Time & Society

Conceptualizing time, space, and computing for work and organizing

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ABSTRACT. Through this article we draw on concepts of time and space to help us theorize on the uses of information and communication technologies in work and for organizing. We do so because many of the contemporary discussions regarding work and organization are too often, and too often implicitly, drawing on rudimentary understandings of these concepts. Our focus here is to advance beyond simplistic articulations and to provide a more conceptually sound approach to address time, space and the uses of information and communication technologies in work. We do this focusing on temporal and spatial relations as a means to depict time and space at work. We characterize work as varying by two characteristics: the degree of interaction and the level of individual autonomy. We then develop a functional view of information and communication technologies relative to their uses for production, control, coordination, access and enjoyment. We conclude by integrating these concepts into an initial framework which allows us to theorize that new forms of work are moving towards four distinct forms of organizing. We further argue that each of these four forms has particular spatial and temporal characteristics that have distinct and different needs for information and communication technologies. KEY WORDS • information and communication technology • organization bull; space • time • work

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1. Introduction

Through this article we theorize on the ways time, space to and uses of information and communication technologies (ICT) provide a means to characterize how work is being done. Like Weick (1995), we see theorizing as a scholarly process that should become a more visible form of discourse in intellectual communities. Through the theorizing developed in this article we make two contributions. First, we advance a more detailed conceptualization of time and space relative to the uses of ICT in work. Second, we explicitly conceptualize the roles of ICT for work relative to time and space (e.g. Orlikowski and Iacono, 2001; Leonardi and Barley, 2008).

Our motivation to pursue this theorizing arises from our observation that, to date, too much of the scholarly and public discourse on new forms of work and organizing have de-problematized time, space and the uses of ICT.[1] Articles in both the popular press and the academic literature trumpet the potential for the use of ICT to save time, speed up work, and allow people to collaborate and communicate with others located in different places and across different time zones (e.g. Friedman, 2005; Orlikowski and Scott, 2008).

Such techno-enthusiasm is fuelled in part by possibilities that might arise from the increased connectivity that the internet embodies. We are encouraged to think of work and organizations in new ways and with new metaphors. People imagine and write on techno-social concepts such as the emerging 'virtual organizations', 'flat worlds', the possibility of having 'virtual offices', and the ability to get work done by 'virtual teams' whose work patterns 'follow the sun' and 'span the globe'. Exactly how this will occur is less often discussed and too rarely with any evidence or rigor.[2] Instead, the scholarly literature on ICT too often makes claims such as 'I(C)T enables us to overcome temporal and spatial constraints'.[3] Often the means to realize these new forms of work and working amount to little more than 'doing things faster' and 'having to work together with people located in different places'.

More broadly, we see the current discourse on time and space is dominated by two extremes. As noted, one extreme (the mundane view) is to take time and space as given: there is no need to study time or space because these are, well, just there. The second dominant discourse on time and space occurs at a significant level of abstraction (the broad view). This level of conceptual abstraction makes it difficult to develop empirical studies of time and space. Such broad generalizations are used by macro-social theorists like Adam (1995) and Giddens (1984). For example, 'timeless time' is mentioned as the dominant temporality of our contemporary society by Castells (1996: 464). This is time which 'occurs when the characteristics of a given context, namely, the informational paradigm and the network society, induce systemic perturbation in the sequential order of phenomena performed in that context'. Castells argues that the occurrences of phe-

nomena are compressed for instantaneity, and discontinuity is randomly introduced in the sequence. Uses of ICT can help to disorder the sequence of events and make them simultaneous. Framed this way time seems to dissolve as the past, present and future become blurred together through using ICT. This broad discourse too often fails to influence, or be reflected in, empirical studies of time (and space), particularly with regard to the uses and roles of ICT.

Our goal in writing this article is to get beyond the taken-for-granted nature of time and space in relation to using ICT. To help shift the discourse we raise here issues with the mutually constituted nature of time and space. Many studies exclusively focus on time (Lee, 1999; Avital, 2000; Lee and Liebenau, 2000a, 2000b; Lee and Whitley, 2002; Sawyer and Southwick, 2002; Saunders et al., 2004; Prasopoulou et al., 2006). However, time and space cannot be separated in theory (Domingues, 1995; Rämö, 2004a) and in everyday experience (Hall, 1983), particularly when ICT are involved (Olson and Olson, 2000; Dourish, 2004; Reddy et al., 2006). For example, tele-working transforms not only the temporal patterns of work, but also patterns of space use by individual workers and organizations. Similarly concepts such as 'homeworking', distributed work, distant learning and mobile work are about both time and space. The question of 'where to work' raises by nature the questions like 'when to work', 'how long to work' and 'how to organize one's work time'.

