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Time and Information Technology: Temporal Impacts on Individuals, Organizations, and Society

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Time has recently become a central issue of discourse in social sciences and management studies. Partly due to the advent of the new millennium, scholars in social sciences and management studies have become fascinated with the notion of time and come to appreciate its complex nature. This newly awakened interest in time can be seen in the recent conferences and journal special issues on the topic.[1] In particular, much of this rising interest can be seen in an awareness of changing time in this "information age." Information technology, recently represented by the Internet, is "transforming time," the way time is perceived, used, managed, and disciplined. Although it is generally accepted that information technology is affecting temporal aspects of contemporary society, all too often the relationship between time and information technology fails to acknowledge the complexity of their relationship and is simply understood in terms of clichés such as "IT enables us to overcome barriers in time and space." While one key aspect of the effect of technology on time is that many things are getting faster, we believe the accompanying changes are much more fundamental.

This special issue on time and information technology aims to provide this deeper understanding, and thereby to further research and discussion on time and information technology. In this editorial, we review why we believe that time and information technology should be a focal point in understanding current changes in organizations and society. In so doing, we draw on Bolter's (1984) concept of "defining technology" and compare modern information technology with the mechanical clocks of the 17th and 18th centuries. Then, we present temporal impacts of information technology at three levels (individual, organizational, and social), as well as broader, theoretical issues. These four areas will be used as a framework onto which the five papers included in this special issue will be positioned. Finally we suggest areas for future research in the study of time and information technology.

DEFINING TECHNOLOGIES: THE CLOCK AND THE COMPUTER

According to Bolter (1984), some technologies occupy a special place in their age. The clock and the steam engine in Western Europe in the 17th and 19th centuries, respectively, 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).

These were defining technologies that defined the age when they were invented and first widely used; in the same way, information and communications technologies, including the Internet, are the defining technology of our age. They not only change many aspects of our material existence, but also affect 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).

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As a defining technology, both the clock and the computer affect temporal aspects of individuals, organizations, and society on the one hand, and the way people view time, on the other. Clocks affected every aspect of temporality not particularly because they were time-measuring machines, but because they were the defining technology.

The mechanical clock, in its simplest form, was a tool for measuring time. However, it had two fundamental differences, which enabled it to make huge impacts on human life and civilizations, compared to its predecessors such as the sundial, water clock, hourglass, etc. First, the mechanical clock, which had became reliable since the application of the regular swing of a pendulum in 1657 by Christiaan Huygens, was incomparable in accuracy. Before 1657 clocks could not keep time more closely than to about 15 minutes per day; within 20 years they kept time with a variation of less than 10 seconds per day (Macey, 1980, p. 33). Now it became a reliable tool which could direct, and provide criteria for, the organization of human activities. For example, before the clock, it was not possible to consider and apply notions of accuracy and punctuality as we do now.

Second, the mechanical clock freed time from nature. Before accurate mechanical clocks, time had always been measured in relation to physical and biotic phenomena, for example, the rising and setting of the sun and the growth of plants. By those temporal indications from nature, people organized and conducted their activities. They woke up and started to work when the sun rose and harvested their crops when the days drew in. This "time was not something fixed in advance and divorced from external events" and with the advent of the mechanical clock, time became "a function of pure mechanism" (Rifkin, 1987, p. 85). People wake up when the clock strikes seven, not because the sun rises. Therefore we can argue that clocks "dissociated time from human events" (Mumford, 1934, p. 15) and "human events from nature" (Landes, 1983, p. 16).

At the organizational level, Thompson (1967) investigated the impacts of the mechanical clock on labor disciplines in early industrial capitalism when the "task orientation" of time organization by which work proceeded in "natural" rhythms gave way to "labor timed by the clock" (pp. 59–60).

Mumford argued that "The clock, not the steam-engine, is the key-machine of the modern industrial age" (1934, p. 14) because the clock was "a model for many other kinds of mechanical works, and the analysis of motion that accompanied the perfection of the clock, with the various types of gearing and transmission that were elaborated, contributed to the success of quite different kinds of machine" (p. 15). Macey (1980) suggests that the British supremacy in the horological revolution of 1660–1760 contributed greatly to the British industrial revolution, which is usually considered to have begun about 1760. He further insists that clocks in the 17th century not only affected industrial organizations, but also affected every aspect of the society: literature, philosophy, theology, and therefore, our way of thinking and our view of the world.

