

# The Internet, mobile phone and space-time constraints

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## Abstract

While the implications of information and communication technologies (ICTs) for daily travel and activities have been studied extensively, there is only scant attention paid to the relations between ICTs and space-time constraints. This study therefore explores the extent to which the Internet and mobile phone increase the spatial and temporal flexibility of everyday activities through a review of the literature and empirical research with data from Columbus (Ohio, USA) and Utrecht (The Netherlands). The analysis suggests that the implications of the Internet and mobile phone are complex and dependent on the type of activity, persons involved, technologies and socio-physical context in which they are embedded. Various regularities can, however, be detected. For the study participants, the Internet and mobile phone relax temporal constraints to a stronger degree than they enhance spatial flexibility. There are also space-time constraints that seem to persist or have come about because of ICT adoption. Finally, it appears that the Internet and mobile phone at best consolidate differences between men and women in the space-time constraints associated with everyday activities.

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## 1. Introduction

The impacts of information and communication technologies (ICTs) on people's travel behavior and their everyday life in general have attracted increased attention in scientific inquiry over the past two decades (see Kwan, 2002a; Mokhtarian and Salomon, 2002, for reviews). Most of this work concentrates on how the Internet influences commuting and shopping behavior, though recently more attention is being directed toward the role of the mobile phone, leisure mobility, and overall travel patterns (e.g., Kwan, 2007; Mokhtarian et al., 2006). Whatever the type of travel and technology addressed, this literature is primarily concerned with the interrelations between ICT use and revealed personal travel behavior. Research about changes in the space-time constraints conditioning the actualization of trips and activities is much scarcer.

There is a broad consensus that modern ICTs are capable of lifting space-time constraints but disagreement exists about the extent of that relaxation. Probably the most extreme position is taken by the proponents of the 'death-of-distance' thesis, which posits that the space-transcending capabilities of recent ICTs render obsolete the notion of distance as an organizing principle of human behavior and urban structure (Cairncross, 2001, for instance). Geographers have long questioned this thesis (Graham and Marvin, 1996; Aoyama and Sheppard, 2003) but tend to disagree about the level of spatial and temporal flexibility afforded by the Internet and more recent mobile technologies. Couclelis (2000, 2004) has noted that the associations between activity, place and time have weakened through ICTs and argued that human activities tend to disintegrate into sets of acts that are distributed across different times and geographical locations. This ICT-enabled fragmentation of activities may coincide with a larger action space and spatial reach for individual travelers. Other researchers are, however, more cautious and argue that space-time constraints continue to be

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relevant in the Information Age, because online activities always have to be accommodated in the physical world and virtual spaces are grounded in social and physical spaces (Kwan, 2001; Dijst, 2004; Zook et al., 2004).

The current paper has two main objectives. It seeks to provide a conceptual discussion of the extent to which the Internet and mobile phone increase the spatial and temporal flexibility of people's daily activities. To this end, we draw somewhat eclectically on the rapidly growing literature about these ICTs in the fields of geography, transportation studies and sociology. Additionally, since there has so far been little empirical research about the extent to which space-time constraints are lifted, we will also bring together some observations from our own research to assess to what extent the Internet and mobile phone modify some of the space-time constraints that shape daily time-space paths. In a nutshell our argument will be that the relations between constraints and ICTs are very complex and depend on the socio-physical contexts in which they are situated. Specifically, these relations often depend on the type of activity undertaken, the persons, technologies, other material artifacts and the places and times involved, as well the social relations in which people are embedded. This last point implies, for instance, that it is essential to consider how sex and gender as major axes of social differentiation affects the relations between ICTs on space-time constraints. We will also argue that it is important to attend to the unforeseen, ambiguous and at times paradoxical impacts of new technologies on space-time constraints. All of this implies that the question to what extent ICTs relax space-time constraints defies simple answers.

## 2. Space-time constraints and ICTs

### 2.1. Time-geography and space-time constraints

We will employ Hägerstrand's time-geography as the basic analytical framework for our exploration and extend it with relevant concepts and notions from other strands of literature where required. Despite trenchant critiques by prominent geographers and social theorists (Giddens, 1984; Harvey, 1990; Rose, 1993, for instance), we believe time-geography to be extremely valuable for our purposes for at least four reasons. First, it provides a conceptualization of space-time constraints and how these condition action in the physical world. Second, although this is not always well understood, its space-time trajectory model was explicitly intended to facilitate inquiry into the interactions between society, nature and technology (Hägerstrand, 1976, for instance). Third, as feminist geographers have employed the approach for several decades to show how women's quotidian activities are affected by gender ideologies (England, 1996; Kwan, 2002b), we believe it to be capable of informing research about the ways ICT usage is entwined with processes of social differentiation. Fourth, advances in GIS and the shift from supply to demand-oriented transportation policies have resulted in renewed

attention for time-geography and space-time accessibility modeling among transportation researchers (Kwan, 2004; Miller, 2005).

A key time-geographic concept is the *space-time constraint*, which can be categorized into three main types (Hägerstrand, 1970):

- *Capability constraints*: or instrumental, physiological, and cognitive limitations;
- *Coupling constraints*: the requirements for people to associate themselves with others and material artifacts at specific places and times for a certain duration in order to realize production, consumption and transactions; and
- *Authority constraints*: laws, rules and norms regulating the access to space-times. Gender-role constraints prescribing specific activities to men or women also fall in this category (Tivers, 1985; Kwan, 2000a).

These constraints can mitigate but also reinforce one another's impacts on activity participation and travel behavior.

Underlying these general types, there are a series of basic conditions or constraints to which all interactions between people, other organisms, and artifacts are subject (Hägerstrand, 1975). These include, among others, the indivisibility of the human body; the limited ability of human beings to take part in more than one task at a time; and the facts that every task has a duration and movement between points in physical space costs time (Table 1).

### 2.2. Relaxation of constraints

#### 2.2.1. Time-geographic basic conditions

It could be argued that modern ICTs have the most profound implications for three of the time-geographic basic conditions originally outlined by Hägerstrand (Table 1). First, strictly speaking recent wired and wireless technologies do not relax the condition of the indivisibility of the human body but they do make it easier to act at a distance (Adams, 1995; Kwan, 2000b). They enable a distributed and networked person consisting of a human body and a varied set of artifacts in other space-times. Consequently, the (corporeal) presence/absence binary characteristic of classic time-geography is modified; the incorporeal presence in other space-times through voice messages, emails and related communications allows for a variety of absent presences (Adams 1995; Schwanen, 2007a). Assemblages of human bodies and communication technologies clearly predate the Information Age, but recent ICTs have greatly expanded the opportunities for action at a distance. These technologies are often conceived of as extensions of the body, but Callon and Law (2004) prefer the metaphor of organs integrated into the body when discussing such devices as the mobile phone. This, they believe, brings out better that ICTs actively reconfigure agency and subjectivity and enhance the senses in ways previously

Table 1  
Influence of Internet and mobile phone on time-geographic basic conditions

Time-geographic basic conditions (see Hågerstrand, 1975)	Impact of the Internet (and wired ICTs in general)	Impact of the mobile phone (and wireless ICTs in general)
(1) Indivisibility of the human being	Not relaxed as such but the corporeal body is more easily augmented with incorporeal parts so that the presence/absence distinction is blurred to a greater extent	Idem, but the effects may be larger as wireless applications are likely to relieve spatial constraints to a larger degree than wired technologies
(2) Limited length of each human life	Not much affected (at least in theory, information on the web may persist after one's death)	Not affected
(3) Limited ability of the human being to take part in more than one task at a time	Somewhat relaxed, as the (wired) Internet facilitates multitasking at a stationary location in space-time	Significantly relaxed, as mobile technologies facilitate multitasking at many more locations and while in transit
(4) Fact that every task has a duration	Not relaxed as such; impact on the duration of tasks is not clear and is probably situation-specific. Probably the largest gain through the substitution of physical trips	Idem
(5) Fact that movement between points in space consumes time	Not relaxed as such, although the time consumption of virtual travel is usually considerably smaller. The exact extent of speeding up depends on the technology utilized and traffic on the network	Idem
(6) Limited packing capacity of space	Indirectly relaxed: incorporeal presence does not occupy more room than that required by the stationary equipment	Indirectly relaxed: incorporeal presence demands that equipment is carried along. With the miniaturization of wireless equipment the effect on the packing capacity of spaces has become very small
(7) Limited outer size of terrestrial space	Not affected	Idem
(8) Fact that every situation is inevitable rooted in past situations	Not relaxed as such, although situations can be rooted more easily in past situations elsewhere	Idem

impossible (see also Amin and Thrift, 2002). Either way, the result is a network of body and artifacts allowing for different modes of presence in multiple space-times.

