PROGRESS REPORT

TIME, INFORMATION TECHNOLOGIES, AND THE GEOGRAPHIES OF EVERYDAY LIFE[1]

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The publication of five books and two special issues on information technologies (IT) by geographers in recent years seems to suggest a new and significant wave of IT-related research in geography (*Geographical Review,* 1997; Janelle and Hodge, 2000; Wheeler et al., 2000; Wilson and Corey, 2000; Dodge and Kitchin, 2001; *Environment and Planning B,* 2001; Leinbach and Brunn, 2001). These publications not only updated and expanded earlier contributions by urban researchers and geographers (e.g., Castells, 1989, 1996; Hepworth, 1990; Brunn and Leinbach, 1991; Batty, 1993; Kellerman, 1993; Graham and Marvin, 1996), they also highlighted important directions for geographical research in IT-related themes. Papers included in these volumes and other recent studies represent a wide range of theoretical and analytical approaches, including city and regional studies (e.g., Dodge and Shiode, 2000; Gillespie and Richardson, 2000; Graham and Marvin, 2000; Townsend, 2001); studies on specific industries or firms (e.g., Brunn and Leinbach, 2000; Dodge and Kitchin, 2001); social and cultural studies of the Internet or cyberspace (e.g., Adams, 1995, 1997, 1999; Warf, 2000); network analysis and spatial interaction modeling (e.g., Wheeler and O'Kelly, 1999; Murnion, 2000; O'Kelly and Grubesic, 2002); and the study of human cyberspatial cognition and behavior (Kwan, 2001).

Since there are helpful reviews of this literature (e.g., Graham, 1998), I do not intend to provide an exhaustive literature review in this progress report. Instead, I focus mainly on three related perspectives and areas of research whose relevance and value to IT-related research in geography is relatively unnoticed to date. These include recent time-use studies, time-geographic research, and studies on human activity-travel patterns in space-time. Common among these studies is their emphasis on the critical role of time in

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shaping the geographies of everyday life in the information age. The conviction of the paper is that, as the increasing use of new information technologies (IT) leads to changes in the timing and location of people's activities[3], time will be a significant dimension for understanding the social and economic geographies of urban areas.[4] The use of new IT will be associated with distinctive patterns of human activities in space-time, and analyses of these patterns could provide part of the empirical basis and/or behavioral foundation for enhancing our understanding of the interaction between new IT, everyday life and urban geographies. Further, my emphasis in the paper is on how the data and methods used in these studies may inform future geographical research on new IT. The paper explores particular directions for approaching empirical research that enhances our understanding of the vastly complex interrelations among new IT, human behavior and everyday life.

SPACE-TIME DISPLACEMENT AND TIME USE STUDIES

A helpful way to understand the impact of new IT on people's everyday lives and urban development is to study the amount of time they spend on new IT compared to traditional technologies and other ways of using time. Since there is a limit to the simultaneous involvement in multiple activities for a particular person, an important feature of time is its zero-sum property—if more time is spent on some new activity or technology, it must necessarily displace the time spent on some other technology or activity (Robinson et al., 2000). Thus, according to this time displacement perspective, the time people spend on the Internet takes time away from other activities. For example, if people spend more time using the Internet, they will spend less time watching television or on social activities. Further, as Internet users purchase online, they will spend less time shopping in and making trips to stores in the physical world. Since the ultimate constraint on human activity is time (Joyce and Stewart, 1999), insights into the potential impact of new IT on human activity patterns and the urban economy may be gained through an examination of how people use their time.

Time-use research has a long history. Szalai (1972) presented results of the first major international and comparative time-use study based on time-budget survey data collected in 12 countries in the 1960s. The activity classification system developed and used in this multinational study—which classified activities into mutually exclusive groups that cover all aspects of human activity—still has an important influence on recent time-use research (Stinson, 1999). Unlike earlier studies that largely used mail or interview surveys, major recent studies like the *1985 American's Use of Time Project* and the *Canadian General Social Survey* collected time-use data through telephone surveys. Robinson

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[3]"New information technologies" in this paper refers to various means through which communications and electronic transactions (e.g., sending or receiving e-mail, e-shopping) can be undertaken. These include personal computers, the Internet, private commercial networks, mobile phones, and handheld Internet devices. The paper, however, does not include works on the impact of mobile phones and handheld devices on the geographies of everyday life—although there are some interesting studies on these technologies (e.g., Kopomaa, 2000). This is mainly due to the focus of the paper on studies that emphasize the role of time and the use of distinctive data collection or analytical methods.