To develop our theorizing, we present this article in four more sections. In the next section, we present our approach to theorizing. In Section 3 we outline the nature of time and space in social organization and the roles that the computer (or ICT) plays as a defining technology. In Section 4 we introduce useful concepts of time and space for our theoretical endeavour after reviewing relevant studies. In Section 5, we unite the temporal and spatial frames. Doing this provides a means to explore and theorize possible uses of ICT in work and social organization. In the final section we summarize the article and make suggestions for further research.

2. Our Approach: Theorizing

Theorizing is an alternative approach to theory development that focuses attention to the selection of core concepts and justifying their presence (Weick, 1995). Theorizing differs from both the empirically based work focusing on theory testing and the primarily case-study-based approaches to theory elaboration that are the common approaches to developing theory in many of the intellectual communities where the socio-technical nature of ICT is considered.[4]

For two reasons our focus builds on what Merton (1968) has called the 'mid-range' approach to theoretical development. The first reason is, as noted, to shift the discourse away from the mundane and broad views that dominate current

discussions of time and space in relation to ICT as used for working. The second reason for focusing on mid-range theory development is related to the question of how to study time and space in relation to ICT: how to access them at the empirical level (e.g. Shen et al., 2004).

Merton (1968: 39) articulates that mid-range theories 'lie between the minor but necessary working hypotheses that evolve in abundance during day-to-day research and the all-inclusive systematic efforts to develop a unified theory that will explain all the observed uniformities of social behaviour, social organisation and social change'. Merton noted that mid-range social theories were more likely to be connected to the reality being observed. This, in turn, could be linked both to larger theories and to the policy and activity recommendation for professionals in practice. We see mid-range theories as vehicles to generalize, while also providing a means to engage practice and connect to macro-scale theory (e.g. Balmer and Wyatt, 2005).

To help us theorize on the role of ICT relative to time and space in work, we build from relevant material found in the literatures on work and organizations; information systems; and computer-supported-cooperative work (CSCW). For example, and building on Barley and Kunda's (2001) argument, we draw from the literature on work regarding the design, functions and roles of space relative to organizations. From the information systems literature we draw on that which helps us to conceptualize the ICT artefact (e.g. Orlikowski and Iacono, 2001). From the CSCW literature we draw on that which engages the design and uses of time and space (Hollan and Stornetta, 1992; Bowers, 1995; Harrison and Dourish, 1996; Crabtree et al., 2005). In doing these things we connect the higher-level discourse on time/space to a level where we can study impacts of ICT on time and space in organizations (cf. Orlikowski, 1996; Perlow, 1999; Perlow et al., 2004).

3. Conceptualizing ICT in Work and Organizing

In this section, we examine the nature of ICT by building on Bolter's (1984) concept of a 'defining technology'. In the second part of this section we develop a functional conceptualization to ICT. Together, this provides us the conceptual bases to articulate the uses of ICT as both core to organizing and to be more explicit about the ways in which using ICT are shaping the nature of organizing for and doing work.

3.1. ICT as a defining technology[5]

We begin by characterizing the computer (or, more broadly ICT) as a 'defining technology'. Bolter's (1984) argument is that certain technologies occupy

a special place in the periods when they are developed and used, and we claim here that the uses of ICT define our age in the same way that the printing press, clock and steam engine defined the ages in which they emerged. Take, for example, the roles of the clock and the steam engine in Western Europe in the 17th and 19th centuries respectively. These technologies not only changed the way people engaged each other and the world in a material sense, but they also provided new ways by which people viewed and understood both their physical and metaphysical worlds. In the 17th century, clockwork became the model of the universe, illustrating the movements of heavenly bodies. Similarly, the steam engine became the metaphor for the universe in the 19th century (Bolter, 1984).

More directly, with the appearance of the mechanical clock, time was no longer viewed as something associated with human activities and natural rhythms, but became 'a function of pure mechanism' (Rifkin, 1987: 85). This way the clock 'dissociated time from human events' (Mumford, 1934) and 'human events from nature' (Landes, 1983). By enabling people to move faster than the sun, the steam engine also changed the notions of time and space. The steam engine, in turn, removed the boundaries that day and night (and the presence and absence of free or cheap light) enforced, making time more pliable and illuminating space in new ways.

In the same way that the clock and the steam engine redefined their age, the presence and uses of ICT are helping redefine ours. The take-up and uses of ICT are both changing our material existence and affecting the way we view the world (e.g. Dutton, 2005). For example, the computer is often used as a metaphor for the human mind or brain in notions like the input and output, and even the hardware and software of the brain (Bolter, 1984). As a defining technology, the computer affects temporal and spatial aspects of individuals, organizations and society on the one hand (for time, see Lee and Whitley, 2002; for space, Lucas, 2001), and the way people view time and space, on the other. It is widely held that time and space are compressed due to the internet and other advanced ICT. Ubiquitous and pervasive technologies are said to 'affect the way we experience the spaces we inhabit and our sense of physical presence in a locale' (Ciolfi, 2004: 37). Simply, computing is 'the contemporary analogue of the clocks' (Bolter, 1984: 10).