Second, and related to the first point, ICTs make it easier for individuals to participate in multiple tasks and activities simultaneously, which implies that to a certain extent the zero-sum property of time is relaxed (Kenyon and Lyons, 2007). Third, ICTs enable a speeding up of movement in physical space, especially when corporeal travel is substituted. The extent of this acceleration should not be exaggerated, however. Despite widespread belief that ICTs have brought the process of time-space compression to completion (cf. Castells, 2000; Virilio, 2000), the effects are geographically highly uneven (May and Thrift, 2001).

Two further remarks about the basic conditions are in order. It is conceivable that ICTs may reduce the time required for completion of task. However, virtual activities can take more time than corresponding physical activities and displace other kinds of physical activities (Kwan, 2002a; Mokhtarian et al., 2006). It is also important to appreciate that wired and wireless technologies have differing implications for space-time constraints. For instance, wireless technologies such as the mobile phone relax the limited ability to take part in multiple activities simultaneously to a greater extent than do wired technologies, especially when the phone is equipped with wireless Internet and other applications (Kwan, 2007).

### 2.2.2. Capability constraints

The interacting impacts of ICTs on the time-geographic basic conditions have implications for the relations of capability, coupling and authority constraints with daily travel and everyday life in general. As alluded to in the introduction, recent ICTs deterritorialize activities, making them less tied to specific time-spaces (Couclelis, 2000; Aoyama and Sheppard, 2003; Urry, 2004). This means that capability constraints imposed by the physical characteristics of one's environment are to a certain extent relaxed. ICTs allow people to undertake a larger set of activities in a given constellation of material objects (Raubal et al., 2004). It has become, for instance, easier to combine paid labor and care-giving at a single physical location (Rakow and Navarro, 1993) or to use waiting or travel time more productively (Mokhtarian and Salomon, 2001; Lyons and Urry, 2005). Consequently, activities are fragmented (Couclelis, 2000) and the boundaries between the various spheres of daily life – paid labor, care-giving and leisure – become blurred (Wittel, 2001; Urry, 2004).

Recent ICTs also affect the relations between capability constraints and people's knowledge. Because corporeality imposes limits on the spatial range of their sensory perception, intimate linkages exist between individuals' corporeal space-time paths and their knowledge accumulated during "watching and doing in highly particular contexts in direct mutual interaction" (Thrift, 1985, p. 373). ICTs enable people to transcend the limitations imposed by traditional,

corporeal sensory faculties and allow them to obtain knowledge of other space-times more easily. Again, this capacity is not specific to modern ICTs; however, because the speed of the circulation of information is higher than ever before (Townsend, 2000), people have unprecedented access to information and knowledge of other space-times. These repertoires of extra knowledge may be utilized in various ways, including the management of uncertainty about travel times and arrival times at destinations both before engaging on a trip or en route and for micro-coordination (Bonsall, 2004; Ling, 2004; see further below). Additionally, one of the attractions of online shopping is that ICTs can be used to obtain more specialized product knowledge and compare alternatives in ways that would be too costly and time-consuming when conducted in physical stores (Farag, 2006).

### 2.2.3. Coupling constraints

With respect to coupling constraints, ICTs like the Internet and especially the mobile phone allow for novel, interaction-based modes of managing spatially and temporally fixed activities. According to Ling (2004, p. 58), clock-based activity planning is complemented with, and sometimes replaced by, phone-based scheduling:

As the mobile phone becomes ubiquitous, it competes with and it supplements time-based social coordination. In essence, we begin to move away from the parallel interpretation of a common metering system, i.e., [clock] time, and replace that with the possibility for direct contact between those who are coordinating their interactions

ICTs thus allow for nuanced management of social interaction or *micro-coordination* (Ling and Yttri, 2002), of which various forms have been identified. First, it has rapidly become custom for persons running late to inform others waiting for them about their late arrival, thereby softening their own schedules (Bonsall, 2004; Ling, 2004). Second, people often make intensive and repeated use of e-mail, text messages and (short) calls to iteratively work out the details of meetings or to re-arrange planned activities and trips. Empirical research has suggested that iterative planning and midcourse adjustment are especially important for parents in dual-earner families who have to combine employment, driving the children around and all kinds of errands (Ling and Yttri, 2002; Hjorthol, 2005; Schwanen, 2008). Third, people use ICTs to mobilize social networks on short notice (Rheingold, 2003). This can be for practical assistance – for instance to arrange instant childcare (Schwanen, 2008) – but also for leisure and social activities (Wittel, 2001). As a consequence, a shift from place-based connectivity to individual, person-to-person connectivity can be observed (Wellman, 2001; Kwan, 2007). Collectively these strategies point to the rise of more open-ended, interaction-based planning and activity scheduling styles thriving on flexibility and spur-of-the moment improvisations, whereby fixed commitments are traded at least to some ex-

tent for flexibility and the possibility to reallocate resources as efficiently as possible (Townsend, 2000).

### 2.2.4. Authority constraints

With regard to authority constraints, ICTs allow people to circumvent the restrictions imposed by the opening hours of brick-and-mortar shops, services and other facilities, thereby increasing individuals' windows of opportunity for shopping and other errands (Crang et al., 2006). Indeed, whereas it is debatable whether it may actually result in time-savings, one of the main advantages of online shopping is that it increases the temporal flexibility of shopping; consumers can perform their shopping at the moments it suits them well (Farag, 2006). In addition, as it allows people to escape their corporeality and play with their social identities, some commentators have heralded the Internet as reconfiguring and overcoming gender-role constraints. In this optimistic view, the Internet is capable of significantly stimulating the emancipation and empowerment of women (Valentine and Holloway, 2002; Madge and O'Connor, 2006, and the references therein).

## 2.3. Multiple relations between ICTs and space-time constraints

The previous discussion suggests that the Internet and the mobile phone are capable of fundamentally altering the space-time constraints configuring everyday life. So far, however, attention has been directed neither to the more ambiguous effects of ICTs on constraints, nor to the possible differences in the implications of ICTs according to sex and gender, class, race/ethnicity, age and other axes of social differentiation. Two bodies of work may inform our exploration of these issues in this and the following sections. First, critical theory can be used to emphasize that ICTs are adopted and used within societies that are dominated by patriarchal (racial, heterosexual, etc.) relations and ideologies and may strengthen existing power relations (e.g., Haraway, 1991; Graham, 2005). The non-neutrality of recent technologies manifests itself in particular in the persistence of digital divides in access to and use of ICTs. Second, for several decades now, commentators in the field of Science, Technology and Society (STS) studies have argued that it is essential to take account of the dynamic interactions between technological changes and social processes. Rather than discussing technology exclusively in terms of tools or instruments employed to achieve a certain goal, the technological and the social should be seen as both cause and effect of each other (Latour, 2002; Callon and Law, 2004, for instance). This means, among others, that individuals' goals and intentions may change through their association with technologies.

### 2.3.1. Intensified space-time constraints on women's everyday life?

Recall from Section 2.2 that incorporeal presence in multiple space-times implies that the boundaries between



different spheres of life are being blurred. This can be welcomed, as it increases persons' freedom to schedule their activities according to their own liking, but there are also disadvantages associated with these developments. People can much easier call upon a person at times and places that s/he may not like this to occur. Further, transgressions from one sphere of life into another may differ between men and women. It has been argued that, whereas the employment sphere transgresses into the domestic space-time for men, the reverse tends to be the case for women (Massey, 1995; Brannen, 2005). Research suggests that the mobile phone facilitates and intensifies this difference. Rakow and Navarro (1993) introduced the term 'remote mothering' to denote the tendency among mothers to manage family responsibilities at-a-distance. Recent mixed-method research in Israel also shows that women use the mobile phone much more often to manage household roles from a distance than do men (Lemish and Cohen, 2005). Using longitudinal data from three communities in New York state, Chesley (2005) provided partial evidence for the notion that ICTs reinforce differences between men and women in the blurring of the employment and domestic spheres. She found that persistent ICT usage resulted in negative spillovers from the domestic into the employment sphere for women but not for men, but also that ICT use was positively linked to spillovers from employment into home for men and women. In sum, while the rigidity of coupling constraints may be renegotiated in interaction-based planning, the frequency and diversity of coupling constraints may in fact increase, particularly for women.

The studies cited in the previous paragraph also illustrate that the Internet and other technologies can reinforce gender-role constraints that prescribe specific tasks and activities to men and women and can be considered one type of authority constraint. Recent research by Madge and O'Connor (2005, 2006) about new mothers' Internet use suggests that cyber-contacts provides virtual social support and information, giving those mothers a real sense of empowerment. At the same time, however, the Internet perpetuated traditional stereotypes about mothering and gender roles. Consistent with other reflections on the interactions between online and offline worlds (Valentine and Holloway, 2002; Aoyama and Sheppard, 2003; Zook et al., 2004), Madge and O'Connor conclude that online activity is always situated in everyday corporeality and embodied practices, thereby reinforcing place-specific social processes and cultural norms and, we might add, also authority constraints.