[4]See also Weber and Kwan (2002) on the pivotal role of time in shaping individual accessibility in urban areas.

and Godbey (1997) also used telephone data collection for their 1995 time-use survey. The main survey instrument used in time-use studies is the time-budget or the time-diary. The time-budget is a detailed record of what a person has done during a specified period of time, usually a 24-hour day or several days. It lists a person's activities in chronological order and states when each activity began and ended. For each activity, time-budgets record who was involved, where the activity took place, and whether there were other simultaneous activities (Michelson, 1985). A time-budget therefore not only provides information on the duration of time spent in various activities; it also captures what time of day and in what sequence these activities take place (Joyce and Stewart, 1999). Further, the chronological reporting procedure avoids many pitfalls that other survey estimation procedures encounter (Stinson, 1999).

Several recent time-use studies examined the impact of new IT on people's everyday lives. For instance, Robinson et al. (2000) compared the mass media use and social life of Internet users and nonusers based on a 1998 survey of 3,993 adults in the United States. They found no significant or consistent evidence of time displacement of mass media use or social activities as a result of Internet or computer use. Internet users showed signs of more active social lives than nonusers. They concluded that Internet use and personal computers may have more in common with time-enhancing home appliances such as the telephone than they do with the time-displacing technology of television.

A study of 2096 households in the United States found that Internet use has considerable impact on a person's time-use pattern and shopping behavior (UCLA-CCP, 2000). The study revealed that Internet users on average spend 9.4 hours per week online and that they watch significantly less television than nonusers. It found that more than half of Internet users have purchased online, and 8.9% of purchasers buy online weekly. The average amount spent online per month by Internet purchasers is $113. About two-thirds of Internet purchasers reported that online purchasing of goods and services has reduced their purchases from brick and mortar retail stores. The more frequently Internet users buy online, the more they shift away from traditional retail. Another study of 4,113 adults in the United States has similar results (Nie and Erbring, 2000). It found that the more time people spend using the Internet, the less time they spend on the traditional media. The media are competing with the Internet for time, especially in the case of television where as little as two hours per week on the Internet lead to a decrease in TV viewing. Further, the study found that the more time people spend using the Internet, the less time they spend shopping in stores and commuting in traffic. This effect grows with the number of Internet hours per week, and is particularly apparent for people who use the Internet for researching product information or for actually making purchases online.

Although revealing how people spend their time, time-use studies often do not explicitly incorporate the spatial dimension in their data collection effort or analysis. The time displacement perspective therefore needs to be expanded to a space-time displacement perspective in order to address the geographical implications of time displacement, and to be useful for understanding the impact of new IT on people's activity patterns in space-time and the urban economy. The space-time displacement perspective not only suggests that the time people spend on new IT takes time away from other activities; it also emphasizes that there are distinctive geographical consequences associated with such time displacement. For example, as mentioned above, if people spend more time using the Internet, they may spend less time on social activities; and as Internet users purchase

online, they may spend less time shopping in and making trips to stores in the physical world. If there is considerable space-time displacement between people's activities and use of new IT, research that focuses on the activity-travel behavior of people (e.g., shopping, social and recreational activities) may help identify important links for deciphering the impact of new IT on the social and economic geographies of urban areas.

CONSTRAINT RELAXATION AND TIME-GEOGRAPHIC RESEARCH

Another perspective helpful for understanding and examining the impact of new IT on people's daily lives and the urban economy is the time-geographic perspective (Hägerstrand, 1970). Time geography conceives and represents an individual's activities and travel in a 24-hour day as a continuous temporal sequence of activities in geographical space. What a person can do in a day is limited by the amount of "usable" time available and the space-time constraint associated with various obligatory activities (e.g., work). An important concept in time geography is the space-time constraint, which refers to the limited locational and temporal flexibility of a particular activity that restricts a person's freedom in choosing where and when to perform other activities. For example, the location and timing of a daily childcare drop-off or other child chauffeuring may impose limits on a mother's work hours (when) and job location (where).

