CHANGING CONCEPTS OF TIME GEOGRAPHY IN THE ERA OF INFORMATION AND COMMUNICATION TECHNOLOGIES

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Abstract
Time geography represents analytical perspective for the analysis of human activities and movements in space-time. For more than 40 years it has attracted considerable research interest and has brought many useful concepts and models helping us to understand the everyday human life. However, development of information and communication technologies and their role in everyday life of individuals has brought about new phenomena, which disrupted the conventional view of human's behavior in time and space. The aim of the paper is to present a new view of basic concepts of time geography and to outline possible trends of future space-time research.

Key words: time geography, concepts, revision, information and communication revolution, virtual mobility.

INTRODUCTION

In the last four decades, time geography has built up not only an elaborated conceptual and methodological apparatus but it also acquired a respected position among other than geographical scientific disciplines (psychology, sociology, transport studies), which adopted some of its techniques. However, since the time when the first concepts of time geography were formulated, society and life of humans have dramatically changed. Development of information and communication technologies (ICTs) and their role in everyday life of individuals has brought about new phenomena, which disrupted the conventional view of human's behavior in time and space. This is the reason why the need to revise the concepts of time geography and their adaptation to new conditions of the post-modern society (mobile communication, internet, hypermobility) is necessary.

The aim of the paper is to present a new view of basic concepts of time geography and to outline possible trends of future space-time research.

TOWARDS A NEW TIME GEOGRAPHY

Before the onset of ICTs that provoked deep changes in time and spatial distribution of human activities, the time-geographical studies, particularly those involved with the geography of human time have pursued several directions. The first is the research into human activities in integrated system of time and space under the effects of spatio-temporal constraints. Authors, apart from conceptualisation of the spatio-temporal behavior of individuals (Hägerstrand 1970, 1975, 1985; Lenntorp 1976; Pred 1977; Thrift 1977; Parkes, Thrift 1978; Carlstein 1982; Ellegård 1993, 1999), were principally involved with biographies of individuals (Hägerstrand 1978; Daniels and Nash 2004; Frändberg 2008) or empiric studies based on "classical" time geography. The central interest was devoted to the analysis how is time used in households and to the study of individual mobility (Lenntorp 1978; Goodchild and Janelle 1984; Janelle et al. 1998; Dijst 1999), observation of transport flows (Lenntorp 1976, 1978; Hägerstrand 1985), or transport accessibility (Burns 1979; Thill

and Horowitz 1997; Kwan 1998). Some results of time-geographical research were employed in practice as they became parts of commercial or public decision-making activities. Example of specific application of time-geographical concepts are the studies under the framework of governmental planning (Ellegård et al. 1977), social reforms (Carlstein and Thrift 1978), formulation of regional policies (Mårtensson 1978) or organization of industrial production (Ellegård 1996).

The second research branch referred to as socio-scientific one concerned with everyday activities of humans developed in response to exaggerated physicality of time geography. It endeavours in finding links between time geography and different fields of social theory such as creation of families, choice of study subjects or choice of job, adaptation strategies of women, and other (Halin 1991 in Osman 2010). Studies of rather sociological nature devoted to the analysis of time used by an individual void of any regards to space might be included as well. But it must be added that a comparatively large part of so far conducted research is located on the interface of the two above-mentioned directions: everyday activities of individual's area analysed only with partial regard for spatial dimension and with limited attention given to effects of constraints on human activities. Similar studies appeared in both the Slovak and Czech literature, where time geography was not given too much significance.

Ira (1986a, 1989, 2001) has brought the first theoretical knowledge of time geography here. Apart from him, Drbohlav (1995) and Žigrai (1999) dealt with a brief theoretical basis of time geography. Ira was simultaneously the first author in the Czech or Slovak environment to introduce possibilities for application of spatio-temporal approach on an example of the village Lom nad Rimavicou (Ira 1986b). Ira also dealt with the analysis of everyday activities of locals in this marginal village in 1997 and 2011 trying to capture and explain possible changes in spatial behavior of the local community under the effects of the (post-)transformation conditions (Ira 2003; Ira et al. 2011). Besides, he also researched into the mobility of Bratislava's population (2000) and his paper from 2006 brings a subjective assessment of sustainability for individual everyday activities of Bratislava's inhabitants. Drbohlav (1990) and Drgoňa et al. (1994) conducted applied spatio-temporal research. While Drbohlav (1990) investigated behavior of the Prague secondary schools students, Drgoňa et al. (1994) observed the daily mobility of pedestrians in the city of Nitra. Osman (2010), dealing with the specificities of spatio-temporal behavior of immobile persons and Mulíček et al. (2010), who investigated transformation of post-industrial city from the viewpoint of its time organization also based their research in time geographical concepts. At present, Czech geographer Jakub Novák actively deals with time geography. Based on time spatial behavior of suburban migrants, Novák along with Sýkora report on time-spatial structure of the metropolitan area of Prague (Novák and Sýkora 2007) and Novák (2010) in his dissertation thesis studied movements of individuals using the mobile operator data. Temelová and Novák (2011) emphasize the necessity to take into account the time dimension of space in urban planning and the everyday manifestations of increasing cultural and social diversity of life styles in the transforming Prague city centre. Temelová et al. (2011) employ tools of time geography to the analysis of adaptation strategies of population in peripheral localities. Klapka and Roubalíková (2010) analyse stations and the effects of changing urban environment on the spatio-temporal behavior of university students.