### 2.3.2. *New and enhanced coupling constraints in urban places?*

The use of ICTs may entail new coupling constraints in time and space, because the material devices that facilitate communications at-a-distance have to be placed in physical space-times. The space-time paths of these devices have to be coordinated and brought together with those of the humans who want to use them (Pred, 1978; Kwan, 2001; Schwanen, 2007a). While such constraints may often be

more rigid for wired ICTs, they also pertain to wireless technologies. This is because mobile connections need to be maintained, meaning that devices need to be taken along, batteries recharged, etc. (Ling, 2004). Much of this maintenance work is so self-evident that it is overlooked; however, it is required to maintain instantaneous connectivity to other persons and incorporeal presence in various space-times.

Additionally, not all activities are liable to ICT-related flexibilization. Many activities are rooted in legal, economic and social obligations and events linked to specific settings, which need to be experienced corporeally (Urry, 2004; Mokhtarian et al., 2006). Such situations of corporeal co-presence with others and physical settings continue to impose coupling constraints on people's activity patterns. Some commentators have argued that telecommunication can intensify the need for face-to-face (f2f) contact and thus entail new coupling constraints. Research has indicated that f2f interaction is often essential to the decoding and interpretation of the massive flows of information circulating through ICT networks in major financial centers like the City of London (Thrift, 1996; Beaverstock, 2005). It is also argued that telecommunication is not as rich as face-to-face communication, because non-verbal communication (through gestures, looks, facial expressions, etc.) is more difficult with the Internet and mobile phone (Urry, 2003, 2004). The implication is that relations of trust are established and sustained more easily in situations of corporeal co-presence and f2f contact. This is one of the reasons for the growth of long-distance travel for social and business purposes and (international) professional meetings (Moss, 1998; Urry, 2003). Also, in consumer-to-consumer e-commerce, buyers and sellers frequently meet up physically to complete transactions, among others for trust-related factors (to reduce the risk of cheating). It remains to be seen whether such future technological developments as in videoconferencing and on-line reputation management systems in e-commerce affect this growth in corporeal travel facilitating f2f contact. If, however, physical co-presence is indeed crucial to the interpretation of digital information, further growth of corporeal travel may still result (Urry, 2004).

Finally, there are various capability and authority constraints restricting telecommunication, some of which have been constructed in response to the use of ICTs. Their usage may be prohibited in specific space-times for reasons of safety – in planes, for example – or to avoid noise disturbance – as in theatres, cinemas or some restaurants (Harvey and Macnab, 2000; Dijst, 2004). In addition, there are various capability constraints preventing people to use ICTs because they lack the resources to do so and/or the ability to operate the equipment and relevant software. Much has been written about the digital divide between the 'haves' and 'have-nots', which is commonly conceptualized in terms of having access to the Internet and typically related to differences in age, education, income, gender, race/ethnicity and geographical location (Graham, 2002;

Rice and Katz, 2003; Willis and Tranter, 2006). More recent contributions have re-conceptualized digital divides, paying more attention to differences in older and newer technologies or to wireless devices (Rice and Katz, 2003; Wareham et al., 2004; Castells et al., 2004), and arguing in favor of a shift in focus from artifacts to styles of use and the ways such uses mediate the logistics of everyday life (Crang et al., 2006). Though results vary by geographical context, these recent studies tend to reinforce the relevance of income, education, occupation and residential neighborhood in relation to digital divides. However, they also suggest that sex, age and race/ethnicity are less important in some geographical contexts, at least in explaining differences in wireless technology.

#### 2.4. *Toward the empirical analysis*

The available literature suggests that the Internet and mobile phone are likely to lift or significantly relax some constraints, but that others will persist or intensify. ICTs also come along with new capability, coupling and authority constraints, because these technologies require certain skills, have to be placed in physical space-times, are subjected to institutional regulation, and adopted in settings with existing social practices and cultural norms. The literature also suggests that the ‘benefits’ of fewer or weaker space-time constraints due to Internet or mobile phone use may be distributed unevenly across individuals. This unevenness stems not only from the persistence of difference in access to technologies but also from differentiation in styles of using ICTs on the basis of sex and gender and such factors as class and race/ethnicity. In brief, it is nearly impossible to state how the Internet and mobile phone reconfigure space-time constraints in general. Instead, sensitivity to the concrete contextualization of ICTs in situated interactions and to differences in the implications of their use is called for in empirical evaluations.

We will therefore try to identify sets of space-time constraints that are (partially) lifted as well as those that have persisted or become more important using two sets of empirical data from distinct geographical contexts, which complement each other despite various differences (the reasons for bringing these data together in this paper are detailed below). First, activity diary data from Columbus (Ohio, USA) will be used to examine the extent to which the Internet is capable of relaxing people’s coupling constraints. Second, using activity diary data and interviews structured around completed diaries, we will investigate how the mobile phone affects the space-time constraints associated with the ‘juggling’ of employment and domestic responsibilities in two-earner family-households in Utrecht (The Netherlands). Notwithstanding differences in methodology (see below), both sets of data enable insight into users’ perceptions and evaluations of ICT use for different kinds of daily activities. Both sets also allow us to concen-

trate specifically on differences in perceptions and evaluations between men and women in the analysis.<sup>1</sup>

The decision to bring together empirical material from two urban areas was made after the data collections had been implemented. This implies that we cannot make rigorous comparisons between these geographical contexts to distil how culture, institutional context or urbanization pattern mediate in the relations between space-time constraints and ICTs. Bringing the two sets of data together is nonetheless helpful, as they complement each other in a variety of ways. Each can be employed to address specific implications of ICT usage proposed in the literature. With respect to differences between men and women, for instance, the Columbus data can be used in relation to the question whether ICTs have intensified coupling constraints in particular for women, while the Utrecht data enhance our understanding of the implications of micro-coordination for mothers and fathers. Thus, the combination of quantitative and qualitative data enables a richer understanding of how ICTs mediate in men’s and women’s everyday life.

Additionally, the two sets of data illustrate the importance of distinguishing between wired and wireless technologies; collapsing the wired Internet and the mobile phone into a single category is not very helpful when studying space-time constraints. While many in the USA and the Netherlands have used the Internet for some time now, the Dutch on average have more experience with mobile phone than Americans albeit not as much as the people in countries such as Finland and Taiwan (Table 2).<sup>2</sup> The more mature cellular phone culture makes the Netherlands a more suitable context for investigating the implications of mobile telephony for space-time constraints.

Finally, though additional data collection enabling systematic comparisons between geographical contexts is definitely required, it should be kept in mind that there is as yet rather limited detailed empirical research about the complicated and two-way relationships between ICT use and activities in socio-physical spaces and possible differences therein between men and women (Valentine and Holloway 2002; Aoyama and Sheppard, 2003; Madge and O’Connor, 2006). In light of this gap in the literature, we believe that our different sets of data collectively enable at least a glimpse of the extent to which interactions between ICTs and space-time constraints manifest themselves in different spheres of daily life for specific social groups. The remaining sections should, however, be

<sup>1</sup> We readily acknowledge the importance of other axes of social differentiation like class, race/ethnicity or age and their interactions with one another and with sex and place. Partly because of data limitations and partly because of the complexity of their interrelations these issues are left for future research.

<sup>2</sup> In both countries mobile phones are increasingly used to replace landline phones, in particular among younger households. In the US this concerns about 6% of the households.

Table 2  
Diffusion of the Internet and mobile phone in selected countries, in 2000 and 2005

	Internet users per 100 inhabitants		Cellular phone subscribers per 100 inhabitants	
	2000	2005	2000	2005
United States of America	44.1	63.0 <sup>a</sup>	38.9	67.6
United Kingdom	26.4	62.9 <sup>a</sup>	72.7	102.1 <sup>a</sup>
Netherlands	43.8	61.6 <sup>a</sup>	67.3	97.2
Finland	37.2	63.0 <sup>a</sup>	72.0	99.7
Taiwan	28.1	58.0	80.2	97.4
Hong Kong	27.8	50.1	81.7	123.5

Source: ITU (2006).

<sup>a</sup> Statistics for 2004.

considered exploratory in nature, intended to draw attention to the complexity of the interactions between constraints and ICTs and to stimulate further thinking and research about this topic.

### 3. The Internet and space-time fixity of activities

Because it is not *a priori* clear to what extent the Internet relaxes coupling constraints, we will first examine the relationships among Internet use, and space-time constraints on everyday activities using activity-diary data from Columbus (Ohio, USA). Columbus is a mid-sized metropolitan area with a population of about 1.62 million in 2000. According to the 2000 US Census, white and African-American groups account for about 95% of the population in the region's most populated county (Franklin County) whereas the proportions of other ethnic/racial groups are small. Columbus is especially suitable for the study because its social and economic characteristics have been representative of the national trend and it has been called the "average city" of the US (England, 1993). Over half of its population have computers and use the Internet – 57.1% have computers while 52.7% use the Internet in 1999, according to the 2000 US Census. The digital divide in Ohio parallels national trends: African-Americans, poorer and less educated people have lower use of computers and the Internet.