The computer is, in its simplest form, a tool for calculation. However, it is "the contemporary analog of the clocks" (Bolter, 1984, p. 10). Information technology is affecting every facet of contemporary society. Time is no exception. "Our appreciation and our evaluation of the passage of time is changing in the computer age" (Bolter, 1984, p. 100). Information technology can affect and change temporality, people's perceptions of time, its measurement, and the way time is organized. As Rifkin (1987) argues,

> It is likely that within the next half century, the computer will help facilitate a revolutionary change in time orientation, just as clocks did several hundred years ago when they began the process of replacing nonautomated timepieces as society's key time-ordering tools. . . . the new computer technology is already changing the way we conceptualize time and, in the process, is changing the way we think about ourselves and the world around us. (p. 13)

The articles in this special issue demonstrate that Rifkin's prediction has come true, far sooner than his 50-year time scale. As we demonstrate, these impacts can be analyzed in terms of individuals, organizations, and society as well as the broader theoretical points they raise.

ARTICLES IN THE SPECIAL ISSUE

There are five excellent articles in this special issue of *The Information Society* on Time and Information Technology. Our call for papers attracted 15 submissions on a diverse set of topics around the notion of temporality and information technology. After an initial review to ensure that they addressed the aims of the special issue, the articles were sent out for review. Despite the broad range of research approaches found, ranging from quantitative experimental studies to ethnographically influenced studies of situated work practices, we were able to obtain three high-quality reviews for each article and are grateful to all our reviewers for their excellent work in this area. For each article we tried to have two reviewers who were familiar with the broad research approach used in the article, and one representing an alternative tradition. On the basis of these reviews, we selected the articles that are included in the special issue.

The special issue therefore reflects much of the diversity in research approach, research subject, and geographical focus of current research on information technology and time. We have articles from Europe, the United States, and Asia; articles focusing on individuals, on organizations, and on societies. The research looks at how time impacts the developers of software systems alongside

the implementers and users of new computer systems, on the direct impact of technology on temporal activities of families in the domestic spaces, and on the indirect impact of technology on the nation state.

Society

At the societal level, many discussions on time and information technology start and end with globalization. With the development of information technology and telecommunications, the global becomes a reachable horizon both in terms of time and space, on which we can act and by which we are acted upon.

The first article, by Soraj Hongladarom, looks at these globalizing effects of time and technology. Globalization is a major theme in much of the discussion of the impact of technology on society, and Soraj's experiences as a Thai are used to discuss the impact of a global notion of time on Thai society. In particular, Soraj discusses proposals by the Thai government, which has already decided to make every village Internet enabled, to change the country's standard time from 7 hours ahead of Greenwich Mean Time to 8 hours ahead. In proposing this change, the Thai government has had to balance the needs of rural farmers, where "daylight" time is still a major driver of everyday activity, with the economic benefits of sharing the same time zone as the global business centers of Hong Kong and Singapore. The article therefore highlights the tensions between the demands of participating in a global, computer-technology-driven economy and the requirements of a local, domestic economy.

The experience of Thailand can perhaps be usefully understood in relation to two other attempts to transform the institutionalized nature of clock time. One is commercially motivated, the other politically. Swatch, the Swiss watchmaker, announced the invention of "Internet Time" in October 1998. This was a new way of measuring time (see Lee & Liebenau, 2000). Swatch argued that frequent communications at the global level, which had been further accelerated by the Internet, required a new universal time. Their "Internet Time" was based on the decimal system, with a day divided into 1000 beats. It also created a new meridian in Biel, Switzerland. Biel Mean Time (BMT) will be the universal reference for Internet Time, just as Greenwich Mean Time is for the current system. Nicholas Negroponte praised this development, saying, "Internet Time is absolute time for everybody. Now is now and the same time for all people and places. Later is the same subsequent period for everybody. The numbers are the same for all" (Swatch, 2002).

Another attempt was presented by the British government, which proposed launching Greenwich Electronic Time (GeT) as an alternative to Greenwich Mean Time (GeT, 2002). It was suggested that this would act as a worldwide clock for the internet in the same way that GMT works for the real world. Its goals were similar to those of Swatch's Internet Time, as 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 use the existing 24-hour clock and the existing GMT. Both approaches imply the existence of a single, global time representing an unprecedented level of simultaneity and instantaneity (Adam, 1995).