FUNDAMENTAL CONCEPTS OF TIME GEOGRAPHY

Lenntorp (1999) discerns as many as 52 concepts in time geography which make it possible to comprehend spatial and time behavior patterns of individuals along with constraints and barriers which limit them. The principal basic time geographical concepts include: *activities, stations, space-time paths, bundles, constraints* and *space-time prism*.

Everything done by a human can be referred to as an *activity*. Activities take place in certain time and place. Places where desired or compulsory activities are carried out are *stations*. According to Ellegård (1993), stations represent the spatial bases for activities and interactions. Humans move between

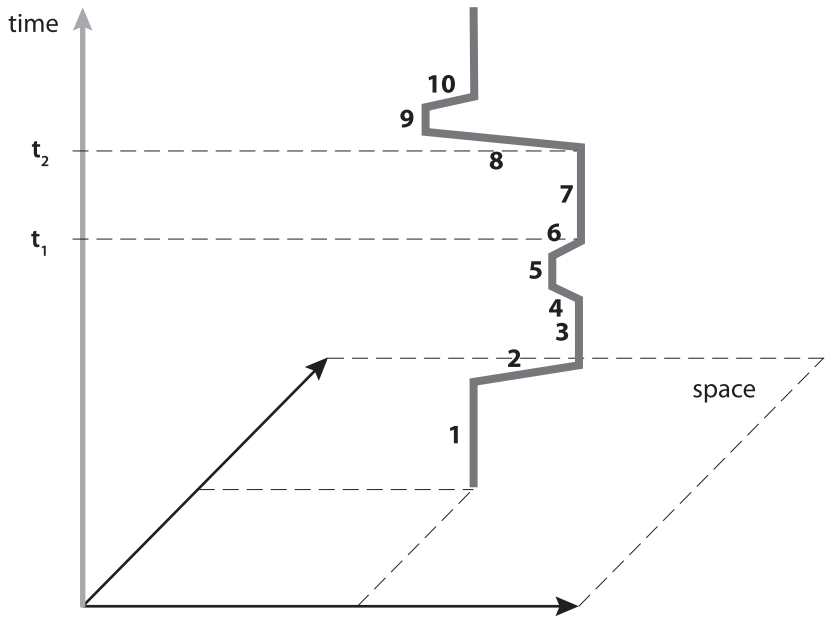

Figure 1 Visualization of individual space-time path. 1) home, 2) drive to work, 3) work, 4) walk to lunch, 5) have lunch, 6) walk back from lunch , 7) work, 8) drive back home, 9) grocery shopping, 10) return home.

individual stations and communicate with them. Environment where individuals occur consists not only of stations but also of transport channels and communications (Ira 2001). Stations are "tubes", through which an individual's spatio-temporal trajectory referred to as the *space-time path* passes in the course of day (week, year, life) (Figure 1). It should be noted that Hägerstrand (1970) considers the life path the basic concept of a *space-time path* (track, trajectory) and any other paths describing shorter intervals are its partial elements. Space-time paths are most often visualised in a 3D orthogonal space – space-time map where a two-dimensional horizontal plane represents the geographical space and time is represented by a vertical axis.

Individuals' trajectories stand for changes of allocations or physical mobility in time and space. While an individual remains some time in one place his/her trajectory is in the form of a constant vertical line. Inclination of individual's trajectory points to the relationship between his/her movement in space and time necessary for such move. The longer and steeper the curve, the more time is needed by the individual for the transfer from one station to another. If two or more individuals' trajectories meet at a certain place (*station*) we talk about *bundles*. Typical bundles are household, working place, etc. (Figure 2).

However, activities of humans are limited to certain extent. They are determined by *constraints*, which are among the fundamental concepts of time geography. Hägerstrand (1970) defines three types of constraints – *capability constraints, coupling constraints* and *authority constraints*. The interpretations of these terms are as follows:

1. *Capability constraints* are derived of the physical (biological) construction of a human and his/her needs such as sleeping, eating, hygiene, etc. Satisfaction of these needs requires space and time, which reduce the overall usable part of an individual's day, including the constraints given by the capability of individuals and capacity of tools, for instance a car with the limiting factors of maximum speed or possession of driving licence.