An activity-Internet diary survey was conducted in the study area in 2003 and 2004 to collect the needed data. The paper-and-pencil survey instrument administered via surface mail collected data about the participants' personal information and Internet use, including the respondent's average Internet use pattern such as the time spent on various Internet activities in a typical week and the most important reasons why they choose to shop online. A two-day activity-Internet diary was also included in the survey, which collected detailed data about participants' physical and Internet activities in the two designated survey days. Since the number of non-Internet users in the sample was small, this section focuses mainly on Internet users. A total of 444 usable surveys from 472 individuals were

obtained. There are 288 women and 156 men among these Internet users. Most of these individuals are white (93%) and highly educated (80% are college or graduate degree holders). About 14% have an annual income under US \$40,000, and 42% an annual income over US\$80,000. There is thus an over-representation of women, whites, and highly educated and high-income individuals in the sample.<sup>3</sup> The activities recorded in the activity-Internet diary are classified into five categories according to their purposes: work or work-related activities, essential household needs, personal needs, pleasure or recreational activities, and social activities with friends and/or family.

The activity-diary data is used to answer two questions. First, we address the question what kind of physical and Internet activities are more spatially and/or temporally fixed in the daily lives of men and women. Second, we will concentrate on the extent to which people's Internet use relaxes their space-time constraints and whether these effects vary between men and women. All survey participants were asked to evaluate the ease with which the location and time to perform an activity can be changed on a scale from 1 to 5 (cf. Kwan, 2000a). A rating of 1 for an activity means that it was easy to change its location or time and a rating of 5 that it was difficult to change its location or time. The activities with ratings higher than three are treated as spatially and temporally fixed in this study.

With regard to the space-time fixity of *physical* activities, Table 3 shows that all physical activities of the male and female survey participants are more spatially fixed than temporally fixed, though this is most pronounced for household needs. This suggests that spatial fixity is more binding than temporal fixity for the research participants. Work, household related activities and personal needs are most frequently fixed spatially (over 70%). This is mainly because many of these activities are undertaken at the workplace or home, which are fixed locations that cannot be changed easily for these activities. On the other hand, only about 50% of the activities associated with recreational activities and social activities are spatially fixed – indicating that the location of many of these activities can be changed relatively easily. There are only minor differences in the spatial fixity of physical activities between men and women. Women's work, household needs and especially social needs are somewhat less fixed but their personal needs slightly more fixed in space than men's. With respect to temporal fixity, employment is the most temporally fixed activity. Less than 50% of all other

<sup>3</sup> This overrepresentation is not the result of sampling strategy, which was random sampling. A total of 32,000 household addresses were randomly selected from a digital phone directory of the study area. A screening package was mailed to these addresses to solicit participation. Households with at least one female adult (either married or unmarried, with or without children) who is 18 years of age or older, and with at least one adult who has Internet access were invited to participate in the study. The 875 households that agreed to participate were then sent the survey package (among these households, 472 individuals returned usable surveys).

Table 3  
Space-time fixity of physical and Internet activities

	Physical activities			Online activities		
	Total number of physical activities	Share of which is spatially fixed (%)	Share of which is temporally fixed (%)	Total number of Internet activities	Share of which is spatially fixed (%)	Share of which is temporally fixed (%)
<i>Employment</i>						
Male	525	87	74	129	58	33
Female	754	85	70	268	49	21
All	1279	85	71	397	52	25
<i>Household needs</i>						
Male	380	80	50	26	42	85
Female	1389	77	51	91	51	11
All	1769	77	51	117	48	10
<i>Personal needs</i>						
Male	1259	73	70	97	48	19
Female	2339	76	71	284	53	13
All	3598	75	71	381	52	15
<i>Recreation</i>						
Male	463	52	39	138	53	14
Female	833	51	36	193	61	16
All	1296	51	37	331	57	15
<i>Social needs</i>						
Male	136	60	53	8	75	13
Female	257	52	50	61	69	13
All	393	54	51	69	69	13

physical activities are temporally fixed, suggesting that the timing for many of these activities can be changed rather easily. Here too, differences between men and women are small. It is slightly easier to change the timing of work, recreation and social activities for women than for men.

With respect to the space-time fixity of *Internet* activities, we find that Internet activities are much less temporally fixed than spatially fixed when compared to physical activities for both men and women (Table 3). Less than 20% of all Internet activities (except work-related ones) are temporally fixed, against around or above 50% of the physical activities (except recreational activities). This suggests that the Internet allows men and women more freedom regarding the times at which they undertake certain activities, especially for non-employment activities. The extent to which Internet use can help relieve people's coupling constraints associated with fixed activity locations is, however, more limited. This is especially true for women: while their work and social activities are less frequently fixed in space, household needs, personal needs and recreation activities are more fixed than men's online activities. When compared to physical activities, women's recreation and social activities online are more spatially fixed than off-line. The same is true of men's social needs (Table 3).

Based on the above discussion, it appears that Internet use has few ramifications for people's spatial constraints restricting their physical movements. This is largely because Internet activities tend to have rather fixed locational requirements when compared to physical activities. For any particular individual, the Internet can

be accessed only at limited locations, especially the home and the workplace. The survey results indicate that only 5% of the participants access the Internet outside of home and office. Nonetheless, if the interaction between physical and Internet activities is considered, people's spatial coupling constraints may be reduced through Internet use because some spatially fixed physical activities may be substituted by certain Internet activities (e.g. using e-banking service instead of visiting a bank). Internet users may experience fewer temporal constraints because Internet activities are less temporally fixed than physical activities. This is especially true if they replace more of their physical activities by Internet activities.

Table 3 suggests that the differences between men and women in terms of spatial and temporal fixity are rather modest. While insightful, the table does not show how many (fixed) activities an individual conducts on-line or off-line per day. Computing these numbers shows that women conduct not only more physical and Internet activities but also more temporally constrained physical activities and more spatially constrained physical and Internet activities than do men per person per day (Fig. 1). This is due to women's larger responsibility for household activities, which is not compensated by men's more intensive participation in (fixed) employment activities or any of the other activity types.<sup>4</sup> Not only does Fig. 3 align with

<sup>4</sup> As differences in daily activity frequencies per person between men and women are only minor for personal needs, recreation and social needs, these activity types are not discussed in detail here.



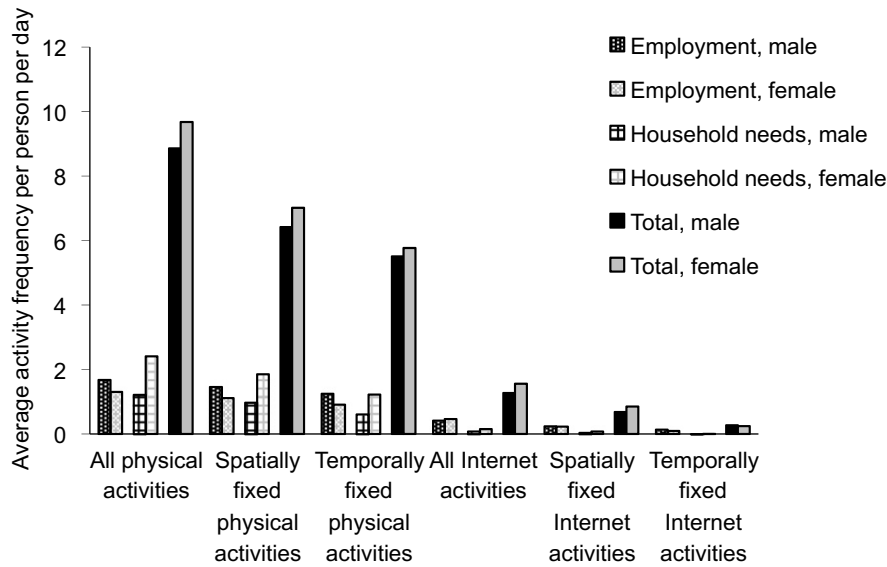


Fig. 1. Activity frequency per person per day.

previous studies showing that women face more stringent space-time constraints than men (Tivers 1985; Kwan, 2000a); it also suggests that the Internet does little to improve the space-time constraints on women and in fact seems to exacerbate spatial constraints. Consistent with the literature discussed in Section 2, it appears that the Internet may indeed intensify space-time constraints for women to a stronger degree than for men. While capable of empowering women, the Internet may also reinforce place-specific social processes and cultural norms and thus perpetuate or enhance differences between men and women in space-time fixity.