3.2. The functions of ICT

We further characterize the ways in which using ICT helps to define our age by depicting these uses as pursuing one or more of five functions: production, control, access, coordination and enjoyment (Taylor, 1982, 1986; Henderson and Cooprider, 1990; Orlikowski and Iacono, 2001; Sawyer and Tapia, 2003). That is, we conceptualize ICTs as both a defining concept and a purposeful tool. This

functional view stands as an alternative to structural or agentic conceptualizations of ICT. The structural conceptualization of ICT is often developed in sociological analyses of computing and is embodied in Barley's (1986) aphorism that computing provides an occasion to structure. Conceptualizations of ICT as having agency are often found in the literatures of management, economics and computer science. In these conceptualizations, the actions of ICT use pursue outcomes of value or change. A functional view conceptualizes ICT as a means to pursue particular actions, focusing more on the goals and not on the relations between these goals, uses and outcomes (e. g. Taylor, 1986; Henderson and Cooprider, 1990). Seen this way, functional conceptualizations of ICT use help to unpack the black box of use by focusing analytic attention to the ways in which particular technological features are used to achieve particular goals. This shifts the attention from describing what is provided (e.g. a list of features that your word processor might provide) towards what gets done with the technology (e.g. a description of uses to write, edit and format digital documents).

Functional approaches to conceptualizing ICT emphasize that computing is embedded in a web of social and organizational relations (e.g. Kling and Scacchi, 1982). This is also an example of the ensemble approach that Orlikowski and Iacono (2001) highlight. Functional approaches are situated in use and focus on use, moving away from descriptions of features or more general dichotomies such as use/non-use simplifications. As Henderson and Cooprider (1990) note, rooted in their study of computer-aided software engineering tools, a functional model differentiates uses in terms of control, production or coordination activities.

From a functional perspective, ICT can be, and often are, used to support the production of work (such as CASE tools, word processors and numerically controlled robotic assembly machines). Examples of ICT functioning for control are access and security routines, statistical analysis, and real-time and exception reporting (such as the panopticon discussed in Zuboff (1998)). Moreover, it is common that ICT may function as both production and control technologies (the five functions are not mutually exclusive). Shared calendars, electronic mail and mobile phones are examples of ICT functioning as coordination technologies, while search engines, online databases, and data mining techniques show ICT as functioning as access technologies. Relative to enjoying the uses of ICT, the issues is rarely considered in studies of organizational and work-based uses of ICT, though the increase in digital music, video, and online games suggests that this is a significant role (and rapidly expanding area) for computing in general and ICT in particular.

Conceptualizing ICT in functional terms allows for characterizations of any use to have more than one functional goal. For example, it may be more enjoyable to access information via Google than via a library's online access system; using to email (coordination) requires passwords and user identification (con-

trol), and writing with a word processer may be both production (doing work) and control (writing about ways in which people can access certain things). Functions may be combined (they are not orthogonal) and often the value of a particular ICT increases when it allows for multiple functions.

3.3. Time and space

To help us better theorize time and space in relation to ICT in work and organizing, in this section we first develop the concepts of time and space as social, building from current and more objective conceptualizations of these concepts. We then turn to developing temporal modes of work and the actor, and spatial types relative to work patterns.

3.3.1. The social perspective on time and space

We begin by noting simply that time is a fundamental dimension of human existence. Social activities such as meetings, personal work, or organizational governance take place within a time frame agreed upon among participants. Simply, 'shared concepts of and ways of mutual interaction in time are essential to social order and to the survival of any organization' (Starkey, 1988: 100).

Too often, however, organizational time is conceived solely as a linear measurement of chronology: hours, minutes, days and quarters (Macey, 1989). We know that time is more complex than a linear measure would suggest. Time has properties such as punctuality, duration, when, sequence, deadline, cycle, rhythm, and speed. These properties differ from time and are concerned with norms, rules and conventions. To represent both, we use 'temporality'. Temporality is the concept used to explain what time means. Temporality is depicted, for example, when we assess that things 'take too long' or 'move too fast'. Temporality helps us to explain to others, and for others to make sense, that one minute of time in a tender embrace with a loved one is experienced as 'shorter' than one minute of time with you stuck in an elevator.