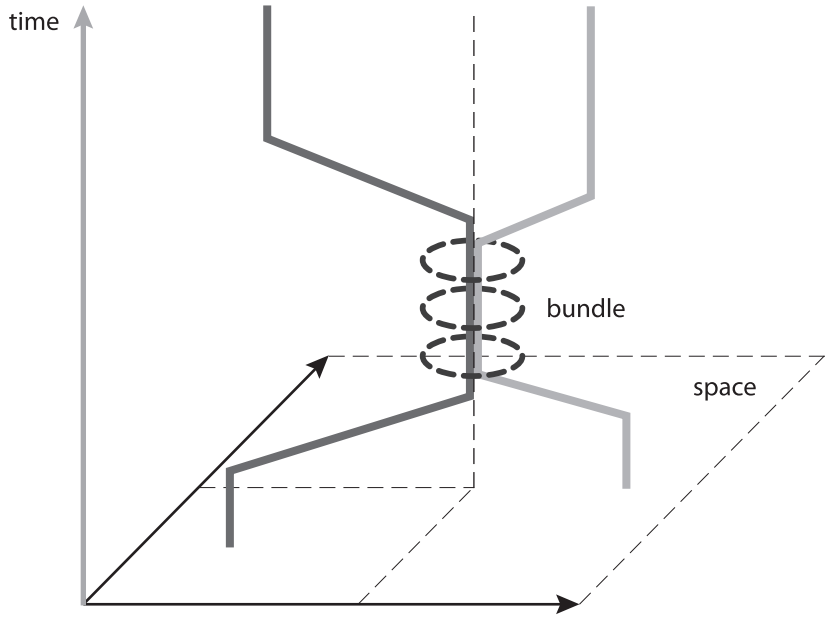

Figure 2 Visualization of bundle in space-time.

2. *Coupling constraints* are given by the fact that a human must carry out his/her activities in certain time in a certain place and mostly uses some tools or company of other individuals. It must be also taken into account that the human being is limited by the fact that he/she cannot stay in all places and with all people. It requires a decision between several alternatives of stay, transport or activity.
3. *Authority constraints* are given by the society (legal standards, economic rules and barriers), or they are determined by the general ethical or moral principles or the personal value system of each individual. Accomplishment of any activity can be, carried out in a particular place and in a particular time. Some individuals can be even prohibited to stay in a particular place or to be active in any way.

Apart from concepts of constraints, classic time geography also leans on general conditions of human existence defined by Hägerstrand in 1975. They are the elementary constraints that determine life of humans and as Ira (2001) reports they pose limits to possible structural and organizational forms. Hägerstrand (1975) reports that any situation is anchored in past situations emphasizing that all human activities are limited by the life-span and indivisibility of human being as he/she cannot stay simultaneously in several places in space. Human being is also limited in the sense that they cannot attend to more than one task in time. Time too, is indivisible and its amount is limited for an individual. Each activity takes some time and the moves between points in space consume time as well. Likewise, space is also limited. Hägerstrand (1975) talks about the limited capacity of space (limited number of people in certain space) and about its limited size (limited space available for certain activities in certain time).

The *time-spatial prism* expresses the limited movement of an individual in space and time. This concept (Figure 3) may be defined as part of space reachable by an individual in certain interval (day, week, year). It is based on the principle of return. If a day is taken for a basic organizational time unit of human life, the prism for a human in the course of this day is delimited by the space, from which the individual can return to the point of start that day –

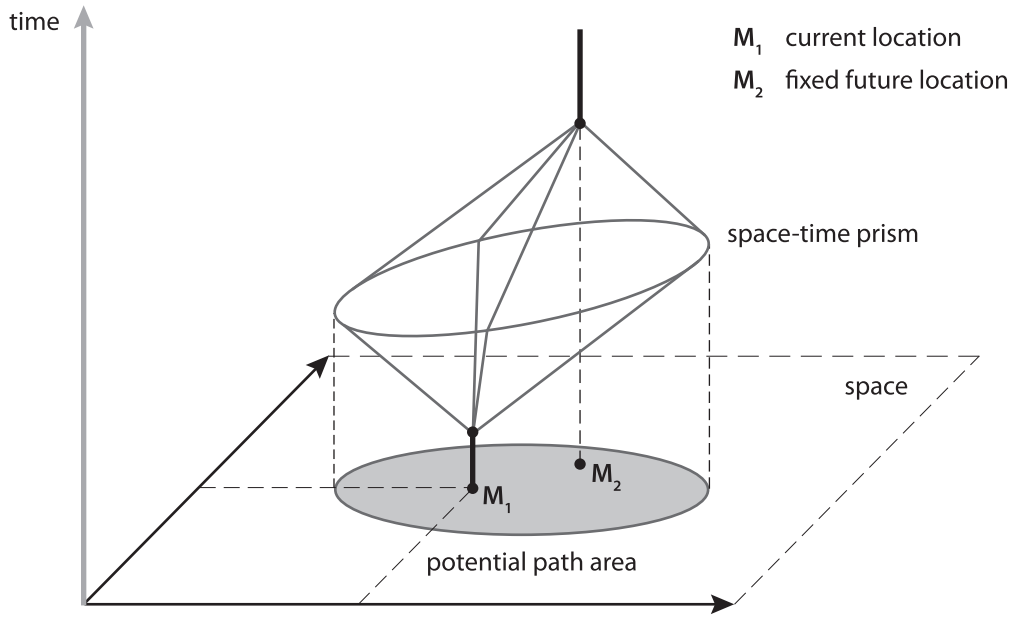

Figure 3 Space-time prism and the potential path area of individual (Yu and Shaw 2008).