#### 4. The mobile phone and juggling employment and domestic responsibilities

Because of its wireless nature, the mobile phone is much less tied to specific physical locations than the (wired) Internet and is likely to reduce spatial constraints to a much stronger degree. This section therefore discusses the relations between mobile phone usage and space-time constraints using empirical material from the Utrecht region, the Netherlands. This region is located in the center of the Netherlands and is part of the Randstad Holland – the most urbanized, polycentric system of cities around the ‘Green Heart’ in the west of the country. In 2006, Utrecht housed some 281,000 people and its suburbs 343,000; the total number of inhabitants of the region was about 624,000 people.

For this study, 40 adults in dual-earner families filled out a one-day activity diary and were interviewed in the period September 2004–February 2005. The paper-and-pencil diaries (sent via surface mail) were administered on weekdays on which both parents engaged in paid employment, as it on these days that space-time competition tends

to be fiercest. The first author interviewed participants on the subsequent day about the diary and more generally about strategies for juggling responsibilities. A purposive sampling strategy was employed; participants were recruited via letters distributed in two day-care centers (one in the Utrecht city center, one in the suburbs) and an elementary school (also in the city center) and via snowballing procedures. This procedure was adopted because it maximized the chances of reaching dual-earner family-households and convincing them to participate. Respondents were selected on the grounds of several criteria. They must live together with a partner and at least one child younger than eight years old. Both adults should also spend at least one day per week on formal employment (or education). Further, it was deliberately attempted to recruit both mothers and fathers, given that the former tend to experience more space-time constraints, as well as individuals with different levels of autonomy over their employment times and spaces. Finally, families from neighborhoods that differ in terms of distance to the Utrecht CBD, local services and access to the highway and railroad systems were enrolled. The respondents cannot be considered representative for all dual-earner households in the Utrecht region. Participants were generally higher educated (82.5%) and white (97.5%) and most had at least one pre-school aged child (70%). Women and urbanites were also over-represented (75% and 65%, respectively), as were families utilizing market-based childcare (85%). However, these are also households experiencing many difficulties in combining employment and care-giving responsibilities and finding a satisfactory work-life balance. While conclusions about ICT use may not be generalizable to the population as a whole, investigating the way the mobile phone mediates the juggling of responsibilities by higher-educated dual-earner families is still interesting. The complicated household logistics imply that these households

in particular may benefit from the increased flexibility in the management of spatially and temporally fixed activities that mobile phones afford.

The interviews and activity diaries are employed to address three questions. First we will focus on how phone-mediated, interaction-based planning styles relax coupling constraints. Second, the question how capability constraints are mitigated will be explored. Finally, the ways in which constraints are created through the mobile phone will be explored.

#### 4.1. (Re)negotiating coupling constraints through interaction

The three interaction-based modes of managing spatially and temporally fixed activities identified in Section 2.2 are regularly employed by the participating dual-earner households. Softening schedules when running late, iteratively working out or re-arranging a meeting or division of labor, and mobilizing one's social network via the mobile phone are common strategies for juggling responsibilities and coping with unforeseen contingencies.

##### 4.1.1. Softening commitments and punctuality?

Using one's mobile phone to announce a late arrival at a destination seems to have become a universally accepted behavior in the Netherlands, and this also holds true for the interviewees. The transcripts provide numerous examples of how parents soften the commitment to be corporeally present at their workplace, a business meeting, their children's school or nursery, or at home for evening dinner at a pre-arranged (clock) time. Realizing they may not make it on time, they call not only to inform others but also to avoid or reduce their own feelings of unease, stress or guilt. Having access to a mobile phone is, however, not a sufficient condition for relaxing coupling constraints in many instances. As 'Jon'<sup>5</sup> (father of two, employed at a public agency) remarks in the context of business meetings with colleagues, the extent to which circumstances are beyond one's control is also important:

It took some time before I got a mobile phone. I was somewhat aversive, but I must say that nowadays I find it comfortable exactly for these kind of things. I notice that at the moment you are running late and you call my child is sick or there is a delay [in the transportation system] then it normally isn't much of a problem. (...) Say more than five minutes late, then I call I will be a bit later and with that I feel more, the problem is gone for me. If I both have a good reason and I tell it, then it doesn't feel as a problem anymore.

The interviews suggest that the possibility to incorporeally overcome physical distance with the mobile phone is no reason for becoming less punctual per se, at least for spatially and temporally fixed activities like business meetings or collecting a child. As timekeeping for these activities is clearly imbued with social norms (Schwanen, 2006), the mobile phone is used to support clock time-based planning rather than substituting for it. For employed mothers and fathers alike, the mobile phone is a useful aid to straighten things out in the event of an emergency preventing an on-time arrival at a destination but does not necessarily reduce the perceived space-time fixity of the activity to be performed there per se.

##### 4.1.2. Progressively working out activity arrangements?

While important for the relaxation of strict time-keeping, the cellular phone is also used to negotiate a division of labor between parents or an appointment with others in a series of communication episodes. It allows them to keep plans more open and flexible and so accommodate unforeseen contingencies. Several mothers related how they arranged social activities with friends in the evening after paid labor in a series of calls. A 'provided that' plan is set up some time in advance; the day before, or the same day as, the meeting another call is made "about how and what, as you never know exactly where you have to work that day and neither does she, or what [my husband] does that day or has in mind" (Kirsten, mother of two, employed at the communication department of a public agency). Whether this interaction-based planning style is adopted also depends on the lifestyle and personality of the other person(s) involved. The iterative planning of leisure activities seems to be more prevalent, if the other(s) also has (have) children who need to be cared for first and can tolerate unpunctuality in others to a larger extent. It should be borne in mind that most interviewees tended not to engage in social activities on workdays due to time constraints or because they lacked the energy to do so after a day's work and caring for the children.

Another activity where mobile phone-enabled, interactive planning has become important is the collection of children from day-care or after-school care, which in the Netherlands usually takes place between 16:30 and 19:00 h. Some interviewees related how they call their partner at the end of the workday about who will pick up their children. This micro-coordination is of a slightly different nature than in the case of social activities. Rather than a means for negotiating the details of an appointment, the mobile phone is used to see whether previously made plans about collecting the children need to be revised in light of momentary circumstances (Townsend, 2000). This way of evaluating earlier plans is illustrated clearly in the following vignette:<sup>6</sup>

<sup>5</sup> Fictional names are used to ensure the respondents' anonymity.

<sup>6</sup> The parts between brackets were spoken out simultaneously.

- 
- Louisa: We call at the end of day, but ((short pause))  
 Tim: So to arrange [who does the children, who the groceries]?  
 +  
 Louisa: [precisely about the planning] though we did agree on that, it is more a kind of eh (short pause) We never ever call each other during the day, but at the end of the day (...) then we start phoning to just see whether the conditional arrangement we have made is still convenient (...) so it is more that we check at the end of the afternoon if this is really the most efficient what we do now. Or can it be done more conveniently? And that is more the reason, and we may have made conditional arrangements, but half of the times, I think, there is a reason to do it just a bit different for whatever reason.
- 

Note, however, that this mode of renegotiating the coupling constraints associated with collecting the children is heavily dependent on parents' socio-physical contexts (cf. Madge and O'Connor, 2006; see also McDowell et al., 2005). If one parent – usually the father – has a much longer commute than the other, this interaction-based planning style is less likely to be found. Both parents also have to commute by transport modes allowing children to be taken along easily, which in practice means that both travel either by car or by bike.<sup>7</sup> Both parents' employment times should also be compatible with the time regime of the childcare providers. Finally, the household division of caring responsibilities is important: the father must be able and willing to take up part of the collection duties, which are still mainly conducted by mothers (Schwanen, 2007b). Thus, whether the mobile phone mitigates the coupling constraints associated with chauffeuring depends on and is enabled by households' socio-spatial context.

#### 4.1.3. Re-scheduling commitments within social networks: a mother's business?

The mobile phone is also indispensable to parents' coping with coupling constraints through the mobilization of social networks. Rather than juggling different claims on one's space-time resources alone, the cellular phone makes it much easier to call in others should this be required. Many interviewees indicated to rely on others if chauffeuring their children to/from childcare, school or extra-curricular activities is difficult to combine with their own activities or if activity schedules are disrupted by transportation failures (traffic jams and train delays), sickness of a child or other unforeseen circumstances. Decisions about

whom is actually called upon are a function of trust and practical availability. Facing incompatible claims on one's space-time resources, parents often first consult their partners to see if they can take their place before asking others outside the nuclear family-household. Next of kin – especially grandparents but also one of the parents' brothers or sisters – and the parents of the children's classmates and friends are the most likely candidates beyond the nuclear family to provide practical assistance.

