All these things may seem trivial, but bit by bit they take the time I plan for my projects away from me. I have to put my projects on hold again and again. I don’t like this. Projects are much more fun and I really enjoy working on them.

In addition to polychronic temporal context, polychronic temporal enactment makes it very difficult, if not impossible, to focus on new development efforts which always demands intense involvement. Some informants choose not to deal with new developments while being engaged in production support. They put off their new development efforts to a later time, which contributes to the deferring of new developments. The account of Jenny, whom I discuss earlier in relation to the positive feeling of “efficiency”, is typical in this respect.

October 20, 2006 at Jenny’s office (Jenny, an instructional technologist)
Jenny: Personally, I prefer to do things in succession because this way can get job done more quickly. I prefer not to multi-task, but I do multi-task with the help of electronic tools. We talked about this minutes ago.

Me: Yes, you just told me it makes you feel more efficient at work. Anything else you feel about multi-task?

Jenny: I find it is hard to multi-task in doing project work that are complex and requires intense involvement.
Me: Can you expand on this?

Jenny: I just can’t do creative work while doing production support. Emails, phone calls, and physical visits are so interrupting. I need a larger chunk of time to focus. But the fact is that production support keeps coming. And I have to keep postponing (project work). Sometimes when the project deadline is pressing, I have to shut myself off from operation support to give myself time for the project. I have to quit on multi-tasking.

5.3.3 Temporal Norms

As already evidenced in their accounts of polychronicity, informants eliminate extraneous distractions to protect their time. They interpret extraneous factors as unwelcome “interruptions” when they need to concentrate or meet deadlines in task completion. They commonly separate themselves from the environment to create time by closing the door or not answering the phone.

Informants feel that electronic communication which penetrates the wall brings out interruptions and distractions to the temporal context under which they operate. Because an electronic message, which can be delivered to its recipients regardless of their physical state of work, communicates less restricted temporal behaviors of tasks and events, informants feel that they are more immediately tied up and it is more difficult for them to separate themselves mentally from their colleagues and end users. The following remarks made by Clay, who is very organized with his work time, typify this state of minds of these informants.

September 25, 2006 at Clay’s office (Clay, a network engineer)
Clay and I talk about his work – what he does and how he does. Clay says that his work on operation support is interruption-driven, and I ask questions to explore “interruption”.

Me: What do you mean by interruption?

Clay: I call all these things that disrupt my work at hand as interruptions. I have a plan for what to do, but always get interrupted by operation needs.
Me: Can you give me some examples of interruptions?

Clay: Sure. Interruptions are everywhere. Like this morning, several colleagues came to my office and asked for assistance. I dropped my own work and helped them out. Things like these are usually simple, and don’t take long. But they are interrupting. When I need time to focus, I choose to close the door. This (closing the door) helps reduce person visits. People know I am busy, and they may come back at a later time when the door is open or drop me an email.

Me: So you physically separate yourself from your colleagues to protect your time.

Clay: That’s a very accurate description.

Me: What else do you do to protect your time in task completion?

Clay: Sometimes I screen incoming phone calls, you know. I usually don’t answer calls from those 1 800 numbers. They are from the vendors, and they send me emails anyway. When I am really into something, I let the answer machine take care (of the phone calls). I will check the messages when I am done.

Me: Are such behaviors as closing the door and screen phones acceptable to your colleagues?

Clay: Yeah, everyone faces the same situation and understands. People do things like these all the time.

Me: Are there any other sources of interruptions in addition to stop-bys and phone calls?

Clay: Emails. Sometime I find emails are even more disturbing. I can shut myself off literally from stop-bys and phone calls, but I can’t do that with emails. Emails just come in. Come with them are requests for operation support, and things of that nature.

Me: But you have control over when to check out and respond to emails.

Clay: You are right. I can work at my own pace in dealing with emails. But you know what? Emails make me feel connected with those things I sometimes want to set myself apart from. Same is with IMs. They pop up literally anytime. Yeah, one can choose not to respond or to respond at a later time. But just emails, they make me feel difficult to stay detached from all these things I don’t want to get involved for the moment. I don’t know. Anyway, emails and IMs make me feel more difficult to withdraw from those people who I interact with and from those tasks where my expertise is needed.

While electronic communication renders informants who desire a higher level of separation at work feel more difficult to eliminate extrinsic factors in task completion, electronic tools, services and functions provide novel means to protect time from disruptions and distractions. For example, as mentioned earlier by some informants (e.g., Beth in the interview on October 13, 2006 where she describes her feeling of fragmentation resulted from behavioral
polychronicity increased by the use of ICT tools and services), informants can use Calendar to block time. Once informants block a certain period of time on Calendar, no one can schedule them into any meetings in that time period. Therefore, Calendar is used by informants as a tool to restrict other’s demand on their time. IM can also be used to guide and regulate the use of time. By turning the IM status to Unavailable, informants communicate a message that they are not accessible for the moment. Under this circumstance, informants don’t feel obligated to respond to received IM messages in a timely manner. As they can shun IM, informants decrease the breaking-in of and time spent on IM communication. As result, their time is saved for tasks at hand.

In addition to blocking time to reduce other’s demand on informants’ time, ICT services and functions can serve as a screening tool. For example, informants use emails to screen out higher priority tasks. The ways that Marie and Clay use emails at work exemplify how emails help informants to respond to competing demands on their time.

September 27, 2006 in Marie’s office (Marie, an instructional technologist)
Marie and I talk about the use of email in her work in the last interview dated September 20, 2006. In that interview, Marie reveals how sometimes she feels frustrated and stressed out with the overwhelming volume of emails.

Me: Last week, you told me that you always have too many tasks to complete within a given unit of time, and that the emails which keep coming make the situation even more frustrating and stressful. You don’t have enough time to read all the emails, but choose to respond only to those with higher priority. Do you screen your emails?

Marie: Yes, I do. I think everyone else does too. I just don’t have enough time available to address all these emails. So I have to filter out those that are not critical. I just eyeball the emails in my inbox and answer those I think need my immediate attention. I have to use my time for those things with higher priority, and so I remove something from my to-do-list.

November 17, 2006 at Clay’s office (Clay, a network engineer)
I observe Clay at work. While observing him, I find that there are some flagged emails in Clay’s inbox. I ask questions and Clay and I have a short conversation on flagged emails (see Figure 11 for the screen shot with flagged emails).
Me: I notice that you put a flag on some emails. What does this mean?

Clay: Flagged emails. OK. When I first checked these emails out, I knew there were no quick answers to them and longer time were needed, but I did not want to deal with them at that moment. So I put flags on them. I usually flag-mark emails that need my time but I am too busy or I don’t want to work on them right away. When I log back on, these flags remind that these emails need my attention. I do this (flag-marking emails) a lot.

Figure 11: Flagged Emails

As illustrated in the above two examples, informants routinely use emails to filter out low priority tasks. They regulate the flow of interpersonal electronic interactions to make their time available for tasks or activities meriting attention. Like blocking time, screening activities facilitated by ICT tools indicate informants’ efforts in protection of time for tasks with higher priorities during work activities. Reinforced in the practices of creating a less interruptive and disruptive environment for task completion (i.e., separation behaviors) is the code of conduct that guides the use of time in informants across the three groups – allocation of time which is a scarce resource to tasks with higher priority.