place where he/she lives (sleeps). The all day long prism, says Hägerstrand (1970) consists of several smaller prisms; such partial prism can be sorted out at any transit from one station to another. In such cases the principle of return is replaced by different points of start and finish. While the point of start is the same as that of finish, it is a symmetrical prism (or return), if not, the prism is asymmetrical (Thrift 1977). Hence, the scope of the prism is, apart from individual constraints (location and duration of obligatory human activities: sleeping, going to work and the like), determined by numerous other factors: available time for the accomplishment of activities, amount of time necessary for the transfer between stations and the speed of used transport means. Projection of the time-geographical prism into a two-dimensional geographical plane gives the *potential path area* (Lenntorp 1976), which delimits all places in space reachable by a human in a given time.

Although time geography primarily leans on the analysis of the individual space-time trajectories, it also provides a conceptual link between individuals and the socio-economic system. For instance, the concept of *project* defined as a sum of activities heading to the fulfilment of some common objective it is not necessarily an individual matter. Many projects concentrate many individuals pursuing the same objective. Such project can follow similar behavior patterns and apply regular procedures common for several individuals (Ira 2006). As a matter of fact, time geography assumes that the everyday life of individuals is a process which determines to some extent the nature of the whole society on different hierarchic levels. Investigation of such processes in their progress and their geographical and social frameworks may disclose different social phenomena and relationships between human activities and the environment.

THE REVISION OF TIME-GEOGRAPHY CONCEPTS UNDER THE INFLUENCE OF INFORMATION AND COMMUNICATION REVOLUTION

Basic concepts of time geography have been formulated more than 40 years ago when the ICTs were only at the beginning of their development. Since the time when the first time geographical concepts were formulated though, the world and everyday

life of individuals have profoundly changed. The postmodern society brought new phenomena into population's life which changes its everyday life. First of all, the widespread possession of personal computers, easy communication with the whole world via Internet and the development of mobile phones changed the ways of people work, educates, buy or spend their leisure time. Hägerstrand (see Hägerstrand 1970) and his colleagues were aware of the importance of *telecommunication*, however, the prevailing part of interactions took place in the physical space hence there was no need to consider non physical interaction. In the world of today, people under the effects of ICTs are able to pursue several parallel activities and most especially, their living space has been enriched by what is referred to as the *virtual mobility*, which distorts the basic principles of organization, location and coordination of human society, among them, for instance, the *face-to-face* contacts, bonds to a place, indivisibility of human being, task of distance, and the like. All that leads to reorganization of human activities in time and space. Hence, the traditional concepts of time geography must be subject of a new approach which reflects the modern trends in space-time behavior.

While in the classical time geography an individual and his activities were strongly linked to physical space, in the new time geography is necessary to consider hybrid physical-virtual space (Shaw and Yu 2009). Under the influence of ICT activities of individual can be carried out from distance and from different places saving time necessary for the physical movement. In the traditional understanding of the time geography a man has to be physically present for the purpose of participating in any activity or interaction with other individuals at a specific location (station). The human movement between stations was inevitable. In contrast, in hybrid physical-virtual space (or *cyberspace*, see Janelle and Hodge 2000; Kwan 2001), the information is transmitted much more efficiently and quickly. It is then obvious, that activities in both physical and virtual spaces are mutually interconnected and affect each other (Batty and Miller 2000; Yu and Shaw 2008). On the one side, information flows in virtual space offer greater flexibility for accomplishment of some activities (mobile phones provide a more natural and more flexible organization of meetings) on the other side they not only reduce but also generate the movement in physical space (e.g. visiting coffee house for *wi-fi* connection).

Regarding the concept of virtual mobility its integration within three types of human spatial behavior should be presented (Vilhelmson, Thulin 2008):

- Physical (corporeal) mobility as interaction facilitated by transit by car, bus, train, plain, etc.
- Virtual mobility which represents the interpersonal contact via PC, Internet, mobile phones, and the like.
- Medial (mass) communication via television, radio and other communication means.

Combination of the quoted types of mobility in one time yields *hypermobility* (Gillespie and Richardson 2000), a result of combination of the physical, medial and virtual mobility (for instance surfing on Internet while travelling to work on bus). Precisely *hypermobility* urges us to reassess the traditional concepts of time geography.

Brief characteristics of key changes of traditional concepts of time geography in the present post modern society will follow.