Interestingly, the social network-based management of incompatible coupling constraints is gendered, which is consistent with other research (Gerstel and Gallagher, 2001; Wheelock and Jones, 2002; Skinner, 2005). It is usually the mother who organizes assistance. Several interviewees suggested that fathers responsible for chauffeuring the children tend to call their spouses to ask them to arrange something because they do not have access to the phone numbers of parents of their child's classmates to ask them if they want to look after their child. It seems, then, that mobile phone use may not be associated with changes in the gender relations with respect to the organization of chauffeuring duties by persons outside the nuclear family, thereby upholding existing practices and norms (Madge and O'Connor, 2006; Valentine and Holloway 2002).

#### 4.2. Relieving capability constraints, multi-tasking and blurring boundaries

The mobile phone also facilitates multi-tasking and to some extent blurs the boundaries between the employment and domestic spheres. Parents are to a certain degree appreciative of these mediations, although there are also more difficult aspects. This makes the mobile phone something of a mixed blessing: "on the one hand it gives you a kind of freedom, that mobile phone, as I at least have everyone in my reach and on the other hand it is of course a stress factor" (Helen).

##### 4.2.1. Reaching into other space-times while traveling

On the positive side, the mobile phone allows them to use time 'lost' in more productive ways. Commute time in general and time spent in road congestion in particular is used to make private business arrangements and maintain social contacts with friends and relatives. The latter is especially done on the return-home trip, as there is little time for these things from the moment of home arrival until the child(ren) have been put to bed and households tasks have been finished. Corporeally stuck in a slowly moving vehicle, the mobile phone is employed to extend oneself incorporeally into other space-times and so make the journey more enjoyable and a moment of relaxation (cf. Mokhtarian and Salomon, 2001; Lyons and Urry, 2005). Some also use the return-home commute to spend some time 'with' their spouse. Maria's husband often encounters congested road conditions and calls her almost daily when driving home:

<sup>7</sup> In the Netherlands the bicycle is the second most important commute mode after the private car (Schwanen et al., 2004). It is also quite common there to drive children around on bikes, particularly in cities where biking is often faster and more convenient. The car is nonetheless used most frequently for chauffeuring trips.

It has actually become a bit of a habit that we are in contact at the end of the day. Also to know where he is but yeah also to just be in contact or something I guess [and talk about] how things were the whole day. You know from each other what the nice and not so nice moments are. Because often when you come home you rapidly get accelerated again (...) while if he calls around half five, well I am cooking or something and we chat for a quarter of an hour every now and then.

Although she has some difficulties with putting her routines into words, Maria's vignette illustrates that the mobile phone is more than a coordination tool used for purely instrumental reasons. Some of the parents also use it in expressive ways for exchanging affection with their partners (a mode of use that remains underexposed in Ling and Yttri's (2002) discussion of household logistics).

The activity diaries administered by the participants also asked for each trip undertaken whether a mobile communication device was used. As the sample size is very small, we have to be very careful when interpreting the findings of any analysis of these data. They nonetheless show some interesting findings. For instance, the use of mobile technologies during trips was fairly modest: on 25 out of the 218 trips (11.5%) collectively undertaken by the respondents one or more mobile phone calls were made, and during four text messaging was also used. Most of these communication episodes were exclusively for private purposes. Further analysis showed that the mobile phone was used more often during trips with longer travel times and when respondents are traveling alone instead of together with others.

#### 4.2.2. *The pros and cons of mingling employment and domestic space-times*

The opportunities the mobile phone offers for bringing the domestic into the employment sphere are also perceived as largely positive by many (female) interviewees because of the security the capacity of connectedness the phone offers (cf. Ling, 2004). Several mothers explained how they leave their cellular phones switched on when at work, so that the nursery staff or school teacher can reach them should there be something with their child(ren). The phone thereby functions as an 'umbilical cord' as one of the mothers metaphorically described it. Here is Helen, a mother of two who brings the domestic sphere into the workplace and engages in a specific form of remote mothering (Rakow and Navarro, 1993):

---

Tim: If you are at work, do you normally have your phone switched on for the whole day?

Helen: Yes, but I don't get many calls you know but (...) it is the case that I take it along when I leave my desk and that is because I have children, I guess. I don't know whether I'd do that if I had no children, because it is for, well, if one falls or something then I want to go there.

---

The capacity to be continuously connected to the location of one's child(ren) was mainly emphasized by the mothers during the interviews. There were, however, households where actually the father was the first person the school or nursery of the child(ren) would contact if something was wrong, because his workplace is closer to the school or nursery, and/or he has more autonomy over his own employment times. The interviews also suggest that the specific form of remote parenting described here may reflect a technology-mediated reconfiguration of (female) parents' needs and intentions to have access to their children during paid labor (Latour, 2002). Through the adoption of the mobile phone, the perceived need to have access to the nursery or school of one's children seems to have increased for some parents. Related to this, the remote mothering/parenting practices enabled by the mobile phone are not always perceived as positive, as they can also increase one's sense of time squeeze and scheduling conflict. Some mothers explained they therefore tried to discipline themselves: "you have to think for yourself that you have to let loose, otherwise I just don't have to go to work, then it gets so stressful" (Maria). In other words, an all too extensive transcendence of one's capability constraints may be unproductive and undesirable; parents seem to be continuously negotiating a balance between corporeal presence at the workplace and incorporeal presence elsewhere.

The previous paragraph already alluded to the more negative aspects of overcoming capability constraints and the blurring of boundaries. Those aspects are more clearly and directly present in the interviewees' discussions how the cellular phone facilitates the invasion of domestic space-times by the employment sphere. Here is Jon again:

But then private and work sometimes get mixed up and that I find rather annoying (...) for instance the other day I was standing on the school playground waiting for my son and I was just chatting with someone and the children were coming, and someone from work called and I caught myself saying something like not just now otherwise I'll call you back later, but without simply saying I am on the playground and it is my day off today. So it's a bit give and take you know.

Several parents – mothers and fathers alike – related how they actively try to resist employment-home spillovers through a variety of strategies and tactics, including the refusal to accept a cellular phone paid by their employer and carefully considering to whom they give their mobile phone number. Others explained not to answer their mobile phone directly but have colleagues record a voice-mail message, which they first listened to before deciding whether or not to call back. By selectively hindering connectedness, these people are in effect reconfirming and cherishing capability constraints.



#### 4.3. *New coupling constraints through maintaining connectivity*

Previous time-geographic studies have pointed out that the use of communication technologies entails the creation of new space-time constraints (e.g., Pred, 1978; Kwan, 2001). The interview material also demonstrates the rise of novel constraints with the adoption of more interactive planning styles. More specifically, the capacity for coordination-based planning of chauffeuring and looking after the children needs to be supported in various ways. This more or less invisible, technically-oriented maintenance work comprises a series of seemingly trivial acts, such as switching on the phone, charging its battery and not forgetting to take it along. One may think of these things as not very important. They need to be done, however, as spur-of-the-moment, interactive planning presupposes synchronous communication between parents and others. If not performed, ‘communication breakdowns’ may occur, hampering micro-coordination and the (efficient) execution of domestic duties. This may in turn cause confusion and tensions between spouses. As Rich remarked, “my wife’s complaint is that I do not have my mobile switched on often enough”.

There is also more socially oriented maintenance work to be done. For instance, to be able to mobilize practical assistance from persons outside the family-household, one needs to have a sufficiently large pool of phone numbers in one’s mobile device or diary. During the interviews various respondents voiced concerns about not being able to reach other persons. Nadine, for instance, “now ha[s] a buffer stock of people in my diary that is too small”. Some interviewees explained they checked and updated their list of phone numbers, whereas others realized during the interview that it was time to do so again: “I am thinking just now that I actually do not carry all those numbers with me. I need to do that one time soon, yeah program them” (Jon). At a more fundamental level, some mothers supervise, organize or participate in extra-curricular, school-related activities of their children. They do so for a variety of reasons but also to get to know and befriend more people with whom they might exchange practical assistance in terms of looking after one’s children in the future:

I am free on Wednesday and I used to be in a garden club. We have a small garden at the school and the infants go play there and I registered for that but at some point I just couldn’t take it anymore (...) now I joined in again because the contact with the others moms, that is very convenient after all and nice too (Helen).

Supporting the capacity for interaction-based planning with people outside the immediate family-household context thus leaks into parents’ other activities and can create new commitments. Helen, for instance, has to be corporeally present at her child’s school (almost) every Wednesday

afternoon. This social maintenance work tends to be distributed unevenly across the sexes; only in a few households did fathers actively engage in attempts to extend networks for the exchange of practical assistance.

In summary, phone-enabled interactive planning to some extent mitigates many space-time constraints through the softening of schedules and reallocation responsibilities within networks. Nevertheless, mobile phone use does not seem to reconfigure gender-role constraints in any straightforward way. Further, because parents’ goals may change through their association with the phone, the phone can result in new and often unforeseen commitments and constraints, in particular for mothers. These include the effort required to maintain connections to space-times where one is not corporeally present.