In a time-geographic perspective, an important transformation that may result from new IT is the relaxation of many of the traditional space-time constraints that limit human spatial mobility and activity space. For instance, as many activities no longer need to be performed at certain places or times (e.g., through e-shopping), more time may become available for undertaking many other activities, and more flexible spatial and temporal arrangements of human activities become possible. Research that focuses on identifying the distinctive patterns of human activities and trips associated with different levels of IT usage may therefore shed important light on how different urban areas and activities will be impacted. Research on the effect of new IT use on individuals' space-time constraints and activity patterns will also help evaluate the validity of the "death-of-distance thesis"—that is, with the friction of distance obliterated by the space-transcending capability of new IT, distance is no longer an organizing principle of human spatial behavior and the city (Mitchell, 1995; Cairncross, 2001). Urban researchers and geographers have long questioned the credibility of this argument (e.g., Couclelis, 1996, 2000; Graham, 1997, 1998; Gillespie and Richardson, 2000; Black, 2001; Malecki and Gorman, 2001), but empirical research that specifically addresses this question using the time-geographic perspective is still quite limited to date.

Using hypothetical examples, Janelle (1995) and Black (2001) illustrated how space-time constraints can be relaxed through the use of new IT and how this will affect a person's activity space—either through the substitution of a phone call for face-to-face meeting, or the substitution of telework for commuting. They both suggested that a person can reach more opportunities and will likely have a larger activity space as the use of new IT helps to relax some space-time constraints. Based on time-use statistics collected in Canada, Harvey and MacNab (2000) examined the real-time communications potential associated with Internet connectivity. Their study revealed that coupling constraint, which relates to the temporal availability of communicating parties, remains important even for individuals with ready access to the Internet. Further, time-budget constraint may be

increasingly important as it becomes more difficult to connect with a person unoccupied when people use multiple modes of communications (e.g., phone, voice mail, pager, e-mail) in their everyday lives. They concluded that temporal coincidence remains a prerequisite for meaningful exchange between individuals, although the need for spatial coincidence is diminishing.

An important conceptual connection between time geography and everyday life in the information age was made by Adams (1995), who provided a theoretical extension of the original time-geographic framework to incorporate human extensibility enabled by the use of telecommunications technologies. The concept of human extensibility was first put forward by Janelle (1973). It refers to the ability of a person to overcome the friction of distance through space-adjusting technologies, such as transportation and telecommunications. Adams (1995, p. 269) extended this notion of extensibility through a new model of the person—where the body is conceived as a dynamic entity which combines "a body rooted in a particular place at any given time, bounded in knowledge gathering by the range of unaided sensory perception," and "any number of fluctuating, dendritic, extensions which actively engage with social and natural phenomena, at varying distances."

Based on this theoretical framework, Adams (1995) developed the extensibility diagram using Hägerstrand's space-time aquarium. It portrays a person's daily activities and interactions with others as multiple and branching space-time paths in three dimensions, where simultaneity and temporal disjuncture of different activities are revealed. Fluidity of personal boundaries is represented by fuzzy zones surrounding the space-time paths. This method, as shown in Adams (1995), can be used to represent a diverse range of human activities in both the physical and virtual worlds, including telephoning, driving, e-mailing, reading, remembering, meeting face-to-face, and television viewing. While Graham and Marvin (1996, p. 192) also illustrated the possibility of understanding the combined use of urban space and electronic space through the time-geographic perspective, Kwan (2000) explored and implemented the extensibility diagram as an analytical tool within a 3D GIS. Using the navigational history of a person's Web browser and data collected through personal interview, she developed a method that takes into account the multiple spatial scales and temporal complexities (e.g., simultaneity and disjuncture) involved in individual activities in both the physical and virtual worlds. Adams (1999, 2000), on the other hand, constructed rich cartographic narratives of five persons' daily lives based upon data collected through personal interviews and detailed records of their communications activities.