Temporality is concerned with conventions that govern the way in which time is organized (Stamper, 1973; Hall, 1983). Hassard (1996) insists that temporal structuring is at the heart of social organization, and that when organizations are designed or changed, temporal factors should be of primary concern. Managers might proactively facilitate organizational change using time by, for example, creating rhythm-changing events that break the expected temporal flow of work such as meeting-free Fridays or blocking email access for certain periods each day to reduce distractions (Staudenmayer et al., 2002). A company can use changes in time as a catalyst for organizational change. For example, Lee and Lee (2008) document how a company, by changing office hours from 9 am to 6 pm to 7 am to 4 pm, created a sense of crisis for change among its employees and in turn led to organizational change. The development of temporal rules,

norms and implicit awareness of how to assign time a meaning is a social activity, and one that differs across social organizations.

In much the same way as time is social, space[6] – and for our interests here we mean space in social organizations – is also socially developed. Space can be seen as a measure of location, and in this conception, it is intimately tied to time as time is the fourth coordinate, as in an expression like 'I am here now'. Moreover, the meaning of 'spatial' implies social relations.[7] Foucault (1979) uses the notion of 'panopticon' to explain how power relations are materialized in space and control is embedded in space design. It is also an often used approach in architecture to interpret buildings, their types and meanings in terms of social relations like power and order (Marcus, 1993). Power is a highly visible social relation in modern organizations and reveals itself in spatial arrangements. For example, a senior manager normally has a larger room than does a middle manager, who in turn has more space than her subordinates. Higher-status members of an organization also typically have more control over space than those in lower positions. That is, they have more and better territory and their territory is better protected than that of lower-status people (Fisher, 1993).

The concept of territoriality is strongly related to power and politics in organizations (Brown et al., 2005). Brown and colleagues argue that the territoriality of physical space in organizations has both positive and negative consequences. While it may lead to increased commitment by giving a sense of belongingness and reduce conflict by clarifying and simplifying social interactions, it can make employees self-focused and isolated. The notion of territory or its absence is also seen important in new flexible office environment such as sharing desks (or 'hotdesking') (Skyrme, 1994). Therefore Brown et al. suggest that when physical space is designed and arranged in organizations, and thereby employees' territories are threatened or lost, potential loss of employee commitment and increase in conflict need to be considered. As managerial authority and identity are embedded in physical proximity (Perin, 1991 from Halford, 2005), space and built structures have both functional and symbolic relationships to social organization (Baldry, 1997).

3.3.2. Temporal modes of work and the actor

At the core of our theorizing is that work is done in time: it is a temporal act, done by actors. Barley (1988), Lee (1999) and Nandhukumar (2002) provide examples of detailed enquiry in which the changes in temporality of work are due to ICT. Barley found that the new computer-based equipment changed the temporal rhythm of work, which in turn reduced the conflict in social relations. Lee showed that the presence and uses of a new information system transformed the temporal profiles of work and created a temporal symmetry between work groups interacting with one another. In a software development organization,

Nandhukumar identified the increasingly and temporally complex nature of software development work.

These studies illustrate that using ICT can alter the ways in which time is structured in work. One of the aspects of structuring time commonly identified in these studies is the distinction between polychronicity and monochronicity (Hall, 1983). Individuals working polychronically place less value on temporal order, accept events as they arise and are likely to engage in multiple activities simultaneously. In contrast, people working monochronically seek to structure activities and plan for events by allocating specific slots of time to each event's occurrence (Barley, 1988).

Monochronicity is well suited to the development, use and management of large systems (Schein, 1992). As such, most organizations take for granted that monochronicy should be the primary (if not the only) way to organize for work. For example the idea of a 'business process' is conceived as work being made sequential and temporally ordered (Lee, 1999). Conversely, polychronic time is considered to be more effective in building relationships and when solving complex problems. It is therefore regarded as more suitable in the developmental stages of an organization, for smaller systems and for organizations where one gifted person is the central point of coordination. When ICT are embedded into work processes, they may disrupt monochronic temporal order by shifting the ways in which people structure their work patterns to be more polychronic (Lee and Liebenau, 2000a). That is, using ICT for example, mobile phones, messaging and file transfer/sharing, enables people to involve themselves simultaneously in several tasks that are located at different places.

We further distinguish between two closely connected aspects of work to which discussions about monochronic and polychronic times can be meaningfully applied. The first aspect of work relates to the temporal nature of tasks and events. We call this the 'temporal mode of work'. While some events take place in an unexpected temporal way, that is, irregularly, sporadically, unevenly and not following a fixed schedule (polychronic), others come in an organized temporal way, regularly, following the predetermined, or at least predictable, sequence (monochronic).

The second aspect of work relates to how workers organize their time to deal with tasks and events. This is concerned with ways of a person's working, and we call it the 'temporal mode of the actor'. A polychronic approach to working is when people deal with tasks and events spontaneously as they arise and may perform several things in any order during a given period of time whether they occur regularly or not. At other times, they may deal with events regularly at specified times and conduct one thing at a time, designating some slots of time for specific tasks. This is monochronic. Moreover, while the temporal mode of work is concerned with the structure of work, the temporal mode of the actor is

		Temporal mode of work (the structure of work)	
		Monochronic	*Polychronic*
Temporal mode of the actor (process of working)	*Monochronic*	Traditional factory work	Call centers and help desks
	Polychronic	Medical clinics	Virtual work environments

FIGURE 1
Temporal modes of work and the actor

concerned with the process of working. Figure 1 shows the matrix formed by crossing the temporal modes of work and actor.