Organizational Impact

At the organizational level, it is generally accepted that information technology, when implemented in organizations, speeds up business processes at an enormous rate and thereby saves the adopting organizations a great amount of time. In spite of its significance in temporality, research on temporal impacts of information technology in organizations is limited. There are some studies on cycle time reduction in relation to just-in-time production (Sakakibara et al., 1997), time-based competition (Stalk, 1988; Stalk & Hout, 1990), and time compression (Gregory & Rawling, 1997). However, they tend to take it for granted that these temporal effects of speeding up, saving time, and reducing cycle time come from information technology. Although Davenport and Short (1990) emphasize the sequential capability of information technology for business process reengineering, in that it "can enable changes in the sequence of tasks in a process, often allowing multiple tasks to be worked on simultaneously" (p. 17), questions about the underlying mechanisms that make these changes possible, of what is happening behind and beyond speeding up, remain unanswered.

Barley (1988) provides a detailed example to address these kinds of questions through his investigation of the impacts of computer-based radiology equipment on temporality and social relations in hospital radiology departments. He employed two ways of organizing time: monochronic and polychronic (Hall, 1966, 1983). In the former, people do one thing at a time, while in the latter several things are done at once. The new computer-based equipment increased the monochronicity of radiologists' work by restructuring the duration, sequence, temporal location, and rate of recurrence of events. This, in turn, enhanced the symmetry of the temporal organization between the radiologists' and technicians' work. The increased temporal symmetry reduced the conflict between radiologists and technicians.

In another study, Lee (1999) showed that polychronicity was enhanced by the information systems implemented in the organizations he studied. They transformed temporal profiles of work and created a temporal symmetry between work groups interacting with one another. Sahay's work

(1998) is also worth noting in this context as it takes a different perspective on time and information technology implementation. Instead of studying the temporal impacts of information technology, he argues that the recipient organization's assumptions of time and space affects the implementation of information systems and shows this by the ways in which geographical information systems are adopted differently in India.

Articles by Joe Nandhukumar and by Steve Sawyer and Richard Southwick present two views on the organizational implications of technology and time. Joe's paper presents the experiences of a software development organization producing executive information systems. He was a participant observer in this organization and was able to follow the workers through time and space as they interacted and worked on various parts of the systems. To analyze this material he presents the idea of time geography and uses this to study the work patterns of the software developers. By mapping out who does what, where, and when, he is able to appreciate the increasingly complex, polychronic nature of software development work. He shows how individual workers spend time on a broad range of different projects and activities over the day and highlights the importance of different social spaces that are used at different times to help manage this diverse workload.

The article by Steve and Richard also has an organizational focus, but this time it is on an organization implementing a new system. The case site is of a medium sized university that is introducing a new enterprise wide system. One consequence of the nature of the organization is that there is no obvious time for the new computer system to be rolled out, as each division of the university has its own particular rhythm. The admissions office is particularly busy at some times of the year whereas the academic registrar's division is busy at other times in the year; the student records division is operating on a different temporal cycle again. As the article discusses, the project was therefore rolled out in stages, with various deadlines for each aspect. Further complications arose with the need to address Y2K compliance issues and a switch from one system supplier to another midway through the project. As a result, the notion of deadline and time scale varied tremendously between different people and sometimes the same people in different roles as the project developed into multiple, overlapping time cycles.

Individual Impact

At the individual level, information technology causes profound changes in the time-frame patterns of the decision making (Failla & Bagnara, 1992). For example, virtual reality technology can help us to simulate the consequences of decisions in advance and we can gain experience of scenarios or events that have never been encountered in real life. Virtual reality technology therefore allows "future" or unexperienced experiences to be experienced. We can reconstruct the experience needed to generate alternatives with the help of information technology. It allows simulation of the future and thereby modifies the time frames, which are no longer relegated to repetitions of the past with little variation.

Failla and Bagnara (1992) also suggest that the relationship between time and information technology be considered within the context of organizational culture. Information technology affects individual time patterns in relation to work. For example, increased mobility by mobile communication devices can transform temporal patterns of individual workers. It also has huge effects on time patterns at an organizational level, which leads to the emergence of virtual teams, virtual offices, or virtual organizations. In this new environment, individuals are encouraged to reorganize their time, but any such reorganization of time should be shared by, and be consistent with, their organization's culture. Palen's work (1998, 1999) on groupware calendar systems illustrates how cultural characteristics of the organizations under study affect the use of groupware calendars and individuals' time patterns.

Nicola Green's article follows this move from the organization to the individual and focuses on the impact of mobility (particularly mobile telephony) on individuals in their work and domestic situations and how they alter their everyday practices of time. As she demonstrates, this ranges from the capabilities of mobile phones for text messaging using abbreviated language and hence rapid communication, to more subjective notions of remaining in touch. Even this aspect varies from workers reconsidering what it means to maintain contact with head office while traveling between meetings to parents revising their notion of what it means to monitor their children through the use of the phone.

