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Abstract

Discussions about new forms of work and organization are typically framed by time, space, and the roles played by information and communication technologies. However, the meaning of time, space, and technology is often taken-for-granted. In this paper, we explore these concepts by first developing a set of constructs and, second, presenting some initial theorizing on the relationships among these constructs. To do so we represent time and space as socially developed constructs of temporal and spatial relations. We conceptualize a functional view of information and communication technologies. And, we characterize work as varying by two characteristics: the level of worker interdependence and the degree of work autonomy. Integrating these five constructs into an initial framework allows us to theorize that new forms of work are moving toward four distinct forms, each with particular spatial, temporal, and information technology characteristics.

1 INTRODUCTION

Articles in both the popular press and the academic literature trumpet the potential for the use of information and communication technologies (ICT) to save time, speed up work, and allow people to work and communicate with others located in different places and across different time zones. This technological opportunity is further enabled by the connectivity that the Internet embodies and we are encouraged to think of work and organizations in new ways and with new possibilities. This leads to imagining techno-social concepts such as the emerging virtual organizations, the possibility of having virtual offices, and the ability to have work be done by virtual teams whose work patterns "follow the sun" and "span the globe." Exactly how this will occur is less often discussed, and rarely with any evidence or rigor.

In response, in this paper we use conceptualizations of time and space to help us theorize on the ways that ICT may be altering work and organization. Most discussions about new forms of work and organization are framed by concepts of time, space and ICT. However, the meaning of time, space, and ICT is often taken for granted.[1] In this paper, we explore these concepts in a more theoretical way. By theoretical we mean two things. First, we provide some conceptual clarity relative to the concepts that inform our theorizing. Second, we provide some initial patterns of relationships among these concepts. In this way we engage in a process of theorizing (Weick 1995).

The paper proceeds in four sections. In section two, we outline the nature of time and space in social organization and the roles that the computer plays as a defining technology. In sections three and four, we discuss studies of the temporal and spatial impacts of ICT. We organize these sections by level of analysis, as the effects of using ICT have been shown to vary across levels of

[1]Some exceptions are Lee (1999), Lee and Liebenau (2000a), Sahay (1998), and Schultze and Boland (2000).

social aggregation (Sawyer and Eschenfelder 2002). In section five, 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.

2 TIME AND SPACE IN WORK AND ORGANIZATION

Fundamental to our theorizing is that social organizations are one form of enduring social structure: they are institutions (Scott 2001, p. 48). While the formalization of the rules, norms, and member's awareness of their existence may vary, such structures are present in all social organizations. Further, a social organization's rules and norms are intertwined within some larger social context and can be both relatively stable over time and still allow for change to occur. Members of social organizations are guided by these structures but also have some individual agency. This allows them to both draw on these social structures and change them through their actions (Giddens 1984). Within these social organizations, and as outlined below, we further characterize time and space as social constructions and, thus, as social structures. We further characterize computers, here embodied as the functional roles that ICT represent, as a defining technology that affect our perceptions of time and space.

2.1 Time and Space as Social Phenomena

Time is a fundamental dimension of human and organizational existence, and is intimately tied to space, as we discuss below. 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, p. 100).

Time is often conceived solely as a linear measurement of chronology, using some agreed upon measurement system (Macey 1989). Temporality is the concept used to explain what time means. Temporality is depicted when we assess when 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 "shorter" than one minute of time with your hand stuck in the car door.

Temporality is concerned with conventions that govern the way in which time is organized (Hall 1983; Stamper 1973). 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. Simply, the development of temporal rules, norms, and explicit 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—and for our interests here we mean physical space in social organizations—is also socially developed. Space can be seen as a measure of volume (and is tied with time, the fourth coordinate of volume). But, the meaning of spatial implies social relations. Power, an often highly visible social relation in modern organizations, 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, p. 221). The notion of territory or its absence is also seen in new flexible office environments such as "hotdesking" (sharing desks) (Skyrme 1994).

2.2 Computers Are a Defining Technology

We also characterize the computer (ICT) as a defining technology. Here we draw on Bolter (1984), who argues that certain technologies occupy a special place in their age. For example, the clock and the steam engine were defining technologies in Western Europe in the 17th and 19th centuries respectively. These technologies not only changed the world in a material sense, but they also provided new ways by which people viewed and understood both their physical and metaphysical worlds. Clockwork was the model of the universe showing the movements of heavenly bodies; the steam engine became the metaphor for the universe in the 19th century (Bolter 1984, p. 32).