Space-time path

The *space-time path* is a concept anchored in physical space and discreet time represents the basic element of construction for the time-geographical analysis. The relative simplicity of this concept though, is disturbed by the virtual mobility activities, which are not only frequent complements of physical activities, but recurrently become the key elements of everyday life with effects on spatial behavior of individual. Moreover, an individual can not only communicate through virtual connection but he/she can acquire information about, for instance, the most comfortable transport means, shopping offers or coordinate decisions regarding other persons. Individual paths on the one side can become more diversified regarding the transport means, visited stations or activities, while hypermobility may simplify and shorten the individual's paths on the other side as his/her spatial behavior is optimised and the activities can be accomplished without the necessity of physical displacement.

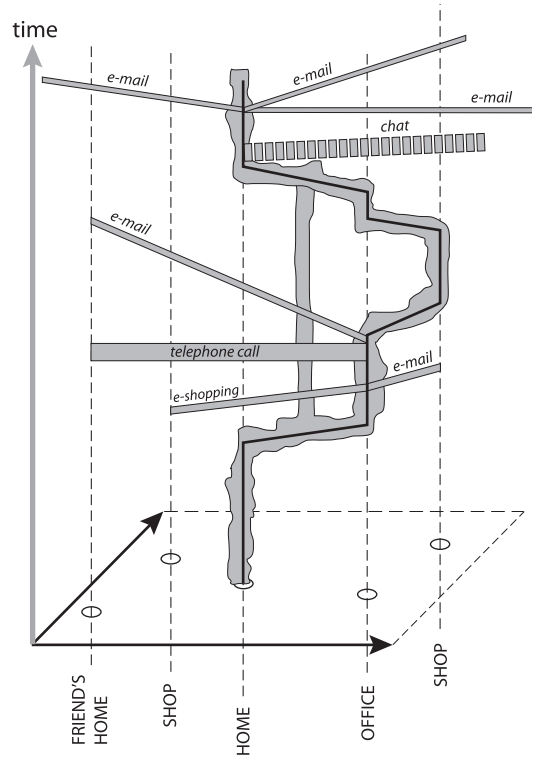

Figure 4 Time-space extensibility diagram. Simplified representation of one day in life of individual. The bold line represents the location of the presence. The shaded area represents extension of an individual in space-time (Adams 1995).

One of the most important problems of the modern time geography is the search for methodological and analytical tools for incorporation of virtual mobility into the concept of space-time path. The key is comprehension of human activities through the concept of *human extensibility*. The concept of the individual as an extensible agent was first formulated by Janelle (1973), where extensibility represents the ability of a person to overcome the friction of distance through using space-adjusting technologies, such as transportation and communication. "Human extensibility not only expands a person's scope of sensory access and knowledge acquisition; it also enables a person to engage in distant social actions whose effect may extend across disparate geographical regions or historical episodes" (Kwan 2004:275).

In the context with the concept of human extensibility, Adams (1995) introduced *time-space extensibility diagram* (Figure 4). This method may be used to represent a diverse range of human activities both in the physical and virtual worlds, including telephoning, driving, e-mailing, reading, remembering, meeting face-to-face and television viewing. Adams' diagram is based on individual's visualisation of activities and interactions as multiple space-time branches of paths in three dimensions. In this way it is possible to represent the temporal and spatial harmony/disharmony of varied activities. Regarding the increasing complexity of the space-time behavior of individuals, Couclelis (2009) proposed to abandon the 3D space and consider multidimensional space which along with the activities in physical space also includes those in virtual space. Couclelis (2009) further proposed the analysis of individual trajectories in time and space accomplished in separate structures, models and stories. An example of work with multidimensional data is the technique of the *parallel coordinate plots* (Figure 5). The *n*-dimensions are represented as a series of parallel axes, and a point in *n*-dimensional space is represented as a polyline crossing the axes. The advantage of this expanded model is that we do not need to sacrifice the cartographic visualization, which constitutes the strength of the space-time prism representation.

However, the quoted methods for the analysis of population's spatio-temporal behavior remain in the position of theoretical concepts. Development of the Geographical Systems (GIS) though offers the possibility for a meaningful processing of the complex time-spatial data. Kwan (1999) was the first to implement the space-time aquarium and space-time paths in a 3D GIS environment using individual-level activity travel diary data. In her work (Kwan 2000) she describes the GIS-based geovisualization methods for dealing with the spatial and temporal dimensions of human activity-travel patterns at the same time while avoiding the interpretative complexity of multivariate pattern generalization or recognition methods. The following studies (Kwan 2001; Kwan and Lee 2003) show, that the GIS provides an effective environment for implementing time-geographic constructs and for the future development of operational methods in time-geographic research. The