Another development was that by Kwan (2001), who proposed a conceptual framework of human cyberspatial behavior based on the time-geographic perspective. She argued that, for several reasons, space-time constraints are still important even in the information age. First, the space-time availability of access devices or connecting services may affect the extent to which individuals can use new IT such as the Internet (e.g., people who have access to computers or the Internet only in the workplace or school). Second, certain types of IT-mediated transactions are still spatially and/or temporally fixed (e.g., real-time chat). Third, Internet users are sensitive to delays and the amount of time needed for IT-based transactions. If users are time-sensitive, it may be concurred that space-time constraints will remain an important influence on the space-time patterns of people's daily activities.

These recent time-geographic studies not only suggest that significant insights can be gained through examining the impact of new IT on people's space-time constraints, they also indicate the kind of data and methods useful for the geographical studies of everyday life and the urban economy. However, this kind of research is still uncommon in geography to date, perhaps due to the fact that the required data are costly and time-consuming to collect, and that there are few established methods for analyzing these complex data. Past studies of human activity-travel patterns by transport researchers, however, may shed light on how data about individual activities in space-time can be collected and analyzed.

TELE-SUBSTITUTION AND HUMAN ACTIVITY-TRAVEL PATTERNS IN SPACE-TIME

With the increasing importance of nonconventional forms of work organization—home-based telecommuting, neighborhood work center and mobile work—new patterns of work and nonwork travel enabled by the use of new IT may have significant implications for urban development in the future (Kurland and Bailey, 1999). Studies on the relationship between telecommunications and activity-travel patterns in the last decade or so mainly focus on the effect of telecommuting on the number and type of trips people make. Activity-travel pattern denotes a summary characterization of all attributes of an individual's daily activities and trips. These characteristics include the timing, duration, location, frequency and sequence of activities, and the travel time and distances of trips. Research on human activity patterns emerged in the 1960s and has witnessed a new wave of development in recent years (e.g., Golob 1998, 2000; Lu and Pas, 1999). These studies rely on data collected through the use of an activity-travel diary, which provides a detailed and continuous record of a person's activities and travel for a particular period of time (from one day to several weeks). The emphasis is on the interconnectedness of a person's daily activities and their interaction with the activities of others in the same household. Using these data, it is possible to understand the everyday life of a particular time and place, as well as the interaction between people's daily life and the local geographical and social context (Hanson and Hanson, 1993).

Several studies used the geocoded activity-travel data from the State of California Telecommuting Pilot Project collected in 1988–1989 to assess the impact of home-based telecommuting on travel. They observed a significant reduction in work-related travel and a contraction of activity space for telecommuters as a result of telecommuting. For instance, Pendyala et al. (1991) found that telecommuters not only substantially reduced their trip making and the total distance traveled, but also chose nonwork destinations that are closer to home. They observed that telecommuters exhibited contracted action spaces after the introduction of telecommuting, and the contraction took place on both telecommuting days and commuting days. In another study, Koenig et al. (1996) observed a significant reduction in the number of trips and vehicle-miles traveled for telecommuters. Telecommuting caused a slight increase in the number of nonwork trips. They found that telecommuters made shorter but more frequent nonwork trips on their telecommuting days. Another study by Saxena and Mokhtarian (1997) has similar findings: the share of activities performed close to home increased considerably for telecommuters on telecommuting days; there was a contraction in the size of the activity space for telecommuters on commuting days, and destinations on telecommuting days were more evenly distributed

in all directions around the home, whereas a majority of destinations on commuting days were oriented toward the work location.

Although these studies observed that telecommuting did not induce a significant increase in nonwork trips and activities, their results may be due to the experimental nature of these early telecommuting projects where participants were aware of the need to reduce travel to mitigate congestion (Mokhtarian et al., 1995). Studies that used other data sets tend to be more affirmative of the possibility that the use of new IT at home may lead to an increase in nonwork trips and activities. Using data from the Puget Sound Telecommuting Demonstration Project, for instance, Henderson and Mokhtarian (1996) observed a considerable reduction in commute-related travel and a slight increase in nonwork travel as a result of center-based telecommuting. In a study that used the data from the California Neighborhood Telecenters Project, Balepur et al. (1998) found that telecommuters undertook a significantly higher number of return home, eat meal, shopping, and social/recreation trips on telecommuting days when compared to nontelecommuting days. Further, although distance traveled by telecommuters declined significantly on telecommuting days, they had more and shorter trip chains, and tended to start traveling later and end earlier on telecommuting days than on nontelecommuting days. This indicates both spatial and temporal changes in people's activity-travel patterns as a result of using new IT for work in telecenters.