In the same way that the clock and steam engine redefined their age, ICT are helping redefine our age, changing both our material existence and also affecting the way we view the world. 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, p. 11). As a defining technology, the computer affects temporal and spatial aspects of individuals, organizations, and society, on the one hand,

and the way people view time and space, on the other. Simply, computing is "the contemporary analog of the clocks" (Bolter 1984, p. 10).

We further characterize how ICT help to define our age by depicting their use as affecting production, control, access, coordination, and entertainment (Henderson and Cooprider 1990; Orlikowski and Iacono 2001; Taylor 1982, 1986). That is, ICT function in ways that enable organizational members to alter how activities are conducted. In this characterization, ICT can function to automate the production of work (such as CASE tools and word processors). Examples of controlling ICT are access and security routines, statistical analysis, and real-time reporting (such as the panopticon discussed in Zuboff [1988]). And, it is likely that ICT may function as both production and control technologies (the five functions are not mutually exclusive). Electronic mail and mobile phones are examples of ICT being used as coordination technologies, while search engines, online databases, and data mining techniques are access technologies. Entertainment uses of ICTs are rarely considered in studies of organizational uses of ICT although the increase in digital music, video, and online games suggest that this is a significant role for computing.

3 TEMPORAL EFFECTS OF ICT

To frame the temporal effects of ICT we focus on societal, organizational, and individual levels of analysis. We select these three because they help us delineate the scale differences of ICT and social organization (Sawyer and Eschenfelder 2002). At the societal level, two examples of efforts to transform the institutionalized nature of clock time showcase the effects of ICT. Swatch, the Swiss watchmaker, announced the invention of "Internet Time" in October, 1998, as a new way of measuring time (see Lee and Liebenau 2000b). Swatch argued that frequent communications at the global level, which had been further accelerated by the Internet, required a new universal, Internet Time (Swatch 2002). Internet Time was based on the decimal system with a day divided into 1,000 beats. It also created a new meridian in Biel, Switzerland. Biel Mean Time (BMT) would become the universal reference for Internet Time, just as Greenwich Mean Time is for our current system of timekeeping.

Concurrently, the British government launched Greenwich electronic Time (GeT) as an alternative to Greenwich Mean Time (GMT) (GeT 2002). GeT would act as a worldwide clock for the Internet in the same way that GMT works for the non-Internet world. Like Swatch's Internet Time, GeT would provide a means by which purchase and delivery times in electronic commerce would be matched around the world. Unlike Swatch's Internet Time, however, the idea was not to create a new time system, but to redefine the existing 24-hour clock and the existing GMT. Although they are likely to remain symbolic rather than practical, both attempts imply the need for a single, global time to represent an unprecedented level of simultaneity and instantaneity (Adam 1995).

At the organizational level, use of ICT is generally believed to speed up business processes. However, there are very few empirical studies exploring this hypothesized effect and their findings do not separate the effects of changes to work processes from the uses of ICT, leaving open the question of what factors contributed to temporal change (Gregory and Rawling 1997; Sakakibara et al. 1997; Stalk 1988; Stalk and Hout 1990). Barley (1988) provides one of the few detailed studies in which the changes in temporality of work are due to changes in ICT. In his investigation of the impacts of computer-based radiology equipment on temporality and social relations in hospital radiology departments, Barley found that the new computer-based equipment changed the temporal rhythm of radiologists' work. This, in turn, reduced the conflict between radiologists and technicians. In another study, Lee (1999) showed that introducing a new information system into a trading company transformed the temporal profiles of work and created a temporal symmetry between work groups interacting with one another.

At the individual level Failla and Bagnara (1992) suggest that the relationship between time and ICT be considered within the context of organizational culture and its work. This context helps to frame the ways in which using ICT affects individual time patterns in relation to work. For example, increased mobility (using wireless communication devices) may transform temporal patterns of individual workers and also affect organizational time patterns. Here, Palen's work (1998, 1999) on groupware calendar systems illustrates how characteristics of the organization, and its patterns of work, affect the use of groupware calendars and individuals' time patterns.

Focusing on individual work within organization settings makes clear that using ICT can alter the ways in which time is structured in work. One of the aspects of structuring time is the distinction between monochronicity and polychronicity (Hall 1983). Individuals working polychronically place less value on temporal order, accept events as they arise, and engage in multiple activities simultaneously, whereas people working monochronically seek to structure activities and plan for events by allocating specific slots of time to each event's occurrence (Barley 1988, p. 158).