5.4 Summary of Findings

Summarized in Table 6 are the study’s findings.
Table 6: Summary of Findings

<table>
<thead>
<tr>
<th>Temporal Dimension</th>
<th>Temporal Sub-dimension</th>
<th>Temporal Attribute</th>
<th>Findings from Financials Group</th>
<th>Findings from Network Engineering Group</th>
<th>Findings from Instructional Support Group</th>
</tr>
</thead>
</table>
| Structural time    | Temporal context       | Temporal location  | ICT impinges upon temporal locations of tasks and events in all three groups.  
|                    |                        |                    | o ICT supports two or more activities to take place at the same temporal location.  
|                    |                        |                    | 1. The automatic information process capability of ICT provides with the means to process two activities at the same time span, supporting two lines of activities going on concurrently with one activity stands at the center of informants’ attention, and the other activity up and running in the background.  
|                    |                        |                    | 2. The use of multiple ICT tools makes possible informants engaging actively in multiple activities at the same time. At the same time can refer literally to “at the same time”, such as talking over the cell phone and sending IM messages simultaneously, as well as to the active interspersing and dovetailing of several activities within the same time period.  
|                    |                        |                    | o ICT adds the temporal ambiguity to the three groups’ work by rendering temporal locations of tasks, especially those related to operational support, less pre-determined.  
| Duration and Frequency |                        |                    | o ICT adds the temporal ambiguity also by increasing variations in duration and frequency of tasks and events, thus making work even more unpredictable.  
|                    |                        |                    | o The programmers, network engineers and instructional technologists do not exercise tight control over electronic queries and contacts. Such low control enforces the effect of operational tasks on duration and frequency of tasks and events.  
|                    |                        |                    | o The increased temporal ambiguity of operational tasks resulted from the use of ICT tools leads to more conflicting temporal demands as popping operational tasks erode the time arranged for planned work. The procrastination of planned work, in turn, adds temporal uncertainty about when planned work to be executed and completed.  
| Sequence           |                        |                    | ICT brings in more interruptions, which alter the sequence in which events or tasks take place, in all three groups. But the sources of electronic interruptions vary in the three groups, and the three groups are also different in their perception of electronic interruptions as disruptive.  
|                    |                        |                    | o IMs from colleagues and emails from end users of financial systems are the two sources of electronic interruptions.  
|                    |                        |                    | o The simplicity of and familiarity with tasks delivered via IMs and  
|                    |                        |                    | o Emails from end users of network infrastructure and services, text messages sent from network monitoring device to cell phone, and IMs from colleagues interrupt electronically the work of the network engineers.  
|                    |                        |                    | o Emails from end users of educational systems constitute interruptions.  
|                    |                        |                    | o The instructional technologists do not consider these interruptions disrupting because they have the control over when to check and respond to emails from end users.  
|                    |                        |                    | o The instructional technologists’ non-  

| Temporal Enactment | Prioritizing | ICT encourages constant prioritizing:
| | o The three groups regularly prioritize their activities to manage electronically delivered tasks, which are of varying levels of importance and urgency and bring in more uncertainties to their work.
| | o The importance of the task as defined in work protocols, the urgency and significance of the task as perceived, group norm, and the time and efforts needed to address the task are found to influence prioritizing tasks from electronic sources. |
| | Scheduling | ICT increases flexible scheduling:
| | o The three groups are spontaneous and open with regard to scheduling their work time to cope with the mandates of tasks and the demands from colleagues.
| | o The flexibility in scheduling are mainly manifested in terms of activities loosely formalized with no specific boundaries regarding to temporal location and duration and schedules open to change to accommodate tasks and events that are temporally located in a relatively spontaneous manner. |
| | Temporal linearity | ICT supports non-linear way of task executing:
| | o The three groups do two or more activities on one task literally at the same time” (i.e., simultaneously) with the help from ICT tools.
| | o The three groups engage in different tasks in a given time span to adapt themselves to unplanned events and interruptions from electronic interactions and communication. |
| | Routinization | The three groups utilize ICT artifacts actively to organize and manage their work time in the following ways:
| | o The use of ICT as central communication tools is incorporated into work routines and is well blended into negative feeling towards email interruptions also have to do with the top priority they give to answering emails from end users in their work. |
and Allocating work habits.

- ICT is used to organize time, i.e., make full use of dead time and waiting time, and coordinate and protect personal work time.

<table>
<thead>
<tr>
<th>Interpretive time</th>
<th>Experience of time</th>
<th>Senses of time</th>
</tr>
</thead>
<tbody>
<tr>
<td>o ICT tools (e.g., Oracle Calendar) promote the awareness of time associated with particular events and activities through the sense of seeing, and such visualization of time makes time more palpable.</td>
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<tr>
<td>o ICT tools (e.g., Oracle Calendar) help bring out the sense of past and facilitate a shared comprehension of history in teamwork.</td>
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<tr>
<td>o ICT tools, services and functions (e.g., computer, the Internet, hyperlink) make it easier to lose track of time and feel time pass very quickly.</td>
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<table>
<thead>
<tr>
<th>Temporal boundary between work and non-work</th>
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<tbody>
<tr>
<td>o Cell phone is used primarily as a management control tool, and the programmers have very limited communication with end users after work.</td>
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<tr>
<td>o Issues or problems in the use of the financial system typically are not urgent and need action straightaway.</td>
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<tr>
<td>o The programmers work overtime because they themselves need to complete assigned work, and don’t really feel intrusion of work into personal life.</td>
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<table>
<thead>
<tr>
<th>Temporal value</th>
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<tbody>
<tr>
<td>Monochronism / Polychronism</td>
</tr>
<tr>
<td>The three groups all report positive or negative feelings towards the increased polychronicity of temporal context and temporal enactment.</td>
</tr>
<tr>
<td>o Positive evaluations include:</td>
</tr>
<tr>
<td>1. Improve efficiency as ICT tools help informants turn waiting time into productive time, have more control over the pace of their work, and maximize work time.</td>
</tr>
<tr>
<td>2. Signal importance of informants in the organization as they are needed by multiple demands and</td>
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</table>

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</tr>
<tr>
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</tr>
</tbody>
</table>
| 2. Signal importance of informants in the organization as they are needed by multiple demands and
multiple priorities.
3. Create a sense of achievement and accomplishment by supporting informants to attain their desired aims and to bring about their intended results.
   - Negative evaluations include:
     1. Segmentation of work time and lacking focus on the job, resulted from growing temporal disorder and disruption.
     2. Stress and frustration
     3. Delays in new development effort

<table>
<thead>
<tr>
<th>Temporal norm</th>
<th>Separation</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>o The three groups all feel that electronic communication makes it more difficult to separate themselves from extrinsic factors.</td>
</tr>
<tr>
<td></td>
<td>o ICT tools, services and functions provide informants novel means to screen out tasks and block time to reduce other’s demand on their time. Perpetuated in such separation practices are the three groups’ principle of action - protection of time for tasks with higher priority.</td>
</tr>
</tbody>
</table>
The case addresses the research questions raised in Chapter 4. For research question 1a: How does ICT especially that is developed more recently shape temporal context of groups?, the study finds that temporal context is increasingly fluid and dynamic as the use of ICT artifacts at work enables multiple activities running in parallel, expands the scope of interruptions, and augments temporal ambiguity of tasks and events. For research question 1b: How does temporal context shifted by ICT affect temporal enactment of ICT-mediated groups?, the study shows that groups rank task priorities on the regular basis, make their schedules open and flexible, and engage in two or more activities or tasks in a given time span to react to the increase in layers, disorder, uncertainty of tasks and activities. For research question 1c: How does temporal context shaped by ICT especially that is developed more recently influence group process and outcome?, the study discovers that temporal disorganization increased by ICT contributes to groups’ procrastination of work on new developments. For research question 1d: How does temporal enactment which is affected by ICT-shaped temporal context influence group process and outcome?, the study demonstrates that concurrent executing of tasks enabled by ICT leads to improved efficiency.