An example of the monochronic mode of work and the temporal mode of the actor being monochromic is traditional factory work. The work is often characterized by a set of events which need to be done in a predetermined sequence at specified points of time. And, workers operate monochronically: pre-allocating a time slot for each task. That is, they make or adhere to a pre-made schedule. Notably, this has been the dominant approach to developing software (e.g. Humphrey, 1989).

In a medical clinic with several rooms, patients are scheduled (monochronic) into the same time slot. Within that time slot, doctors and nurses in the clinic manage to meet and treat these patients by switching among rooms (polychromic). The temporal mode of the actor is (often aggressively) polychromic, though the schedule is following a monochromic temporal mode of work.

It may be that the work is polychromic, but the temporal mode of the actor is monochronic. For example, in call centres calls come in a polychromic manner. But, they are scheduled so that each operator gets a linear sequence of calls. This means the temporal mode of the actor is monochromic, as work (the call) is allocated to each operator sequentially, even though the temporal mode of work is polychronic. More broadly most dispatch-oriented work (policing, emergency response) shares these characteristics that the actors pursue the work sequentially even though the work does not occur this way.

When workers deal with tasks spontaneously as they arise and may perform several tasks at a time, they are acting polychronically. In this kind of work tasks are expected to be completed in a timely manner without a separate coordinating arrangement unless there is too much work loaded on each worker. We call this a virtual work environment and in doing so highlight that distributed work arrangements, virtual team work, and many aspects of virtual organizations are reflected in this cell. Virtual work environments are busy places, with

temporal disruptions and task-completion delays embedded in their work practices (e.g. Rennecker and Godwin, 2005).

3.3.3. Spatial types and work patterns

The relationships of work and organizing with space can be considered from both work governance and work design perspectives. From the governance perspective, spatial issues arise relative to managing distant employees and coordinating teamwork when members are distributed across time and space. Many technologists, leaders and managers often evoke increased uses of ICT to bridge these distant spaces and to better support and enable distributed work. For this reason, work space design has become increasingly important to organizations. However, much of the past work in this area has been guided by heuristics more than by empirics or theory (Harmon-Vaughan, 1995; Heath et al., 1996; Stallworth and Kleiner, 1996). The more recent work makes a departure from this heuristic approach enlightened by the approaches of social sciences (e.g. Becker, 2004; Halford, 2005).

Halford (2005) examines the spatial reconfiguration of work, management and organization enabled by ICTs. She suggests a new term, 'hybrid workspace', which is created by the increasing number of workers who work both from home and from organizational workplace mediated by access to and uses of ICT. It is a consequence of 'a hollowing out of the fixed organisational workspace and a polarisation towards the *relocation* of work into domestic space on the one hand and the *dislocation* of work into cyberspace on the other' (p. 19). In developing this, Halford argues well for a general trend in workspace uses, but does not examine changes in physical office space and their impacts other than saying 'hollowing out'. And, while there are a few studies on the roles that space plays (e.g. Schultze and Boland, 2000) and on space in relation to time (e.g. Sahay, 1998; *Organization*, 2004; Sarker and Sahay, 2004; Halford and Leonard, 2005), they have little to do with physical space.

The issue of office space or layout in relation to electronic equipment appeared in management literature as early as in mid 1980s (Stone and Luchetti, 1985). It has remained under-explored since. Baldry (1997, 1999) is one exception in that he emphasized the built working environment or office space, which had been ignored in social sciences, as 'the final frontier' of the analysis of work organizations. Boland and Citurs's (2001) work showcases this analysis as they examine how the work of software development reshapes physical space as well as virtual space by selectively opening and closing the spaces in which developers interact, which leads to them experiencing different time paces.

Recently, Becker (2004) has suggested a strategic approach to workspace. He examines the influences of the physical settings on social and organizational systems in organizations, and vice versa. He suggests seeing workspace as an organizational asset not simply as a real estate because 'space that is well planned,

designed, and managed energizes employees, improves morale, and contributes to the social relationships and interaction pattern that underpin all knowledge work, even in today's increasingly digital world' (p. xxi). Workspace strategies can be used 'to change work patterns, attitudes, or performance through changes in the physical workspace, from the layout of a floor to the location, design, and use of an entire building or campus' (p. xxii).