Monochronicity is well suited to the management of large systems (Schein 1992). As such, most organizations take it for granted as being the only way to get things done efficiently—take as an example the idea of a business process in which work is seen as 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 text transfer—enables people to involve themselves simultaneously in several tasks that are located at different places.

We further distinguish between two closely connected concepts of work to which discussions about monochronic and polychronic times can be meaningfully applied (Lee 1999). The first domain relates to the temporal nature of tasks and events. We call this the *temporal behavior of work*. While some events take place in an unexpected temporal way, i.e., irregularly, sporadically, unevenly, and not following a fixed schedule (polychronic), others come in an organized temporal way, i.e., regularly, following the predetermined, or at least predictable, sequence (monochronic).

The second concept of work relates to how workers organize their time to deal with tasks and events. This is concerned with ways of working, or the temporal behavior of working. 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. Figure 1 shows these modes of temporal behavior.

Factory work is often characterized by the specific timing and ordering of sequenced events. Workers operate monochronically, pre-allocating a time slot for each task; that is, they make a schedule. In medical clinics, multiple patients may be scheduled into the same time slots, even though doctors follow monochronic work procedures with each patient they see. In call centers, calls taking place in a polychromic manner are scheduled so that each worker gets a linear sequence of calls. Polychronic forms of working mean that workers deal with tasks spontaneously as they arise and may perform several tasks at a time. In this case, 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.

		Temporal behavior of work	
		Monochronic	*Polychronic*
Temporal behavior of working	*Monochronic*	Conventional factory work	Call centers and help desks
	Polychronic	Medical clinics	Virtual work environments

Figure 1. Modes of Temporal Behavior

4 SPATIAL EFFECTS OF ICT

In this section, we explore the spatial effects of ICT across societal, organizational, and individual levels of analysis. At the societal level of analysis, Lucas (2001) predicts that the trends of increased telecommuting will lead to about a 30 percent reduction in office space demand and at least 10% conversion of existing office space to hoteling (sharing offices) throughout the United States by 2006. Beyond these effects due to large-scale organizational change, people's consumer habits will also reorient spatial needs. For example, online purchasing is expected to bring about a 30 percent decline in the need for retail space (Lucas 2001, pp. 89-90).

At the organizational level of analysis, the relationships among using ICT and space can be considered from both governance and design perspectives. From a governance perspective, issues with managing distant employees, coordinating teamwork when

members are distributed across time and space, and new leaders and managers often evoke increased use of ICT to bridge space. For this reason, work space design has become increasingly important to organizations, although this work is still driven by heuristics more than by empirics or theory (Harmon-Vaughan 1995; Heath et al. 1996; Stallworth and Kleiner 1996). Here we introduce two approaches that help us theorize about space and organization, building on the concept of virtual office (Duffy 1997).

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 (Davenport and Pearlson 1998). For example, unplanned interactions, indirect supervision, and impromptu socialization are important events that occur in organizational space. And, given that teams are increasingly seen as the basis of organizational work, virtual space must allow dispersed team members to work together (Harmon-Vaughan 1995). Duffy (1997) characterizes the differences between conventional office work and the new, virtual, ways of working (see Table 1). Here individual work is bound up in space with the work of the team's members. Given this, we continue our discussion of spatial effects in teamwork as a means of pursuing the spatial issues with both organizational and individual levels of analysis.

Table 1. Conventional and New Ways of Working
(Adapted from Liang et al. 1998, Figure 9)

Conventional Office	New Ways of Working
• Central office locations. People commute to these locations.	• Office being replaced by a distributed set of work locations linked by networks of communications.
• Staff occupy individual workstations and there is one desk per person. Spaces are designed to be used by individuals to work alone. Group spaces are at a premium.	• Space is shared among work team's members. Work settings not "owned" by individuals but occupied on an as-needed basis and provided to serve a variety of tasks, both individual and group.
• Staff follow structured (e.g., "9 to 5") work.	• The daily work timetable is extended and irregular.
• Work is assigned to individuals. Individuals have assigned roles.	• Work is assigned to teams. People's roles change as work changes.
• Staff are full time, typically employees.	• Staffing may be composite of full and part time employees, contractors, and other temporary help.
• There is a rigid hierarchy of space standards, with rank ruling the space layout.	• Space is reconfigurable. The layout of the office is geared to the work process and its tasks.

Duffy 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. Autonomy refers to how much control an employee has over the hours worked, the work location, the nature of work, and the tools provided to do that work. In this way, Duffy identifies four major work patterns and their spatial types: hive, cell, den, and club.