The study also deals with interpretive time. For research question 2a: How do ICT-occasioned changes in structural time affect interpretive time in groups?, the study finds that groups value the increased polychronicity in temporal context and temporal enactment both positively and negatively. For research question 2b: How does temporal interpretation of ICT-shaped structural time guide new rounds of temporal enactment in ICT-mediated groups?, the study discovers that screening tasks and block time, enabled by ICT, reinforce the temporal norm of separation in groups. For research question 2c: How do the emergent experience of, norms about and attitudes towards time in ICT-mediated groups affect group
process and outcome?, the study shows that the sense of the past enhanced by ICT betters the understanding and communication in groups.

In addition, the study finds direct impact of ICT on experience of time. ICT influences the sense of time and the temporal boundary of work and non-work in groups. Such direct impact of ICT also is found in temporal enactment. ICT provides groups means to better organize and control time. Temporal enactment like screening tasks and blocking time, supported by ICT, helps groups to manage increasingly polychronic temporal context. Next, I discuss the findings of the case study.
This chapter discusses the empirical study’s results and suggests avenues for future research. I first highlight what is learned holistically about the temporal impacts of ICT in groups from the case study. Next, I analyze the results and outline future research with respect to the literature in Chapter 2 Theoretical Backgrounds and the findings from Chapter 3 Literature Survey. My discussions cover ICT technological features, structural and interpretive time, group process and outcome, moderators, the multiplicity of temporal impacts of ICT, and data deficiencies that constrain the empirical findings.

6.1 Overview

Figure 12 shows what is learned from the empirical study about the temporal impacts of ICT on groups. First of all, ICT has direct effects on temporal context, temporal enactment and experience of time. While some of such effects remain the same across groups, others vary. Secondly, temporal context, temporal enactment and experience of time, as impinged upon by ICT, influence group process and outcome. Thirdly, structural time and interpretive time, as shaped by ICT, are intertwined. Fourthly, temporal context and temporal enactment, as shaped by ICT, interact with each other.
A: Temporal context is increasingly fluid and dynamic (i.e., polychronic) as ICT enables superimposed activities, intensifies interruptions, and adds temporal ambiguity of tasks and events.
B: Groups engage in constantly prioritizing, flexibly scheduling and concurrently executing tasks, which augments polychronicity in temporal enactment, to react to increasingly polychronic temporal context.
C: ICT provides groups means to better organize and control time.
D: Groups engage in such activities as screening tasks and blocking time with the help of ICT to manage increasingly polychronic temporal context.
E: ICT influences the sense of time and the temporal boundary of work and non-work in groups.
F: The sense of future, enhanced by ICT, facilitates planning of work.
G: Groups value the increased polychronicity in temporal context and temporal enactment both positively and negatively.
H: The temporal norm of separation leads to screening tasks and blocking time, and such temporal behavior reinforces the temporal norm of separation in groups.
I: Temporal disorganization increased by ICT contributes to group members’ procrastination of work on new development.
J: Concurrent executing of tasks and organizing time with the help of ICT lead to improved efficiency for group members.
K: The sense of past enhanced by ICT betters understanding and communication in groups.

Figure 12: Empirical Links of Temporal Impacts of ICT on Groups
Table 7 summarizes answers to research questions raised in Chapter 4 Research Questions and Methodology. The results not only validate previous empirical studies’ findings on the relationships among ICT, temporal context and group process and outcome, but also lend empirical support to earlier theoretical prediction about the associations among ICT, temporal enactment and group process and outcome. They also substantiate prior conceptual analyses of the intervening effect of interpretive time by specifying how interpretive time is connected to the link between ICT and group process and outcome.
### Table 7: Answers to Research Questions

<table>
<thead>
<tr>
<th>RQ 1a: How does ICT especially that is developed more recently shape temporal context of groups?</th>
<th>Findings:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Temporal context is increasingly fluid and dynamic (i.e., polychronic) as ICT, such as mobile phone, instant messaging, email, the Internet, and software applications, enables superimposed activities, intensifies interruptions, and adds temporal ambiguity of tasks and events.</td>
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<thead>
<tr>
<th>RQ 1b: How does temporal context shifted by ICT affect temporal enactment of ICT-mediated groups?</th>
<th>Findings:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Groups engage in constantly prioritizing, flexibly scheduling and concurrently executing tasks, which augments polychronicity in temporal enactment, to react to increasingly polychronic temporal context.</td>
<td></td>
</tr>
<tr>
<td>• Groups engage in such activities as screening tasks and blocking time with the help of ICT, such as email, Calendar, to manage increasingly polychronic temporal context.</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>RQ 1c: How does temporal context shaped by ICT especially that is developed more recently influence group process and outcome?</th>
<th>Findings:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Temporal disorganization increased by ICT contributes to groups’ procrastination of work on new developments.</td>
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<table>
<thead>
<tr>
<th>RQ 1d: How does temporal enactment which is affected by ICT-shaped temporal context influence group process and outcome?</th>
<th>Findings:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Concurrent executing of tasks and organizing time with the help of ICT lead to improved efficiency for groups.</td>
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<table>
<thead>
<tr>
<th>RQ 2a: How do ICT-occasioned changes in structural time affect interpretive time in groups?</th>
<th>Findings:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• ICT, such as Calendar, database applications, email and mobile phone, influences the sense of time (i.e., the sense of the past, the present, and the future), and the temporal boundary of work and non-work in groups.</td>
<td></td>
</tr>
<tr>
<td>• Groups value the increased polychronicity in temporal context and temporal enactment both positively and negatively.</td>
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<table>
<thead>
<tr>
<th>RQ 2b: How does temporal interpretation of ICT-shaped structural time guide new rounds of temporal enactment in ICT-mediated groups?</th>
<th>Findings:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• The sense of the future, enhanced by ICT, facilitates planning of work.</td>
<td></td>
</tr>
<tr>
<td>• The temporal norm of separation leads to screening tasks and blocking time, and such temporal behavior reinforces the temporal norm of separation in groups.</td>
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</table>