The importance of space is further highlighted with the unfolding rhetoric regarding the virtual office. One constraint on virtual office space design is that space remains important in organizations. Physical offices can offer several advantages all of which cannot be replaced yet by ICT-enabled virtual spaces (e.g. Davenport and Pearlson, 1998; Peponis et al., 2007). For example, unplanned interactions, indirect supervision, and impromptu socialization are important events that occur in organizational space: what Hollan and Stornetta (1992) have argued as the value of 'being there' in organizational work. Changes in office design and layout also can affect practices of knowledge management and its effectiveness as demonstrated in the case of Arthur Andersen (Dutta and De Meyer, 1997)

To conceptualize this, we draw on notions of spatial design from architecture (Duffy, 1997; Laing et al., 1998). Architects are trained to consider spatial aspects of work and design, and they are increasingly focusing on designing for knowledge work (e.g. Peponis, et al., 2007). Here we build on Duffy (1997) who characterizes work as varying by the degree of interaction and level of individual autonomy (see Figure 2). Interaction is concerned with how much office workers need to work or communicate face-to-face with their colleagues. For example, members of an emergency room triage team must work and communicate face-to-face more often with more direct consequences for work outcomes than do the members of a pharmaceutical company's sales force. Autonomy refers to the degree of control an employee has over the hours she works, her work location, the nature of work, and the tools provided for her to do that work. For example, college faculty have more work autonomy than do secondary school teachers. Duffy uses these two dimensions to identify four archetypical work patterns and their spatial arrangements, which he calls: hive, cell, den and club (see Figure 2).

Hives are characterized by individual, routine process work with low levels of interaction and low autonomy. Examples of representative organizations or work groups include telesales, data entry or processing, financial and administrative operations, and basic information services. Hives reflect command and control structure and focus on rationalizing common resources.

Cells support individual, concentrated work with little interaction. Highly autonomous people, such as researchers, lawyers, management consultants and computer scientists work in intermittent, irregular patterns with extended working days and often work elsewhere some of their work hours. Interactions are infrequent and often spontaneous, typically as a function of moving from place

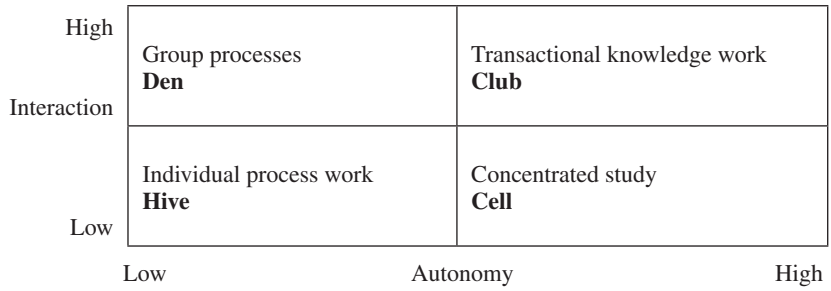

FIGURE 2
Work patterns and spatial types (adapted from Duffy, 1997)

to place. Cells provide access to common and perhaps high-value resources such as archives, high-cost machinery, or restricted access materials.

Dens are associated with group work, typically highly interactive but not necessarily highly autonomous. While space is often designed on the assumption that individual office workers occupy their 'own' desks, they also have access to local space for meetings and project work. Tasks are often short term and intense, and involve multiple collaborators. Typical work includes design, some media work, advertising and other project-based forms of work. These work spaces are often fast-changing environments, with an emphasis on sharing and interacting, and flexible re-shaping (such as can be found in cubicle-based workplace designs) of the physical spaces.

Clubs are for knowledge work: both highly autonomous and highly interactive. The pattern of occupancy is intermittent and often continuous (albeit by different workers) over an extended working day. A wide variety of shared task-based settings serve both concentrated individual and group interactive work. Individuals and teams occupy space on an as-needed basis, moving around the available spaces to take advantage of a wide range of facilities. The ratio of sharing will depend on the precise content of the work activity and the mix of in-house versus out-of-office working. Clubs are for creative work such as advertising, idea generation, crisis response and other temporally dependent decision-making work.

4. Integrating the Temporal and the Spatial for Work and Organizing

Returning to our thesis that time and space cannot be separated, we note, as do others, that this demands connecting them when analysing social systems such as work organizations (Domingues, 1995). And, from above, we develop ini-

tial claims that uses of ICT may further effect the construction of temporal and spatial perspectives of work and organization. In this section we integrate these elements and theorize on the temporal and spatial issues with ICT uses relative to forms of work and organizing.

In Figure 3 we summarize the initial claims from our theorizing. This theorizing on organizing work is structured by five constructs: the *temporal mode of work (i.e. the structure of work)*, the *temporal mode of the actor (i.e. the process of working)*, the degree of *work autonomy*, the level of *work interaction*, and the *functional uses of ICT*. In presenting our theorizing we are (acutely) aware that the nature and directions of the relationships within work contexts, and among many of the constructs, are yet to be developed. Still, given the empirical and conceptual evidence in the contemporary literature, it is both appropriate and useful to speculate on the nature and needs of these work environments (Vaughan, 1992; Weick, 1995).