The results of other studies also supported the tendency for nonwork activities and trips to increase as a result of higher level of new IT usage. For instance, Gould and Golob (1997) assessed the potential impact of electronic home shopping on travel using data from the Portland Household Activity and Travel survey. They found that people working exclusively at home on a given day spent significantly more time shopping on the work day than did persons working away from home. Further, there was a tendency for home workers to shift the focus of their shopping activities toward their residential locations. They concluded that a significant portion of travel time saved through using electronic shopping will find its way to increased out-of-home activities and to newly generated travel.

In another recent study, Mokhtarian and Meenakshisundaram (1999) examined four types of interaction between the use of new IT and travel: substitution, generation, modification and neutrality. They found a predominant effect of generation—which occurs when the use of one mode increases the use of another (e.g., the greater the availability of information about activities and people of interest, the greater the travel to participate in those activities or meet those people). They observed that e-mail and face-to-face meetings are the fastest growing mode of communication, and that increasing use of new IT is unlikely to reduce travel significantly. Based upon the results from a survey in the U.K. of home-based telework in medium and large-sized firms, Gillespie and Richardson (2000) observed that, far from reducing the need to travel and contributing to more environmentally sustainable urban forms, the use of new IT is associated with mobility-intensive and spatially dispersed activity patterns. They argued that telework and tele-activtities are best understood not as developments that suppress the demand for mobility but rather as forms of "hypermobility." Other studies have also found complementarity between the use of new IT and travel to be stronger than substitution (e.g., Zumkeller, 1996).

From the evidence provided by these studies, it is apparent that the impact of new IT on human activity-travel patterns and urban development is highly complex, and substi-

tution tends not to be the dominant effect as often assumed. As Mokhtarian (1990, p. 240) asserted, the most important impact of telecommunications is that "it permits much more flexibility in whether, when, where, and how to travel, and thus loosening the constraint of having to be at a certain place at a certain time." Similarly, Salomon (1985) argued that people's desire to move about will offset a large proportion of the travel that will be replaced by telecommunications. The total effect of new IT on transport is likely to be a modification of travel patterns rather than a reduction in the demand for travel. Their early observations are supported by the results of a national study in the U.S. (Niles, 1994). Perhaps the only thing certain from the results of previous empirical research is that the increasing use of new IT will lead to changes in the space-time patterns of human activities and travel, and this will likely have an impact on urban development in the future. How these changes and impacts will unfold in a particular geographical and social context can only be concretely specified through empirical research.

CONCLUSION

One of the critical impacts of new information technologies (IT) on everyday life and society is their potential for changing the spatial and temporal arrangement of human activities. Urban researchers and geographers have made important contributions to studying these changes in the past. Several helpful perspectives that can enrich this area of research, however, have been relatively ignored in the literature. This progress report discussed three of such perspectives that emphasize the importance of time: (1) space-time displacement and time-use studies; (2) constraint relaxation and time geographic research; and (3) tele-substitution and studies on human activity patterns. The distinctive data and methods used in the studies reviewed in the paper may also inform future geographical research on new IT. Several challenges, however, remain for future research on the impact of new IT on the geographies of everyday life.

First, in light of the fact that individual-level analyses are able to identify relationships that are not apparent at the aggregate level, researchers need to move beyond the reliance merely on aggregate area-based data. Research on IT-related themes at present, however, does suffer from a lack of individual-level data at fine spatial and temporal scales. The second area of challenge for future research is therefore the collection of geo-referenced data of individuals' activities and travel that allow the construction of detailed account of the space-time geographies of everyday life in particular urban areas. Methods for analyzing these complex space-time data will also need to be developed. Third, examining interactions among household members is also important since any change in a person's activity pattern may be accompanied by changes in the activity patterns of other members within the same household. Uncovering these within-household variations may shed light on the differentiated impact of new IT on the quality of life for different individuals. Finally, future research will also need to examine the role of social and geographical context in shaping the impact of new IT on particular social groups and in particular urban areas. Issues pertinent to the effect of gender, race and class, as well as landuse pattern, the transport system, and localized social networks will need to be examined.

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