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<thead>
<tr>
<th>RQ 3c: How do the emergent experience of, norms about and attitudes towards time in ICT-mediated groups affect group process and outcome?</th>
<th>Findings:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• The sense of the past enhanced by ICT betters understanding and communication in groups.</td>
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### 6.2 Technological Features of ICT
As found in Chapter 3 Literature Survey, ICT has features related to time and space. Summarized in Table 8 is how specific technological features of ICT affect time, both structural and interpretive, in the groups under study.
### Table 8: Temporal Impacts of ICT Technological Features

| ICT Technological Features                                                                 | Temporal Impacts                                                                                                                                                                                                 |
|-------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------- ------------------------------------------------------------------------------- |
| • Automatic information processing enabled by ICT tools like monitoring devices/programs    | • These ICT features enable two or more activities to be super-imposed upon each other at the same temporal location. And such super-imposition of activities supports concurrent execution of tasks, and making full use of dead time in all three groups. |
| • ICT tools make use of different human senses (e.g., talking with mobile phone, typing with laptop) and can be utilized at the same time |                                                                                                                                                                                                               |
| • Electronic communication, asynchronous, constant, and real-time, supported by ICT applications such as email, IM, cell phone | • Electronic communication and interaction add unpredictability and variations in temporal location, duration and frequency of tasks and events.            |
|                                                                                           | • To cope with such increased temporal ambiguity of tasks and events, the three groups constantly prioritize, flexibly schedule, and execute tasks in a non-linear way. |
|                                                                                           | • The three groups all report both positive and negative feelings towards the increased polychronicity in temporal context and temporal enactment, resulted from electronic communication. |
|                                                                                           | • The three groups feel that electronic communication makes it more difficult to separate themselves form extrinsic factors (i.e., separation becomes more difficult). |
| • Visualization of time supported by Calendar                                             | • Calendar makes time of time more palpable.                                                                                                           |
|                                                                                           | • Calendar enables the three groups to have a better sense of the future in planning work.                                                             |
| • Storage function of ICT applications such as TeamTrack, REMMEDY                         | • This function strengthens the sense of the past by rendering the project history accessible, and facilitates a shared comprehension of the history in teamwork. |
| • Connectivity increased by various ICT applications such as the Internet, email, IM       | • The increased connectivity enables the three groups to work continuously without leaving their desks to seek information, makes it easier to lose track of time, and transforms the sense of the present. |
|                                                                                           | • The electronic connectivity also stretches the network engineers’ work across temporal conditions and blurs the boundaries between their work and non-work hours. |
Most notably, ICT enables the storage of data over different time and space conditions and the communication between people and machines with each other across time and space boundaries, the two technological capabilities that receive attention in the surveyed literature. This study furthers this line of inquiry in at least two aspects. First, it discloses the connections between these technological capabilities and interpretive time. Secondly, this study methodologically advances the surveyed literature which employs experiments or quasi-experiments by investigating groups in their natural group settings. Its findings on structural time complement the results from previous studies.

Moreover, this study explores newer time-related ICT features, enhanced by the recent advances in data processing and transmitting, network capabilities, and wireless infrastructure, like interactivity and connectivity. ICT-improved interactivity and connectivity have been analyzed conceptually (Jaureguiberry, 2000; Kakihara & Sorensen, 2002; Lyytinen & Yoo, 2002), and this study provides empirical support to some theoretical speculations. For example, the study explicitly shows how the use of ICT tools like IM and cell phone adds temporal ambiguity in temporal context and temporal flexibility in temporal enactment and, therefore, corroborates that improved interactivity and connectivity increase unpredictability in group members’ actions (Jaureguiberry, 2000).

This study goes beyond the existing discussions about ICT-enabled interactivity between group members by looking into interactivity between group members and ICT itself. ICT applications (e.g., the web, email, online search, and wiki) make information needed for work readily available without leaving desks. Besides, ICT applications (e.g., hypertext links) allow to read and to consume information based on varying and spontaneous, rather
than pre-determined, needs. Such interactivity with electronic applications is found to influence the experience of time by losing track of time and feeling time pass very quickly.

Additionally, recent technological developments enable or strengthen many other time-related ICT features that the study does not tap into. One of them is separation of interaction from place, accelerated particularly by mobile and ubiquitous computing. Removing the bindings between fixed places and information and communication resources, mobile and ubiquitous computing frees people from their reliance on specific physical sites to receive services and to interact with their colleagues (Lyytinen & Yoo, 2002). As people gain control over where they can do their work, the line between work and non-work place is no longer as clear as it used to be. Because place is intimately bounded with time, such decreased dependence on specific places for services and interactions has significant temporal implications. Future research can look into how the stretch of work across spatial boundaries influences the distinction between work and non-work time in groups, and how groups in turn, give meaning to the shifting temporal boundary between work and non-work.

Location independence also allows forms of time-space configurations other than group members being present spatially and temporally at the same time (Lee & Perry, 2001). For example, in the virtual team work environment, time-space paths of group members become more and more different from one another, and the regionalization of group members’ activities exhibits more complicated time-space combinations. The diversification and irregularity of group members’ time-space paths present research opportunities to explore how groups temporally coordinate to connect their complex time-space paths smoothly with one another’s.
Another area for future research is to examine the combined influences of different ICT capabilities. Groups in natural settings work with an expanding assembly of ICT artifacts. When multiple ICT artifacts are mobilized, different combinations of them may influence differently a wide range of temporal attributes, and generate additional emergent properties. This study examines a variety of ICT artifacts in natural group settings, but does not capture the complexity of how temporal attributes interact with each other as to affect temporal context and temporal enactment. Future research can investigate interactions between multiple technological artifacts that can support multiple aspects of group work to enrich the understanding of how a set of ICT capabilities together shape groups temporally.

6.3 Structural and Interpretive Time

As revealed in Chapter 2 Literature Survey, only a very small number of papers (e.g., Dennis, 1996; Kahai & Cooper, 2003; McLeod & Liker, 1992; Miranda & Saunders, 2003; Nunamaker et al., 1987; Smith & Vancek, 1990) explicitly look at how ICT itself impinges upon structural time. Earlier research notes that ICT capabilities change the temporal location, frequency, and speed of information access in groups. This research continues the examination of the impingement of ICT upon structural time, and augments empirically the impacts of ICT on structural time. Besides, the study explores the connections between temporal context and temporal enactment in ICT-mediated groups, an under-researched area in prior research. It strengthens the finding from earlier research (e.g., Cramton, 2001) that temporal context shapes temporal enactment. More interestingly, the study demonstrates that groups actively manage temporal context as shaped by ICT. By recognizing the reciprocal
relationships between temporal context and temporal enactment, the study enhances the understanding of the impingement of ICT on structural time.

The study answers the call for research on interpretive time, which has been largely neglected in the surveyed literature. It makes the discovery that ICT has a direct link to groups’ experience of time. Empirical data also illustrate how interpretive time is shaped by and shapes structural time (Barley, 1988) in ICT-mediated groups. While this empirical investigation sheds light on interpretive time in groups, interpretive time still remains quite elusive. Research is needed to enrich the understanding. Future research may wish to validate interpretive time’s links with ICT, temporal enactment, and group process and outcome, as revealed in this study. It could also explore connections other than those identified by the study. Interesting questions for future empirical research in this regard includes, but are not limited to, following. Does the use of ICT directly influence aspects of interpretive other than experience of time? If so, what are they? And how? Are there any aspects of interpretive time other than experience of time mediating the relationship between the use of ICT and group process and outcome? If so, what are they? And how?

6.4 Group Process and Outcome

The study catches a glimpse of how structural time and interpretive time affect group process and outcome. It strengthens several reviewed papers’ finding of the influence of temporal context on group process and outcome (Barkhi, 2001-2002; Dennis et al., 1996; Dennis et al., 1997-1998; Dennis et al., 1999; Grise & Gallupe, 1992-1993; Horten & Biolsi, 1993-1994; Horton et al., 1991-1992; Massey et al., 2003; Maznevski & Chudoba, 2000; Santanen et al., 2004). In addition, the relationship between interpretive time and group
process and outcome is revealed in the observation that the awareness of the past, which ICT tools help bring out, improves understanding of and communication between parties involved in ongoing work.