Wider Issues

There are also wider issues about time and information technology beyond the individual, organizational, and social arenas. The transformation of time by information technology is global and generic. According to Castells (1996), the dominant temporality of our contemporary society is timeless 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" (p. 464). The occurrence of phenomena is compressed for instantaneity, and discontinuity is randomly introduced in the sequence. Information technology can disorder the sequence of events and make them simultaneous, and thereby time is dissolved, with past, present,

and future mingled in the new communication system. Multimedia's hypertext is an example of this timelessness. Information technology's impacts on time-frame patterns of decision making (Failla & Bagnara, 1992) are also understood in terms of this commingling of past, present, and future.

Information technology is making huge impacts on space, its use and allocation at individual, organizational, and societal levels, too (Lucas, 2001). A simple example is teleworking, which transforms not only time patterns of work but also space use patterns by individual workers and organizations. Time and space cannot be separated when analyzing social systems (Domingues, 1995), and particularly when discussing impacts of information technologies. We expect that an integrating approach will emerge to understand the interaction among time, space, and information technology in studies of work, organizations, and society. An example is time geography (Carlstein, 1982; Hagerstrand, 1975) as used in Joe Nandhukumar's article.

Although the call for articles focused on questions of time, as the articles in this special issue demonstrate, it is not possible to consider time outside the controlled experiment without also considering space. Adrian Mihalache nicely demonstrates this in the final article. He takes an innovative approach, unusual in the mainstream literature cited by *The Information Society*, whereby he draws inspiration from the work of the artist William Blake. He shares Blake's concern about the restrictive way we consider space and time purely in Newtonian terms and uses Blake's plates as multimedia architectures to present an alternative conceptualization of time and space that can shed light on our understanding of cyberspace and cybertime.

FURTHER AREAS FOR RESEARCH

We hope that the article in this special issue will stimulate further research in the area of time and information technology. In this last section we raise a few particular research questions in this area that we believe are worthy of further study.

At the individual level, information technology has given birth to a variety of calendar applications such as personal digital assistants, groupware calendars, and web-based calendars (e.g. Yahoo, 2002; AOL, 2002). They provide individuals (of course, in organizations) with opportunities to implement new time management regimes. Although studies on electronic calendars or time-management tools are increasing (Palen, 1998, 1999; Pino & Mora, 1998; Blandford & Green, 2001; Lee, 2002), this area still remains largely unexplored. Current knowledge on how people use these calendar applications is limited. Furthermore, research is required to investigate how the use of these applications transforms users' temporal orientation. We also need to know how individual (temporal) characteristics affect the use pattern of these technologies.

Another area we suggest for further research at the individual level is consumers' time in electronic commerce. Online purchasing assumes a different decision-making process in which time is a crucial factor. In addition, online shopping may also change consumers' time use or time allocation, for example, between work and leisure. These issues need to be addressed to understand temporal transformations of the contemporary society that are being experienced by individuals.

At the organizational level, information and communication technologies are generating new patterns of working and new forms of organizations, such as virtual teams and virtual organizations. Being "virtual" implies a fundamental transformation in the temporal aspects of work and organizations. However, temporal implications of these technology-driven organizational changes are little known yet. For example, the time discipline that was shaped by the advent of industrial capitalism (Thompson, 1967) and that has since dominated management thinking is being challenged as many temporal (and spatial) constraints are overcome by information technologies. As a result, rigid time disciplines may no longer be the most effective tool for managing and controlling employees in virtual work environments, and there are interesting areas for investigating the rhythms of work practices, especially in areas like software development, where the project-based nature of the work provides scope for considerable polychronic work practices.

For social and wider issues, virtuality again is an area requiring further investigation, particularly in relation to mobile communication devices. Virtuality implies, by nature and by definition, fundamental transformations of temporal (and spatial) aspects of interaction, work, and organization. It is a key word for understanding social changes taking place currently not only in a material sense, but also in a conceptual one.

We would like to end by thanking Rob Kling and his editorial assistants, whose support throughout the preparation of this special issue has been particularly helpful.

We hope you enjoy this special issue.

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NOTE

1. For example, the Academy of Management set "New Time" as the conference theme for its 2000 annual conference and its three journals all announced special issues on new time (*Academy of Management Review*, 2001). In sociology, *Work and Occupations* (2001) published a special issue on "Time at Work." *American Behavioral Scientist* (2001)

also issued a special issue on "Temporal Dimensions of Employment Relations."

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