We theorize *Hive* work as characterized by monochronic work structures and monochronic work processes. In hives, work will be routine and individualized. Hive workers engage the tasks sequentially and these are allocated to them by some set of pre-determined rules. In this work the critical functions for ICT will be those used to support work processes (production) and to enable managerial control of work. Hives represent the intellectual factory that the many scholars of work flow envision. The uses of ICT in hive work will likely be focused on supporting (and perhaps guiding) individual usage and will be tightly monitored. We further speculate that hive workers may not need common space, though hive workers may be asked to share space. Call centres and bank branches are hive-like workplaces, as are most back-office environments such as claims processing units, project reporting and auditing units and most organization's finance departments.

Cells differ from hives in that cell work processes are polychronic. Each piece of work may be either linear or simultaneous, but cell workers will schedule and conduct their own work. Cell workers will manage their work process by taking on multiple tasks and switching among them quite often. Examples of the kinds of work that is done in cell-like arrangements include research, lawyers, insurance agents, and others who have great autonomy over their work pace and structure. We speculate that cell workers will appropriate and use those ICT that help them gain access to needed resources and support their production efforts: using search engines and possibly specific information search tools (against private data sets or archives) along with ICT to support production efforts (such as word processing and data analysis/manipulation and reporting applications). We further expect that cell workers will resist uses of ICT for control (declining to voluntarily use shared electronic calendars or time/effort reporting systems). Cell workers are likely to have intermittent needs for shared spaces, so that cell-oriented workspaces will have few common meeting areas.

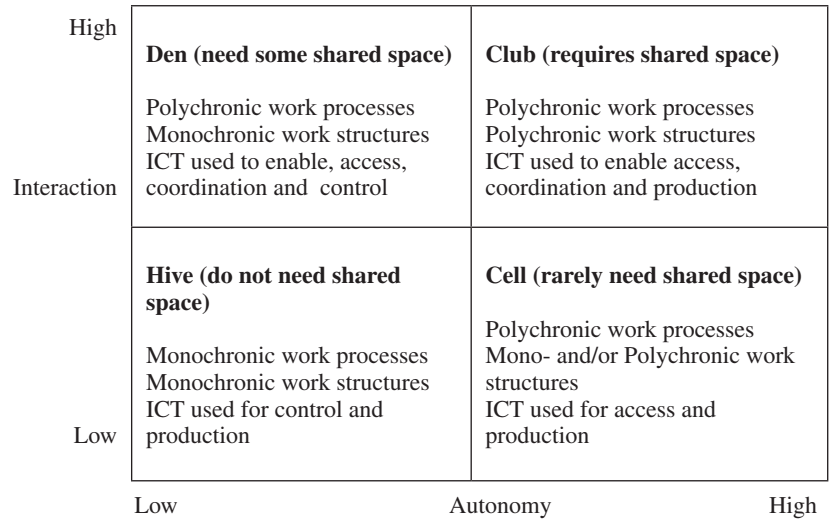

FIGURE 3
Integrative frame of time/space and ICT

Den work will be characterized by polychronic work processes and monochronic work structures. In den work people will have specific skills that they apply across multiple projects, such as being a database administrator for several development groups, providing expertise to various clients, or providing specialist services as a member of a medical team. In particular we speculate that den workers are likely to rely on ICT whose uses provide access to work and resources, allow for managing (controlling) access to resources, and supporting the coordination and communication needs among co-workers who are engaged in common work outcomes or drawing on shared resources. For example, den workers are likely to use search tools, databases and version control systems to help with work, and groupware functions like group calendar and shared databases to coordinate amongst one-another. We further speculate that den workers will need shared physical space to allow for interactions, including shared monitors and collaborative input and display systems. This shared physical space may not need to be dedicated, but must be easily accessed. One example of this would be operating rooms in a hospital, another would be examination rooms. In these the collaboration of specialists is supported by providing co-located access for specific needs. A second example of a den work would be control centres (for monitoring pipelines, electric grids, nuclear plants, air traffic, weapons systems, space launch and other complex operations). In these centres, specialists sit together but focus on doing their work and using specific

ICT to support this work with the overarching intent to contribute their particular expertise to the larger shared goal that brings these specialists together.