6.5 Moderating Variables

While earlier research finds temporal variations across work groups (Ballard & Seibold, 2000; Dubinskas, 1988b; Lawrence & Lorsch, 1967), this study captures group differences in the temporal impacts of ICT, as manifested in the disrupting effect of interruption and the experience of time. The characteristics, contents, and timing of interruptions and psychological feelings attached to specific types of work are found to moderate the relationship between interruptions and disruptions. The characteristics of tasks delivered electronically moderate the influence of the use of ICT on temporal boundary of work and non-work.

The study also detects individual variations in temporal enactment and temporal values, as shaped by the use of ICT. Members of the three groups are found to engage in different degrees of screening and blocking behavior – while some use electronic tools (e.g., emails, Calendar, cell phone) extensively to block out distractions, others do not. They also exhibit individual differences in evaluating increasing behavioral polychronicity brought by the use of ICT – while some think it positively, other evaluate it negatively. In sum, individual level characteristics moderate the influence of ICT on group members’ subjective behavior and perception of time.

So far, this study identifies several variables that moderate the influence of ICT on temporal enactment, experience of time and temporal value on the subjective and inter-
subjective levels. Moderating factors can be further investigated in at least two directions. First, future empirical research could solidify variables that moderate the influence of ICT on temporal enactment, experience of time and temporal value as revealed by this study. It could verify those moderators (e.g., the characteristics, contents, timing of tasks, psychological feelings to certain work, individual characteristics) identified by this study as well as investigate other moderating factors. Secondly, further research may wish to investigate moderating factors on relationships other than the influences of ICT on temporal enactment, experience of time and temporal values as identified by this study. For example, are there any variables moderating the influences of ICT on temporal context? In addition to the influence of ICT, future research could also look into factors that moderate the relationships between structural time and interpretive time, between structural time and group process and outcome, between interpretive time and group process and outcome, and between the interaction of structural and interpretive time and group process and outcome.

6.6 Multiplicity of Temporal Impacts

The empirical findings demonstrate the multiplicity of temporal impacts of ICT on groups (Failla & Bagnara, 1992). Such multiplicity is observed in a number of ways. First, different ICT applications may have different temporal impacts. For example, software applications like network monitoring tools used by network engineers enable super-imposing activities and influence temporal context, one sub-dimension of structural time. Database applications like TeamTrack used by programmers enhance the palpability of the past and affect the sense of time, one sub-dimension of interpretive time. Secondly, one ICT application may have various temporal impacts. For example, email contributes to
interruptions and disruptions and temporal ambiguity in temporal context. It also is utilized to make full use of dead time and waiting time and, therefore, affects temporal enactment. While some ICT applications like email influence different sub-dimensions of structural or interpretive time, other ICT applications impact both structural and interpretive time. For example, Calendar shapes the sense of time as it promotes the awareness of time associated with particular events and activities through the sense of seeing and helps cognitive configuration of time by supporting graphic presentations of temporal locations and durations of events and activities. Moreover, the impingement of Calendar is found in temporal enactment as it is used to block time. Thirdly, the temporal impacts of ICT may vary across groups. As discussed in above section 6.5 Moderating Variables, the temporal impacts of ICT on groups are moderated by some group variables such as task characteristics and features of interruptions.

6.7 Data Constraints

The empirical findings are constrained by several inadequacies in the data. The first data constraint is related to ICT tools that have been examined. ICT tools used by the three groups can be categorized into work tools and communication tools (see section 5.1.4 for information on this categorization). While communication tools (e.g., email, instant messaging, calendar, mobile phone) are pretty much the same in the three groups, work tools (e.g., ChangeMan, Cisco Work) exhibit variations across the three groups. The data from interviews and observations primarily focus on communication tools, and as a result, little is known about the temporal impacts of work tools, and their variances, if any, across groups. In addition, the data are collected mainly on several most commonly used communication
tools (e.g., email, Calendar, IM, and cell phone). Other less popular electronic communication tools (e.g., video conferencing, VOIP) have not been carefully examined. As such, the study may lose additional insights into the relationships of time and ICT in the three groups.

Secondly, the spatial movement data are too limited to generate significant findings. I did not capture much spatial movement in my observations of the programmers, network engineers and instructional technologists at work. This may be related to the fact that the programmers, network engineers and instructional technologists mainly work at their desk during the course of their work. The lack of spatial movement data does not support any meaningful analysis of the impact of ICT on the spatial experience of time.

Thirdly, the data do not tap into how ICT restrains time in groups. While the data support examining the enabling power of ICT – how ICT creates new temporal possibilities for groups, they are insufficient for analyzing the constraining effect of ICT – how ICT restricts temporal aspect of group work. Such inadequacy fails to generate useful recommendations as how to improve ICT for better support of group work.
CHAPTER 7
CONCLUSION

This chapter concludes the dissertation. I first present how the research contributes to
the knowledge about ICT-mediated groups. Next, I reflect on limitations in the theoretical
synthesis, literature survey and case study. Finally, I conclude by summarizing the
dissertation.

7.1 Contributions

Time has not been explored well enough in IS research, considering its fundamental
importance in organizations (Lee & Liebenau, 1999). This study, building upon prior IS
research on ICT-mediated groups, enriches the theoretical understanding of time in groups.
The conceptualization of time developed in this research provides a theoretical basis for
research on time in ICT-mediated groups. It stresses time as changeable and multiple and
makes the distinction between temporal context and temporal enactment. More importantly,
it acknowledges the internal and subjective aspects of time and underlines the importance of
experienced and interpreted time in group life. The conceptualization that time has both
structural and interpretive dimensions offers new research opportunities to capture the
complexity of time in ICT-mediated groups.

Secondly, the literature survey, building upon an extensive set of studies, provides a
systematic synthesis of how time has been studied in IS research on ICT-mediated groups. It
condenses various treatments of time into a comprehensive framework, identifies significant
weaknesses in the literature, and reveals some intriguing areas and questions for future research on ICT, time and group process and outcome.

Thirdly, the case study advances the empirical knowledge on temporal impacts of ICT on groups. While earlier experimental research studies time with the assumption that groups work only under one temporal condition (e.g., Gersick, 1988), this study looks into how groups cope with multiple temporal demands in their natural settings. Along with other time research on organizational groups (e.g., Perlow, 1999; Staudenmayer et al, 2002), this study provides a more realistic view of time in groups. More importantly, this study taps into the role of ICT in shaping temporal dynamics in groups. It strengthens the links between ICT and structural time by revealing other impacts of ICT on temporal context than those shown by earlier research (e.g., Barley, 1988; Lee, 1999). It also helps understand how the use of ICT affects the temporal behavioral of working (Lee & Sawyer, 2002) by showing the temporal enactment of groups in response to the shifts induced by ICT in the temporal context. Moreover, it finds new connections between ICT and interpretive time, between temporal context and temporal enactment, between interpretive time and structural time, and between interpretive time and group process and outcome. Additionally, it identifies factors that moderate the influence of ICT on structural time and interpretive time in groups.