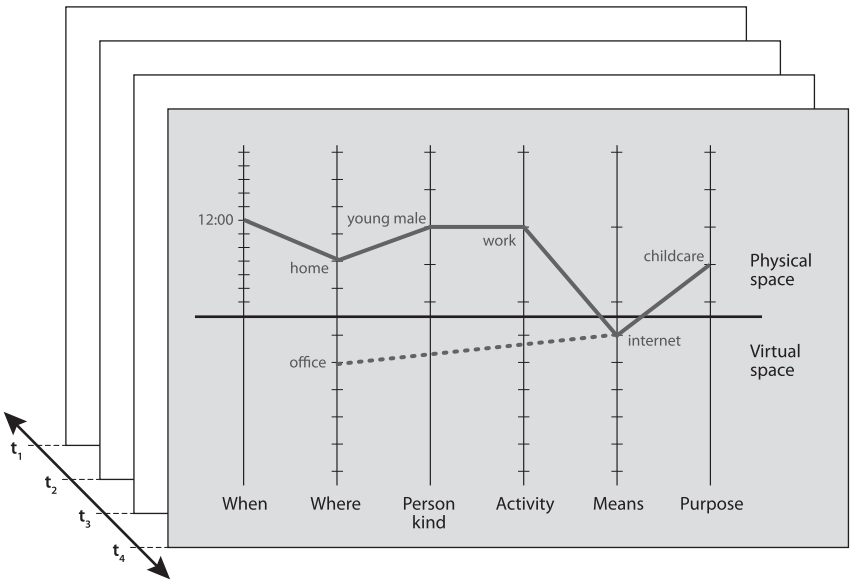

Figure 5 Schematic representations of physical and virtual activities through a graph of parallel coordinate plots. Virtual means used to perform tasks, and remotely accessed locations, are represented below the horizontal axis. Stacks of profiles, ordered by time or another dimension, may be useful as data models in many cases (Couclelis 2009).

understanding and operationalizing the concept of time-space path is the most significant task in the further time-geographic research. The concepts of path provide a useful basis for understandings of fundamental ecological and social conditions and processes. As noted by Lenntorp (2004:223) "The trajectory can provide an equally operational basis for understanding ecological forms as the molecule does in many of the natural sciences."

Stations

Time-spatial paths are not isolated; they meet in *stations* where the individuals' activities concentrate into *bundles*. Traditional stations such as work place or shop receive competition in form of their virtual counterparts (Figure 6). Their conceptualization though is not definite. In what station is the individual performing his/her work via teleworking? Is shopping in on-line shop some kind of virtual station? Activities in virtual social networks such as *Facebook*, or *MySpace*, which also represent stations with abundant interactions between individuals, should be also mentioned. While stations and bundles in physical space are identified through spatial and temporal proximity between individual space-time paths, in virtual space, relationships between them should be rather considered. In classical time geography, a person can be at only one location at a time. In virtual space, a person can form virtual bundles at multiple virtual stations at the same time.

Prism

An important aspect of the new time geography is the definition of the *space-time prism*, which has, up to now, appropriately reflected the relationship of physical activities within the different space-time limits. However, as far as any activity occurs out the territory of individual's potential path delimited by the original space-time prism, the individual cannot participate in it. A person with access to virtual world though, disposes of several options how to participate in a given activity. At first glance, it may seem that the time-geographical prism in virtual space is unlimited. But here too several limits forming its time-spatial geometry

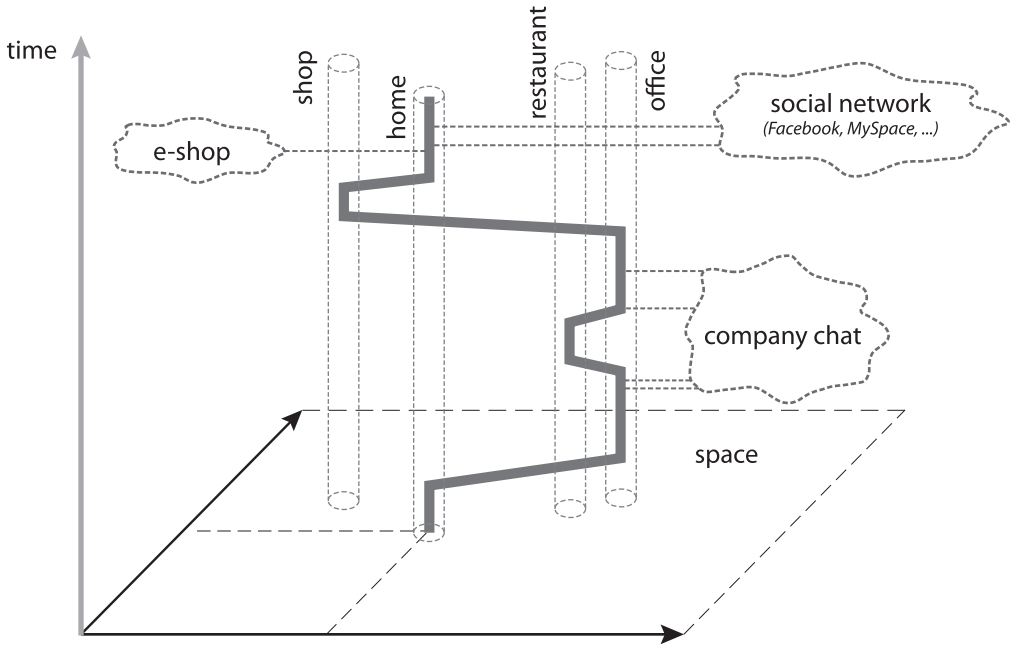

Figure 6 Traditional and new concept of stations in space-time.