### 5. **Conclusions and discussion**

The available literature suggested that the Internet and mobile phone are likely to lift or relax some space-time constraints but that others will persist, become more important or come into existence. Among the participants in our studies, these technologies primarily allow for more temporal flexibility of activities and thus for a relaxation of time-oriented coupling constraints. The Columbus activity-diary data indicate that the space-time fixity of online activities is lower than for offline activities. The study from Utrecht shows how the mobile phone enables employed parents to (re)negotiate the timing of activities when running late and through iterative planning. The prevalence and impact of mobile phone-mediated planning should not be exaggerated, because clock-based punctuality continues to be important for temporally fixed activities and because the micro-coordination of chauffeuring logistics is dependent on and facilitated by specific social and space-time relations. There are also second-order effects in the form of largely invisible work required to maintain the connectivity to other space-times and so increase temporal flexibility, which needs to be incorporated in the already busy activity schedules of the parents interviewed.

For our respondents, ICT use also appears to be associated with more spatial flexibility of activities but the increase is not as large as for temporal flexibility and limited to specific activity types. The Columbus study has suggested that Internet use only enhances the spatial flexibility of work, household and personal needs, and not for social and recreational activities, which reflects that Internet use overwhelmingly takes places in the home and workplace. The Dutch data indicate that the mobile phone increases parents’ opportunities to undertake multiple activities both when stationary at a physical location – exemplified by the remote parenting practices – and when traveling. Use of the mobile phone en route is, however, fairly modest among the study participants. In addition, the ability to undertake multiple activities at a single location is not always valued positively, because it distracts people from their primary activities. Parents therefore actively resist the relaxation

of capability constraints through the mobile phone in some situations.

The relations between ICTs and space-time constraints also differ in various ways between men and women. The Columbus data indicated that, rather than increasing the equality between men and women, the Internet does little to improve the space-time constraints on women and in fact seems to exacerbate spatial constraints. The Dutch study provides few clues that mobile phone use results in a larger role of employed fathers with young children in household responsibilities or major changes in the associated coupling and authority constraints. For the participants in both studies, ICTs by and large consolidate differences between men and women in the space-time constraints associated with everyday activities, upholding many social practices and cultural norms in the physical world (Valentine and Holloway, 2002; Aoyama and Sheppard, 2003; Madge and O'Connor, 2005, 2006).

All in all, we concur with Valentine and Holloway (2002, p. 316) that ICTs do “not have any inherent properties or universal impacts”. Rather, the nature of the interactions between these technologies and space-time constraints depend on the type of activity, the persons, technologies and other material involved and the social, cultural, institutional and physical contexts in which they are embedded. Our empirical findings should nonetheless be treated with caution, primarily because of the relatively small numbers of respondents and the over-representation of women, whites, and highly educated and high-income individuals. And given the situated nature of the implications of ICT use, our conclusions are not necessarily directly transferable to larger populations or people elsewhere; further investigation with other and larger datasets is required.

Some issues and implications for future research can be identified on the basis of the work reported in this paper. First, we believe that research into the relations between ICTs, space-time constraints and activity patterns should be focused on the situational, practical and material aspects of those interactions. In this way, the situatedness of those interactions in social relations, cultural and institutional contexts and physical space-times can be understood better (e.g., Zook et al., 2004; Madge and O'Connor, 2006). Such an approach implies, for instance, that due attention is paid to the socio-material networks in which people are enrolled and avoids the treatment of individuals as atomized agents (Kwan, 2007; Schwanen, 2007a,b). Second, it is important to conceive of the social, physical and the technological realm as mutually constitutive of one another (Hägerstrand, 1976; Latour, 2002; Callon and Law, 2004). Assumptions that the introduction of ICTs has unidirectional and linear impacts on society (technological determinism) are to be avoided, among others because the socio-spatial implications of new technologies are sometimes ambiguous if not contradictory. Third, this paper has insisted on the relevance of attending to social differentiation in the impacts of ICT use. While our analysis has shown how sex and gender are implicated

in the relations between ICTs and everyday life, future work should also address other major axes of differentiation like class, race/ethnicity and sexuality and interactions and geographical variations in their implications. It can only be hoped that heeding these issues will enhance our understanding of the implications of ICTs for everyday life and contribute to policies that seek to mitigate digital divides and other downsides of technological change.

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### References

- Adams, P.C., 1995. A reconsideration of personal boundaries in space-time. *Annals of the Association of American Geographers* 85 (2), 267–285.
- Amin, A., Thrift, N., 2002. *Cities: Reimagining the Urban*. Polity Press, Cambridge.
- Aoyama, Y., Sheppard, E., 2003. Guest editorial: the dialectics of geographic and virtual space. *Environment and Planning A* 35 (7), 1151–1156.
- Beaverstock, J.V., 2005. Transnational elites in the city: British highly-skilled inter-company transferees in New York city's financial district. *Journal of Ethnic and Migration Studies* 31 (2), 245–268.
- Bonsall, P., 2004. Traveller behavior: decision-making in an unpredictable world. *Journal of Intelligent Transport Systems* 8 (1), 45–60.
- Brannen, J., 2005. Time and negotiation of work-family boundaries. *Time and Society* 14 (1), 113–131.
- Callon, M., Law, J., 2004. Absence – presence, circulation, and encountering in complex space. *Environment and Planning D* 22 (1), 3–11.
- Cairncross, F., 2001. *The Death of Distance: How the Communications Revolution is Changing Our Lives*. Harvard Business School Press, Boston.
- Castells, M., 2000. *The Rise of the Network Society*, second ed. Blackwell, Oxford.
- Castells, M., Fernandez-Ardevol, M., Linchuan Qiu, J., Dey, A., 2004. *The Mobile Communication Society*. Report for the International Workshop on Wireless Communication Policies and Prospects: A Global Perspective, Los Angeles, LA, October 2004.
- Chesley, N., 2005. Blurring boundaries? Linking technology use, spillover, individual distress, and family satisfaction. *Journal of Marriage and Family* 67, 1237–1248.
- Couclelis, H., 2000. From sustainable transportation to sustainable accessibility: Can we avoid a new tragedy of the commons? In: Janelle, D.G., Hodge, D.C. (Eds.), *Information, Place, and Cyberspace: Issues in Accessibility*. Springer-Verlag, Berlin, pp. 342–356.
- Couclelis, H., 2004. Pizza over the Internet: e-commerce, the fragmentation of activity and the tyranny of the region. *Entrepreneurship & Regional Development* 16 (1), 41–54.
- Crang, M., Crosby, T., Graham, 2006. Variable geometries of connection: urban digital divides and the use of Information Technology. *Urban Studies* 43 (13), 2551–2570.