7.2 Limitations

This dissertation research is not without limitations. The proposed temporal framework, although a rigorous synthesis of significant amount of literatures on time, still can miss significant temporal attributes. The theoretical framework, therefore, is comprehensive but may not be exhaustive. Subsequently, it may not help unearth all aspects
of time in groups. The literature survey samples eight major IS research outlets, but excludes research that meets the selection criteria but are appeared in other journals or conferences. Its results are thus not complete, though they reflect well the general status of the research on time in ICT-mediated groups. In terms of empirical data, a limitation stems from the nature of the three groups under study. The three groups are all responsible for maintaining IT infrastructure and the extensiveness of ICT usage at their work may not be typical for organizational groups. The findings may not directly replicable in other organizational groups, though the fundamental ideas and notions emerging from this study would still be valid in a board sense.

7.3 Concluding Remarks

This study starts off with three objectives. The first is the development of a theoretical framework to allow a systematic analysis and empirical investigation of time in ICT-mediated groups. The second objective is to provide a whole picture of how time has been studied in the IS literature on ICT-mediated groups. The third objective is to enhance empirical knowledge on the temporal impacts of ICT on groups.

I synthesize a large amount of literature from sociology, psychology, anthropology and organization studies and formulate a conceptualization of time. Next, I use it as an analytical scheme and conduct a comprehensive literature review on ICT-mediated group research over the past two decades. To address issues identified in the literature survey, I then carry out a case study on three groups of IT professionals. The case study sheds new light on the different contours of this difficult and complex subject of time in ICT-mediated groups.
It is my hope that ideas and research issues set forth in this research will stimulate further interest in time in ICT-mediated groups. Deeper appreciation of this topic can be of significant practical use as ICT is increasingly penetrating organization work. It can help understand the complexities involved and formulate guidelines how to implement the use of new technologies, and how to shape their designs under varying temporal and spatial circumstances.
Appendix A: Coding of 53 Papers Analyzed for Their Temporal Contents

Note: (1) The 53 papers that touched explicitly upon time were coded on “ICT Capability”, “Research Method”, “Temporal Contents”, and “Group Process and Content Related to Time”.
(2) There are 30, 9, 8, 4 and 2 papers in the category of “Changes in group properties over time”, “ICT features related to time and space”, “Group temporal condition”, “Group outcomes measured in time”, and “Group temporal enactment”, respectively.
(3) Papers are first grouped by category, and then are listed in alphabetical order by author(s)’ last name(s) within each category.