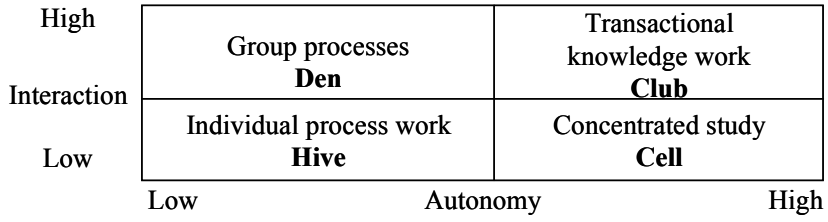

Figure 2. Work Patterns and Spatial Types

Hives are characterized by individual, routine process work with low levels of interaction and low autonomy. Typical organizations or work groups include telesales, data entry or processing, financial and administrative operations, and basic information services.

Cells accommodate 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.

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, and advertising.

Clubs are for knowledge work, both highly autonomous and highly interactive. The pattern of occupancy is intermittent and 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 space 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 working in-house versus out-of-office. Clubs are for creative work such as advertising and media development.

5 INTEGRATING THE TEMPORAL AND THE SPATIAL

Time and space cannot be separated when analyzing social systems such as work in organizations (Domingues 1995). Boland and Citurs (2001) show that the work of software development by a globally distributed team selectively opens and closes space and thereby experiences a different pace of time. We have also made some initial claims that uses of ICT may further affect 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, work, and organization. Figure 3 summarizes both the framing and initial claims of our theorizing. Our theorizing is structured by five constructs: the temporality of work, the temporality of working, work autonomy, work interaction, and uses of ICT. These five constructs are further theorized to vary by the institutional arrangements in which they are embedded. In presenting our early theorizing, we are (acutely) aware that the nature and directions of the relationships among institutional contexts, and among many of the constructs, are yet to be developed. However, given the empirical and conceptual evidence in the contemporary literature, it is both appropriate and useful to advance initial propositions.

Within the institutional frame that we consider time and space, we theorize that **den** work will be characterized by polychronic work processes, and monochronic work structures, and that ICT will be mostly used to enable access, coordination, and control. In den work, people will have specific skills that they apply across multiple projects, such as being a database administrator for several development groups. People in these workspaces will rely on ICT to allow access to work and resources, coordination among workers, and control. For example, den workers will use search tools, databases and version control systems to help with work and e-mail and phones to coordinate amongst one-another. This suggests that den workers will need shared physical space.

Den (need some shared space)	**Club (requires shared space)**
Polychronic work processes Monochronic work structures ICT used to enable, access, coordination and control	Polychronic work processes Polychronic work structures ICT used to enable access, coordination and production
Hive (do not need shared space)	**Cell (rarely need shared space)**
Monochronic work processes Monochronic work structures ICT used for control and production.	Monochronic work processes Polychronic work structures ICT used for access and production.

Figure 3. Integrative Frame of Time/Space and IT

Hive work will be characterized by monochronic work structures and processes. Work will be routine and individualized, an intellectual factory. The ICT will be used to support work processes (production) and enable both local and managerial control. These are ideal spaces for workflow systems. Hive workers may not need common or shared space.

Cell work, however, will differ from hives in the polychronicity of work processes. Each piece of work may be linear, but these workers will schedule and conduct their own work, taking on multiple tasks and switching among them quite often. Cell workers, such as research faculty, will appropriate ICT to help them access resources and support production efforts: using search engines, library searches, and word processing and data analysis applications. Hive workers may also resist uses of ICT for control (such as sharing electronic calendars). These workers may have only intermittent needs for shared space.

Club work exhibits polychronic work processes and work structures, intense and flexible workplaces where ideas and inventions are made through interaction. Workers use ICT to provide access to resources, to enable coordination, and to help speed up elements of work (such as drawing and updating documents). Club work is both the engine of innovation and requires extensive collocation.

6 GOING BEYOND THEORIZING

In this paper we have developed a means to both characterize and explore a set of defining theories on the temporal and spatial nature of ICT use in work and social organization. Our theorizing is an initial, and clearly incomplete, step in better representing the complex sets of relationships among the temporal structures of work, working, work autonomy, work interaction, and the functional roles of ICT use. We have further characterized work as being embedded into larger institutional contexts. The relationships among context and work are unexplored in this paper and deserve additional attention. The importance of, and relationships among, the underlying constructs need to be empirically investigated. This initial theorizing can also serve as a base for additional, more complex theorizing, which we see as a principal role of scholarship (Vaughan 1992; Weick 1995).

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