exist. Yu and Shaw (2008), for instance, stress that the indispensable condition in entering the virtual world is the physical presence at the place that makes such access possible. Conducting activities in virtual space is still controlled by constraints in physical space and time. Another limits are in relation with the phenomenon of *digital divide*. A digital divide refers to an inequality between individuals, households and geographic areas (at different socio-economic levels) in terms of access to ICT. Another meaning of digital divide refers to abilities of individual users to consume or produce internet content.

Yu and Shaw (2008) distinguish two type of access channels (Miller uses term *portal* [1]) to virtual world: i) fixed connection which makes it possible to carry out virtual activities from fixed localities (phone line, cable connection), and ii) wireless connection which unlike the discrete point localities offers an approach to virtual world from a territory with an area determined by the scope of the given network (a territory covered by mobile and *wi-fi* networks). Based on two types of access channels they define the widened form of the time-spatial prism as derived from the intersection of the traditional Hägerstrand prism and the *space-time life path*. The authors distinguish two forms of the space-time life path depending on whether the individual uses the fixed or wireless connection: *space-time life lines of wired accesses* or *space-time life cylinders of wireless accesses* for the permanence in the virtual world (Figure 7). Their visualisation is reached by extension of the corresponding access channel into the virtual space along the temporal dimension during which individual can carry out the virtual activity.

[1] In the context of space-time conditions Miller (2005) has extended the time-geographic measurement theory. He included virtual interaction and introduced two new time-geographic objects: portals and message windows. A portal is a type of space-time station where actors can access communication services. He distinguishes wired and wireless connectivity. Wired portal have zero service radius. Its range for ICT access, indicating the maximum distance from the source at which an actor can access the service, is 0. For wireless connectivity is the range positive real number. A necessary condition for virtual interaction is the interaction of an individual with the portal. The message window refers to the potential for interaction. It is a time interval when actors interact with portals.