Changes in groups properties over time

<table>
<thead>
<tr>
<th>Paper</th>
<th>ICT Capabiity</th>
<th>Research Method</th>
<th>Temporal Contents</th>
<th>Group Process and Outcome Related to Temporal Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ahuja et al (2003)</td>
<td>Email</td>
<td>field study</td>
<td>(1) Two distant periods of time were used to minimize limitations and to raise confidence of findings.</td>
<td>Not found</td>
</tr>
<tr>
<td>Alavi et al. (1995)</td>
<td>Conferencing</td>
<td>field experiment</td>
<td>(1) Longitudinal study over 3 work sessions and an initial training session</td>
<td>(1) Face-to-face, local desktop videoconferencing and distant desktop videoconferencing groups were equally effective in terms of student knowledge acquisition, and equally satisfied with their learning process and outcomes, but the distant desktop videoconferencing groups were found to have higher level of critical thinking skills, be more committed and attracted to their groups by the end of last session.</td>
</tr>
<tr>
<td>Berdahl &amp; Craig (1996)</td>
<td>GSS</td>
<td>laboratory experiment</td>
<td>(1) Groups spanned over 7 weeks.</td>
<td>(1) CMC participation was perceived as more centralized than as FTF participation in groups’ first meetings, but as similar for the remaining six meetings.</td>
</tr>
<tr>
<td>Bouas &amp; Arrow (1996)</td>
<td>GSS</td>
<td>laboratory experiment</td>
<td>(1) Groups spanned over 7 weeks.</td>
<td>(1) In the original groups, group identity started high and declined for both FTF and CMC groups. In the reconfigured groups, developmental patterns differed from those of the original groups, and also differed by communication medium. Individual differences accounted for a substantial amount of variance in group identity across original and reconfigured groups.</td>
</tr>
<tr>
<td>Burke &amp; Chidambaram (1999)</td>
<td>GSS</td>
<td>laboratory experiment</td>
<td>(1) Groups spanned over 4 weeks.</td>
<td>(1) The perception of social presence and communication interface did not develop over time, but that of communication effectiveness did</td>
</tr>
<tr>
<td>Chidambaram (1996)</td>
<td>GSS</td>
<td>laboratory experiment</td>
<td>(1) Groups spanned over 4 weeks.</td>
<td>(1) Electronic groups’ attitudes developed over time from highly negative to somewhat positive, and group outcomes improved as well, though more slowly</td>
</tr>
<tr>
<td>Chidambaram et al. (1990-1991)</td>
<td>GSS</td>
<td>laboratory experiment</td>
<td>(1) Groups spanned over 4 weeks.</td>
<td>(1) Computer supported groups developed productive conflict management and group cohesion over time</td>
</tr>
<tr>
<td>Cunnings et al. (1996)</td>
<td>GSS</td>
<td>laboratory experiment</td>
<td>(1) Groups spanned over 7 weeks</td>
<td>(1) In the later weeks, CMC groups produced essays with higher integrative complexity than FTF groups.</td>
</tr>
<tr>
<td>Dennis &amp; Garfield (2003)</td>
<td>GSS</td>
<td>field study</td>
<td>(1) Groups spanned over 7 weeks.</td>
<td>(1) The leadership and work processes in the GSS teams were not consistent across teams and changed over the life of the project.</td>
</tr>
<tr>
<td>Easley et al. (2003)</td>
<td>Hybrid</td>
<td>field study</td>
<td>(1) Group spanned over 4 months.</td>
<td>(1) During the period of 4 months, collaborative system use intervened between teamwork quality and performance for tasks supported by the system but not for unsupported tasks.</td>
</tr>
<tr>
<td>Galegher &amp;</td>
<td>Email</td>
<td>laboratory</td>
<td>(1) Groups spanned over 2 weeks.</td>
<td>Not found</td>
</tr>
<tr>
<td>Authors</td>
<td>Study Type</td>
<td>Research Design</td>
<td>Duration</td>
<td>Findings</td>
</tr>
<tr>
<td>---------</td>
<td>------------</td>
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</tr>
<tr>
<td>Kraut (1994)</td>
<td>experiment</td>
<td>GSS laboratory experiment</td>
<td>(1) Group history</td>
<td>(1) Group history was related to group prior communication, which was found to be positively associated with accuracy of attribution of authorship of technically anonymous comments.</td>
</tr>
<tr>
<td>Hayne et al. (2003)</td>
<td>field study</td>
<td>Conferencing</td>
<td>(1) Teams spanned over 4 months.</td>
<td>(1) Although virtual teams had similar start-up conditions they evolved in different ways over time. These differences can be attributed to the different routine patterns of media use that the team members mutually enacted.</td>
</tr>
<tr>
<td>Huysman et al. (2003)</td>
<td>field study</td>
<td>Email</td>
<td>(1) Groups spanned over 8 weeks.</td>
<td>Not found</td>
</tr>
<tr>
<td>Jarvenpaa et al. (2004)</td>
<td>field study</td>
<td>Hybrid</td>
<td>(1) Groups spanned over 8 weeks.</td>
<td>(1) Sources of trust showed different effects on trust over time (e.g., the effect of perceived ability decreased over time, and the effect of propensity to trust remained strong over time). (2) Compared with low trust teams, high trust teams were explicit on time management.</td>
</tr>
<tr>
<td>Jarvenpaa &amp; Leidner (1999)</td>
<td>field study</td>
<td>Email</td>
<td>(1) Groups spanned over 6 weeks.</td>
<td>(1) Trust changed over time.</td>
</tr>
<tr>
<td>Jarvenpaa et al. (1998)</td>
<td>case study</td>
<td>Hybrid</td>
<td>(1) Groups spanned over 8 weeks.</td>
<td>Not found</td>
</tr>
<tr>
<td>Kayworth &amp; Leidner (2001-2002)</td>
<td>laboratory experiment</td>
<td>Hybrid</td>
<td>(1) Groups spanned over 5 weeks.</td>
<td>Not found</td>
</tr>
<tr>
<td>Lebie et al. (1996)</td>
<td>laboratory experiment</td>
<td>GSS</td>
<td>(1) Groups spanned over 7 weeks.</td>
<td>(1) There were no significant differences in the way CMC and FTF groups changed over time.</td>
</tr>
<tr>
<td>Majchrzak et al. (2000)</td>
<td>case study</td>
<td>Hybrid</td>
<td>(1) A group spanned over 10 months.</td>
<td>(1) The process of adaptation of technology changed over time.</td>
</tr>
<tr>
<td>Malhotra et al. (2001)</td>
<td>case study</td>
<td>Hybrid</td>
<td>(1) A group spanned over 10 months.</td>
<td>(1) Strategy-setting, technology use and work restructuring in the group changed over time.</td>
</tr>
<tr>
<td>Mennecke &amp; Valacich (1998)</td>
<td>laboratory experiment</td>
<td>GSS</td>
<td>(1) Group history</td>
<td>(1) Group history affected group information sharing, decision quality and satisfaction.</td>
</tr>
<tr>
<td>Orlikowski et al. (1995)</td>
<td>case study</td>
<td>Conferencing</td>
<td>(1) The group spanned over 15 months.</td>
<td>(1) Technology-use mediation promoted effective electronic communication both initially at the point of adoption, as well as over time as needs, preferences, experiences, and conditions changed.</td>
</tr>
<tr>
<td>Piccoli &amp; Ives (2003)</td>
<td>laboratory experiment</td>
<td>Hybrid</td>
<td>(1) Teams spanned over 36 days.</td>
<td>(1) Timing of reneging and incongruence-based incidents - when the final deadline neared, when attention of the project was at a peak - were most likely to be detected; reneging and incongruence might have the strongest impact on trust decline.</td>
</tr>
<tr>
<td>Potter &amp; Balthazard (2004)</td>
<td>laboratory experiment</td>
<td>GSS</td>
<td>(1) 30-minute experimental sessions</td>
<td>(1) There was a clear decay in the generation of ideas and high quality ideas as the brainstorming task proceeded.</td>
</tr>
<tr>
<td>Reinig &amp; Shin (2002)</td>
<td>laboratory experiment</td>
<td>GSS</td>
<td>(1) Longitudinal research design using two classes of undergraduate students in two consecutive semesters</td>
<td>Not found</td>
</tr>
<tr>
<td>Rhoades &amp; O'Connor (1996)</td>
<td>laboratory experiment</td>
<td>GSS</td>
<td>(1) Groups spanned over 7 weeks.</td>
<td>Not found</td>
</tr>
<tr>
<td>Walther (1995)</td>
<td>laboratory experiment</td>
<td>Conferencing</td>
<td>(1) Groups spanned over 5 weeks.</td>
<td>(1) Electronic groups achieved over time more positive outcomes in several dimensions of interpersonal communication than did face-to-face groups, while there were no differences between groups in other dimensions.</td>
</tr>
<tr>
<td>Yates et al. (1999)</td>
<td>case study</td>
<td>Conferencing</td>
<td>(1) Groups spanned over 15 months.</td>
<td>(1) Technology-use mediation shaped the enactment of genres in the R&amp;D project over time.</td>
</tr>
<tr>
<td>Yoo &amp; Alavi (1999)</td>
<td>laboratory experiment</td>
<td>Conferencing</td>
<td>(1) Group history</td>
<td>(1) Group history was related to group cohesion.</td>
</tr>
<tr>
<td>Paper</td>
<td>ICT Capability</td>
<td>Research Method</td>
<td>Temporal Contents</td>
<td>Group Process and Outcome Related to Temporal Contents</td>
</tr>
<tr>
<td>---------------------------</td>
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<td>-------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Dennis (1996)</td>
<td>GSS</td>
<td>laboratory experiment</td>
<td>(1) The parallelism function. (2) Delayed feedback</td>
<td>(1) Delayed feedback in the GSS groups reduced the credibility of new information.</td>
</tr>
<tr>
<td>Hiltz et al. (1991)</td>
<td>Conferencing</td>
<td>laboratory experiment</td>
<td>(1) Conference systems supported both synchronous and asynchronous communication.</td>
<td>In the condition of synchronous computer conferences (1) designated leadership improved levels of agreement; (2) in the absence of a leader, statistical feedback improved level of agreement slightly; (3) characteristics of the individuals and groups were also associated with variations in outcomes.</td>
</tr>
<tr>
<td>Kahai &amp; Cooper (2003)</td>
<td>Hybrid</td>
<td>laboratory experiment</td>
<td>(1) Feedback immediacy. (2) Media speed of electronic media</td>
<td>(1) Feedback immediacy, together with cue multiplicity, of electronic media negatively affected the groups’ social perception, message clarity and evaluation of others, which, in turn, decreased the groups’ decision quality.</td>
</tr>
<tr>
<td>McLeod &amp; Liker (1992)</td>
<td>GSS</td>
<td>laboratory experiment</td>
<td>(1) Parallel communication</td>
<td>(1) Parallel processing led to information overload, and negatively affected reciprocity in group communication.</td>
</tr>
<tr>
<td>Miranda &amp; Saunders (2003)</td>
<td>GSS</td>
<td>laboratory experiment</td>
<td>(1) Simultaneity (concurrent information sharing). (2) The study examined information sharing in decision making under time constraints.</td>
<td>(1) Simultaneity contributed to information overload, and negatively affected reciprocity.</td>
</tr>
<tr>
<td>Nunamaker et al. (1991)</td>
<td>GSS</td>
<td>laboratory experiment &amp; field study</td>
<td>(1) Parallel communication</td>
<td>(1) Parallel communication freed brainstorm participants from turn-taking.</td>
</tr>
<tr>
<td>Nunamaker et al. (1987)</td>
<td>GSS</td>
<td>field study</td>
<td>(1) Parallel processing</td>
<td>Not found</td>
</tr>
<tr>
<td>Ruhleder &amp; Jordan (2001)</td>
<td>Conferencing</td>
<td>field study</td>
<td>(1) Delay in electronic communication</td>
<td>(1) Delay impacted the ability of conversational participants to create shared meaning by engendering some kind of trouble, which disrupted the turn-taking system and made the participants unable to identify the true source of the trouble.</td>
</tr>
<tr>
<td>Smith &amp; Vancek (1990)</td>
<td>Conferencing</td>
<td>field experiment</td>
<td>(1) Asynchronous vs. synchronous communication</td>
<td>(1) Asynchronous computer conferencing groups shared less information, were less comprehensive in considering all aspects of the decision-making task, and made less progress toward the perceived decision goal, and were significantly less effective than face-to-face groups in solving problem.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group temporal condition</th>
<th>Paper</th>
<th>ICT Capability</th>
<th>Research Method</th>
<th>Temporal Contents</th>
<th>Group Process and Outcome Related to Temporal Contents</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Dennis et al.</td>
<td>GSS</td>
<td>laboratory experiment</td>
<td>(1) Groups worked under time constraint.</td>
<td>(1) Time constraints increased the rate of idea generation.</td>
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<tr>
<td></td>
<td>(1996)</td>
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<td></td>
<td>Dennis et al.</td>
<td>GSS</td>
<td>laboratory experiment</td>
<td>(1) Controlled the length of time period to brainstorm</td>
<td>(1) Time structure did not affect the number and quality of ideas generated electronically in groups.</td>
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<td></td>
<td>(1999)</td>
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<td></td>
<td>Grise &amp; Gallupe</td>
<td>GSS</td>
<td>laboratory experiment</td>
<td>(1) GSS regulator set the pace at which group members moved from one batch to the next.</td>
<td>(1) When pace was set, more ideas were organized, more categories were created, and more ideas were repeated. But group members also found using the regulator tool to be harder, since the mental</td>
</tr>
</tbody>
</table>
(1992-1993) workload was higher.  