Club work is that which exhibits polychronic work processes and work structures. Club work demands intense and flexible workplaces where ideas and innovations arise through interaction. We speculate that club workers will use ICT that help them gain access to needed resources, enable coordination with relevant others, and help to speed up elements of work such as drawing and updating documents, file sharing, providing for shared digital workspace, and supporting sophisticated collaborative functions (such as can be found in groupware and some of the newest social media). As an aside, we see club work as both the engine of innovation and work that requires extensive collocation. Thus, we speculate that club spaces are likely to be open, shared, flexible and in constant demand. Clubs are busy places and need to be designed in ways to maximize spatial and temporal interaction. For example, a crisis response centre, with its open floor plan, multiple public display screens, and extensive communications and information-sharing systems represents one form of a club-mode of work organizing. Some forms of software development (done in team rooms) and most brainstorming-oriented work (such as is found in media, public relations and marketing companies) are best supported by club-like spaces.

5. Conclusion

Through this paper we have theorized on the temporal and spatial nature of working relative to the uses ICT for work and organizing. To do this we have argued that the socially oriented concept of temporality, not the linear concept of objective time, is an important, though under-developed, lens to understand work in organizations. This helps us, in turn, to make clear that the *temporal mode of working* and the *temporal mode of the actor* are useful concepts to frame analysis of organization work. In doing this we have drawn on the small but growing literature on time and temporality in organization and provided some initial dimensions of temporality.

We then argued that ICT act a defining technology in that its presence and uses are helping people rethink what is possible, re-imagine what is desirable, and explore what is useful. To better characterize how ICT serves to do these things, we developed a functional characterization to represent people's needs relative to *production, control, access, coordination* and *enjoyment*.

Bringing together these concepts, we focused on mid-level theorizing and our contribution is a conceptually grounded depiction of four types of ways to organize work relative to their temporal, spatial and ICT needs. For each of these four ways to organize work (hives, dens, cells and clubs) we go on to theorize on the temporal, spatial, and ICT functional characteristics.

Still, there is much to do. Most clearly, the importance of, and relationships among, the underlying constructs developed here demands empirical investigation. Moreover, each of the conceptual positions we have developed – temporality, social space, modes of work and working, and the functional view on using ICT – are verdant topics for additional conceptual attention.

For example, we can imagine that scholars of organization who are curious on the nature of temporality can extend our theorizing relative to the nature of temporality (e.g. Perlow, 1999; Avital, 2000). Scholars of ICT relative to social organizing will be able to extend our functional characterizations of ICT relative to organizing for and doing work (e.g. Dutton, 1999, 2004). Scholars of work and organizations can build from our theorizing regarding both the structure and organizing for work (e.g. Barley and Kunda, 2001; Crabtree et al., 2005).

More broadly, the theorizing we have developed here is an initial, and clearly incomplete, step towards better representing the complex sets of relationships among time, space (both physical and virtual), work (autonomy, interaction and beyond), and the functional roles of ICT in organizations. This initial theorizing provides a base for additional and more complex theorizing, something we see as the principal role of scholarship.

Notes

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1. For more on this see National Science Foundation (2008).
2. Exceptions to this include Lee (1999), Lee and Liebenau (2000a), Sahay (1998), Nandhakumar (2002), Boland and Citurs (2001), Sarker and Sahay (2004) and Shen et al. (2006). These studies make clear that more research is required to understand new forms of organization and new patterns of work that arise from uses of ICT as these have both temporal and spatial implications of significance.
3. For example: 'Modern communication technology has eliminated distance as a factor for many types of work in many situations' (Laudon and Laudon, 1998: 20); 'in digital firms, both time shifting and space shifting are the norm' (Laudon and Laudon, 2006: 7).
4. Such is the case in information systems, the intellectual community where both authors have been trained, and related intellectual communities such as social studies of information technology.
5. Much of this is drawn from Lee and Liebenau (2000b). Please see the paper for a more complete development.

6. Because the term, virtual space, is so popular particularly in relation to ICT, readers may think that we are going to talk about virtual space. Some studies of time and space examine temporal and spatial issues in the context of virtual teams (Saunders et al., 2004) and distributed work (Sarker and Sahay, 2004). By space, however, we mean 'physical space'. We are interested in how office space has changed due to office technologies from typewriters through computers to the Internet. Only when physical space disappears, we realise the functions it has fulfilled until then. Space could possibly include virtual space later when our thought develops further.
7. According to the spatial notions of Greek origin, human action takes place not in abstract space called *chora*, but in a concrete place with a specific contextual setting, called *topos* (Rämö, 2004b). Aligned with this division, Harrison and Dourish (1996) distinguish between space and place: 'Place is a space which is *invested with understandings* of behavioural appropriateness, cultural expectations and so forth. We are *located* in "space", but we *act* in "place"'. If we follow this terminology as currently used in the HCI (human computer interaction) community and information systems (e.g. Schultze and Boland, 2000; Sarker and Sahay, 2004), 'place' may be better than 'space' in expressing what we refer to by 'space' because place is space filled with human experiences and social relations. But we use space to be consistent with the usage in many studies in information systems research and organization studies.

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