- Dijst, M., 2004. ICT and accessibility: an action space perspective on the impact of new information and communication technologies. In: Beuthe, M., Reggiani, A., Zamarini, L. (Eds.), *Transport Developments and Innovation in an Evolving World*. Springer-Verlag, Berlin, pp. 27–46.
- England, K., 1993. Suburban pink collar ghettos: the spatial entrapment of women? *Annals of the Association of American Geographers* 83, 225–242.
- England, K., 1996. Who will mind the baby? In: England, K. (Ed.), *Who Will Mind the Baby?* Routledge, London, pp. 3–19.
- Farag, S., 2006. E-Shopping and Its Interactions with In-Store Shopping. PhD Thesis, Department of Human Geography and Planning, Faculty of Geosciences, Utrecht University.
- Gerstel, N., Gallagher, S.K., 2001. Men's caregiving: gender and the contingent nature of care. *Gender and Society* 15 (2), 197–217.
- Giddens, A., 1984. *The Constitution of Society: Outline of the Theory of Structuration*. University of California Press, Berkeley, CA.
- Graham, S., Marvin, S., 1996. *Telecommunications and the City: Electronic Spaces, Urban Places*. Routledge, London.
- Graham, S., 2002. Bridging urban digital divides? Urban polarisation and information and communications technologies (ICTs). *Urban Studies* 39 (1), 33–56.
- Graham, S., 2005. Software-sorted geographies. *Progress in Human Geography* 29 (5), 562–580.
- Hägerstrand, T., 1970. What about people in regional science? *Regional Science Association Papers* 24 (1), 7–21.
- Hägerstrand, T., 1975. Space, time and human conditions. In: Karlqvist, A., Lundqvist, L., Snickars, F. (Eds.), *Dynamic Allocation of Urban Space*. Saxon House, Westmead, pp. 3–14.
- Hägerstrand, T., 1976. Geography and the study of interaction between nature and society. *Geoforum* 7 (5–6), 329–334.
- Haraway, D.J., 1991. *Simians, Cyborgs, and Women. The Reinvention of Nature*. Routledge, New York.
- Harvey, A., Macnab, P.A., 2000. Who's up? Global interpersonal temporal accessibility. In: Janelle, D.G., Hodge, D.C. (Eds.), *Information, Place, and Cyberspace: Issues in Accessibility*. Springer-Verlag, Berlin, pp. 147–170.
- Harvey, D., 1990. *The Conditions of Postmodernity*. Blackwell Publishers, Cambridge, MA.
- Hjorthol, R.J., 2005. Mobility in daily life. The car and use of information and communication technology for family logistics. Paper presented at 45th Conference of the European Regional Science Association, Amsterdam, 23–27 August 2005.
- ITU (International Telecommunication Union), 2006. Free Statistics. Available at: <http://www.itu.int/ITU-D/ict/statistics/> (accessed 08.05.06).
- Kenyon, S., Lyons, G., 2007. Introducing multitasking to the study of travel and ICT: examining its extent and assessing its potential importance. *Transportation Research A* 41 (2), 161–175.
- Kwan, M.-P., 2000a. Gender differences in space-time constraints. *Area* 32 (2), 145–156.
- Kwan, M.-P., 2000b. Human extensibility and individual hybrid-accessibility in space-time: a multi-scale representation using GIS. In: Janelle, D.G., Hodge, D.C. (Eds.), *Information, Place, and Cyberspace: Issues in Accessibility*. Springer-Verlag, Berlin, pp. 241–256.
- Kwan, M.-P., 2001. Cyberspatial cognition and individual access to information: the behavioral foundation of cybergeography. *Environment and Planning B: Planning and Design* 28 (1), 21–37.
- Kwan, M.-P., 2002a. Time, information technologies, and the geographies of everyday life. *Urban Geography* 35 (5), 471–482.
- Kwan, M.-P., 2002b. Feminist visualization: re-envisioning GIS as a method in feminist geographic research. *Annals of the Association of American Geographers* 92 (4), 645–661.
- Kwan, M.-P., 2004. GIS methods in time-geographic research: geocomputation and geovisualization of human activity patterns. *Geografiska Annaler, Series B: Human Geography* 86 (4), 267–280.
- Kwan, M.-P., 2007. Mobile communications, social networks, and urban travel: New topologies of spatial interaction. *The Professional Geographer* 59 (4), 434–446.
- Latour, B., 2002. Morality and technology: the end of the means. *Theory, Culture & Society* 19 (5/6), 247–260.
- Lemish, D., Cohen, A.A., 2005. On the gendered nature of mobile phone culture in Israel. *Sex Roles* 52 (7/8), 511–521.
- Ling, R., 2004. *The Mobile Connection: The Cell Phone's Impact on Society*. Elsevier, Amsterdam.
- Ling, R., Yttri, B., 2002. Hyper-coordination via mobile phones in Norway. In: Katz, J.E., Aakhus, M. (Eds.), *Perpetual Contact. Mobile Communication, Private Talk, Public Performance*. Cambridge University Press, Cambridge, pp. 139–169.
- Lyons, G., Urry, J., 2005. Travel time use in the Information Age. *Transportation Research A* 39 (2–3), 257–276.
- Madge, C., O'Connor, H., 2005. Mothers in the making? Exploring liminality in cyber/space. *Transactions of the Institute of British Geographers NS* 30 (1), 83–97.
- Madge, C., O'Connor, H., 2006. Parenting gone wired: empowerment of new mothers on the Internet? *Social and Cultural Geography* 7 (2), 199–220.
- Massey, D., 1995. Masculinity, dualisms and high technology. *Transactions of the Institute of British Geographers NS* 20, 487–499.
- May, J., Thrift, N., 2001. Introduction. In: May, J., Thrift, N. (Eds.), *Timespace: Geographies of Temporality*. Routledge, London, pp. 1–46.
- McDowell, L., Ray, K., Perrons, D., Fagan, C., Ward, K., 2005. Women's paid work and moral economies of care. *Social and Cultural Geography* 6 (2), 219–235.
- Miller, H.J., 2005. A measurement theory for time geography. *Geographical Analysis* 37 (1), 17–45.
- Mokhtarian, P.L., Salomon, I., 2001. How derived is the demand for travel? Some conceptual and measurement considerations. *Transportation Research A* 35 (8), 695–719.
- Mokhtarian, P.L., Salomon, I., 2002. Emerging travel patterns: do telecommunications make a difference? In: Mahmassani, H.S. (Ed.), *Perpetual Motion: Travel Behaviour Research Opportunities and Application Challenges*. Elsevier, Oxford, UK, pp. 143–182.
- Mokhtarian, P.L., Salomon, I., Handy, S.L., 2006. The impacts of ict on leisure activities and travel: a conceptual exploration. *Transportation* 33 (3), 263–289.
- Moss, M.L., 1998. Technology and cities. *Cityscape: A Journal of Policy Development and Research* 3, 107–127.
- Pred, A., 1978. The impact of technological and institutional innovations on life content: some time-geographic observations. *Geographical Analysis* 10 (4), 345–372.
- Rakow, L., Navarro, V., 1993. Remote mothering and the parallel shift: women meet the cellular phone. *Critical Studies in Mass Communication* 20 (3), 144–157.
- Raubal, M., Miller, H.J., Bridwell, S., 2004. User-centred time geography for location-based services. *Geografiska Annaler, Series B: Human Geography* 86 (4), 245–265.
- Rheingold, H. (Ed.), 2003. *Smart Mobs: The Next Social Revolution*. The Perseus Book Group, New York.
- Rice, R.E., Katz, J.E., 2003. Comparing Internet and mobile phone usage: digital divides of usage, adoption, and dropouts. *Telecommunications Policy* 27, 597–623.
- Rose, G., 1993. *Feminism and Geography: The Limits of Geographical Knowledge*. Polity Press, Cambridge.
- Schwanen, T., 2006. On 'arriving on time', but what is 'on time'? *Geoforum* 37 (6), 882–896.
- Schwanen, T., 2007a. Matter(s) of interest: artefacts, spacing, timing. *Geografiska Annaler, Series B: Human Geography* 89 (1), 9–22.
- Schwanen, T., 2007b. Gender differences in chauffeuring children among dual-worker families. *The Professional Geographer* 59 (4), 447–462.
- Schwanen, T., 2008. Managing uncertainty through sociomaterial associations. *Environment and Planning B: Planning and Design* 35.
- Schwanen, T., Dijst, M., Dieleman, F.M., 2004. Policies for urban form and their impact on travel: the Netherlands experience. *Urban Studies* 41 (3), 579–603.

- Skinner, C., 2005. Coordination points: a hidden factor in reconciling work and family life. *Journal of Social Policy* 34 (1), 99–119.
- Thrift, N., 1985. Flies and germs: a geography of knowledge. In: Gregory, D., Urry, J. (Eds.), *Social Relations and Spatial Structures*. Macmillan, Houndsmills, pp. 366–403.
- Thrift, N., 1996. New urban eras and old technological fears: reconfiguring the goodwill of electronic things. *Urban Studies* 33 (8), 1463–1493.
- Tivers, J., 1985. *Women Attached: The Daily Lives of Women with Young Children*. Springer, London.
- Townsend, A.M., 2000. Life in the real-time city: mobile telephones and urban metabolism. *Journal of Urban Technology* 7 (2), 85–104.
- Urry, J., 2003. Social networks, travel, and talk. *British Journal of Sociology* 54 (2), 155–175.
- Urry, J., 2004. Connections. *Environment and Planning D: Society and Space* 22 (1), 27–37.
- Valentine, G., Holloway, S.L., 2002. Cyberkids? Exploring children's identities and social networks in on-line and off-line worlds. *Annals of the Association of American Geographers* 92 (2), 302–319.
- Virilio, P., 2000. *Open Sky*. Verso, London.
- Wareham, J., Levy, A., Shi, W., 2004. Wireless diffusion and mobile computing: implications for the digital divide. *Telecommunications Policy* 28, 439–457.
- Wellman, B., 2001. Physical space and cyberplace: the rise of personalized networking. *International Journal of Urban and Regional Research* 25 (2), 227–252.
- Wheelock, J., Jones, K., 2002. 'Grandparents are the next best thing': informal childcare for working parents in urban Britain. *Journal of Social Policy* 31 (3), 441–463.
- Willis, S., Tranter, B., 2006. Beyond the 'digital divide': Internet diffusion and inequality in Australia. *Journal of Sociology* 42 (1), 43–59.
- Wittel, A., 2001. Toward a network sociality. *Theory, Culture & Society* 18 (6), 51–76.
- Zook, M., Dodge, M., Aoyama, Y., Townsend, A., 2004. New digital geographies: information, communication and place. In: Brunn, S.D., Cutter, S.L., Harrington, J.W. (Eds.), *Geography and Technology*. Kluwer Academic Publishers, Dordrecht, pp. 155–176.