Majchrzak et al. (2005)  
Hybrid field study  
(1) Distributed team members in different time zones  
Not Found  

Massey et al. (2003)  
Hybrid laboratory experiment  
(1) Teams spanned over 15 days. (2) Virtual teams were in different time zones. (3) Temporal coordination mechanism that structured group interactions  
(1) Temporal coordination mechanisms improved group performance under deadline.  

Santanen et al. (2004)  
GSS laboratory experiment  
(1) In treatment condition, a prompt was given every 2 minutes for 40 minutes.  
(1) Groups using directed brainstorming generated more solutions with higher creativity ratings, produced solutions with higher average creativity ratings, and produced higher concentrations of creative solutions than did groups using free-brainstorming.  

Sarker & Sahay (2004)  
GSS field study  
(1) Teams spanned over 14-week. (2) Different rhythms (different physiological cycles and social activity schedules) in groups in different time zones. (3) Different local (clock) time in teams. (4) There were significant time differences among virtual team members. (5) Unexpected delays in replying by remote members  
(1) Lack of vigilance in the difference in group rhythms led to unattended synchronous meetings or missed deadlines, and this, in turn, got interpreted as a lack of seriousness or commitment. (2) Significant time differences among virtual team members made it difficult to work in parallel. Members experienced unproductive waits before other sides responded to their questions. (3) Silence of unexpected delays in replying by remote members tended to be interpreted negatively, with attributions of incompetence and a lack of commitment. This issue was serious enough to occasion a breakdown of even functional relationships. (4) Participants in Internet-mediated communications experienced a temporal disordering in the recipient of messages - team members need to sort through and make sense of messages originating in different local times and address concerns that were either past or future for the other side. (5) During "real time" synchronous chats, it became difficult to causally link a response with a question or a comment due to temporal and topical shift. (6) Team members took advantage of the time difference between different locations to extend the usual daytime working. (7) Team members instituted norms relating to teamwork to manage uncertainty arising from temporal distance. (8) Team members functioned in a polychronic manner to handle the problems in the communication due to delays in typing, delays in message transfer across the Atlantic and topic shift).  

Souren et al. (2004-2005)  
GSS laboratory experiment  
(1) Time differences between geographically dispersed virtual teams  
Not found  

<table>
<thead>
<tr>
<th><strong>Group outcomes measured in time</strong></th>
<th><strong>Paper</strong></th>
<th><strong>ICI Capability</strong></th>
<th><strong>Research Method</strong></th>
<th><strong>Temporal Contents</strong></th>
<th><strong>Group Process and Outcome Related to Temporal Contents</strong></th>
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<tr>
<td>Barkhi (2001-2002)</td>
<td>GSS</td>
<td>laboratory experiment</td>
<td>(1) Decision time</td>
<td>(1) Compared with non-GDSS groups, GDSS groups were less efficient with respect to the time and number of messages to converge to a final solution.</td>
<td></td>
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<tr>
<td>Dennis et al. (1997-1998)</td>
<td>GSS</td>
<td>laboratory experiment</td>
<td>(1) Decision time</td>
<td>(1) When there was a distinct majority/minority, groups took no more time to reach decisions when they used a GSS than when they did not use a GSS. (2) When there was no majority preference, GSS groups took more time to reach decision than non-GSS groups.</td>
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<tr>
<td>Horton &amp; Biolsi (1993-1994)</td>
<td>GSS</td>
<td>laboratory experiment</td>
<td>(1) Time to complete a task</td>
<td>(1) Well coordinated groups spent less time on completing a writing task than poorly coordinated groups in a computer meeting supported environment.</td>
<td></td>
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<tr>
<td>Horton et al. (1991-1992)</td>
<td>GSS</td>
<td>laboratory experiment</td>
<td>(1) Time to complete a task</td>
<td>(1) The technology altered the way the groups spent their time on different activities in the writing process. (2) The technology did not change the time spent on completing the task (i.e., no impact on the groups' efficiency).</td>
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<tr>
<td>Paper</td>
<td>ICT Capability</td>
<td>Research Method</td>
<td>Temporal Contents</td>
<td>Group Process and Outcome Related to Temporal Contents</td>
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<tr>
<td>Cramton (2001)</td>
<td>Hybrid</td>
<td>Field study</td>
<td>(1) Teams spanned over 7 weeks. (2) Frequencies of team members accessing information via ICT were different. (3) Speed of electronic transmission differed across team members. (4) Rate of communication differed in different part of teams. (5) Feedback lags existed in team communication.</td>
<td>(1) Different frequencies and media speed in accessing information led to team members communicating at different rates, and lengthening of feedback cycles within teams. (2) Different rates of communicating eventually contributed to the failure of mutual knowledge in dispersed group collaboration. (3) Feedback lags amplified the problems of information exchange and interpretation in teams.</td>
<td></td>
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<tr>
<td>Maznevski &amp; Chudoba (2000)</td>
<td>Hybrid</td>
<td>field study</td>
<td>(1) Teams spanned over 21 months. (2) Rhythm in team interactions</td>
<td>(1) Effective global virtual teams exhibited rhythms in teams' interactions.</td>
<td></td>
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</table>
Appendix B: Interview Guide

A: General information about interviewees

• What is job/position? How long have you been on this job/position?
• Can you describe your typical work?
• What percentage of your work is group work?

B: ICT artifacts used in group project

• What are the ICT artifacts do you use in your work?
• How often do you use _____ (name of the ICT artifact, e.g., instant messaging)?
• Can you give an example of using _____ in your recent work?

(Interviewee is probed on the example, which he/she gives, of the use of ICT in the recent group project.)

C: Use, perception and experience of time, group process and outcome

• What are the temporal features, you think, that ____ has?
• How do you use these temporal features of ____ in your work?
• How do these temporal features of ____ affect the ways you do your work, interact with other group members?
• How do you and the group as a whole use these temporal features of ____ to organize the activities and tasks of the group project?
• How do these temporal features of ____ affect your and the group’s perception and senses of time?
• How do these temporal features of ____ affect your and the group’s spatial experience?
• How do your use, perception and experience of time, resulted from the use of ____, impact the group and the group project?
REFERENCE