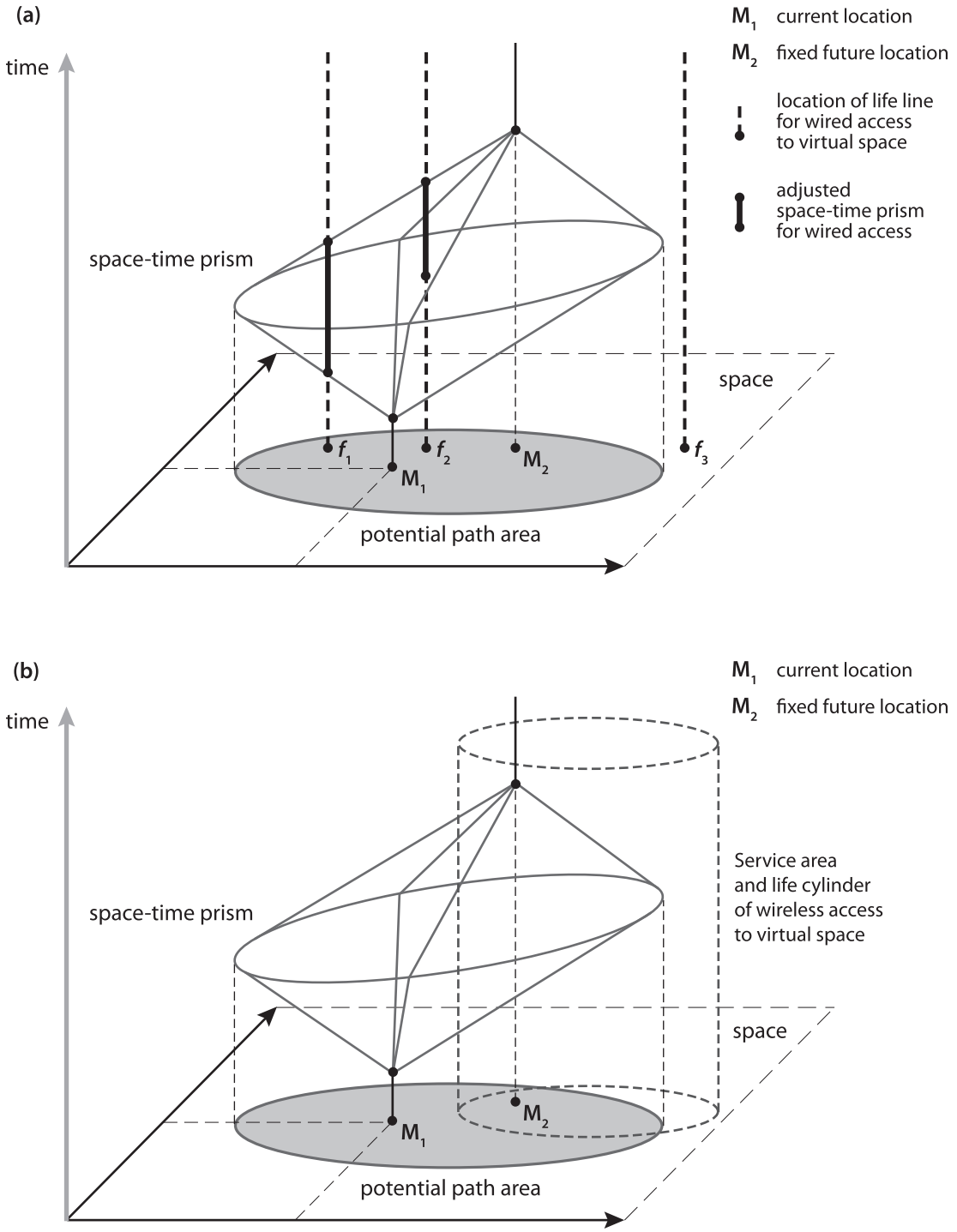

Figure 7 Adjusted space-time prism for virtual activities with a) wired access b) wireless access (Yu and Shaw 2008).

Constraints

Constraints in traditional time geography are perceived above all in connection with limits of physical space (existence of transport network, speed limits, and the like), claims on transport (duration of transport), or institutional limits (opening hours). However, the option to perform certain activities in virtual space impairs physical constraints – *relaxation of constraints*, which become ever less important elements determining our everyday live. For instance, thanks to on-line shopping it is possible to buy a product from a shop 100 km away which would not be cost-effective if visited personally (cost of transport). But traditional constraints still play a significant role in everyday life of humans as the majority of activities in virtual space is anchored in the physical and social space (see Kwan 2001; Dijst 2004; Schwannen and Kwan 2008). Information and communication infrastructure which makes it possible to enter the virtual world is not (so far) accessible from any place in physical space. Hence, the physical space still plays its role in performance of human activities. It is not only the store and carrier of physical activities but also a kind of *liaison* with the virtual world (Yu and Shaw 2008). In the consequence of virtual mobility, new forms of constraints emerge which may definitely influence the spatial behavior of individuals (for instance, choice of a café with access to *wi-fi*).

Effects of ICTs on traditional time geographical constraints have been treated in detail by Schwannen and Kwan (2008). In their opinion, a human cannot always perform anything, anywhere, any time. Practical constraints given by the space and socio-institutional constrains exist that affect the individual's capacity to distribute his/her activities at will. The binary nature of *presence* (means *corporeal presence*) or absence of traditional time geography is modified due to the capacity of *telepresence* (means *incorporeal presence*) through voice or text messages and other form of communication (Adams 1995; Schwanen and Kwan 2008). Generally, based on accessible references, it is possible to assert that Internet and mobile communication remove some spatio-temporal constraints. Some of them do last or even become more important in life of humans. However, it is difficult to establish the generally valid consequences of ICTs. The relationships between ICT and spatio-temporal constraints depends on the type of activity a person that carries it out, used technology, as well as the cultural, institutional and physical context.

In order to help understanding the increasing diversity of human spatial behavior, the category of *cognitive constraints* is adding to the list of traditional concepts of constraints. Cognitive constraints provide a guide how to fill the gap between individual and social factors determining the spatial behavior (see Raubal et al. 2004). The idea of cognitive constraints is based in Gibson's theory of *affordances*. According to Gibson (1979), a representative of ecological psychology, affordance represents a set of options for the use of a given object by a particular individual. During any activity individuals perceive various physical and socio-institutional affordances and use them in order to reach their aim. For instance, a bus stop offers an option to get on various busses, to buy a ticket and simultaneously to talk on phone. Such approach is useful for the creation and provision of *location-based services* which enjoy a boom with the mass expansion of mobile phones and portable computers.

CONCLUSION

Postmodern society and information-communication revolution require transformation of traditional concepts of time geography. It must be admitted though, that it is not only necessary to adapt the geometry of the time-spatial tools and concepts but also the overall paradigm of our approach to the issue. Changes in individuals' behavior to great extent are invisible and independent on space. In difference to a journey to a shop or to work, online shopping and teleworking are not ruled by the principles of physical accessibility and the shortest distance and do not leave observable trajectory in space. As noted by Lenntorp (1999), the new time geography offers a mental approach which makes it possible to consolidate spatial and temporal perspectives of research via different scientific disciplines. It simultaneously brings a more solid platform for research that the traditional approach

considering only the physical space often degrades time geography to a certain simplifying apparatus of individuals' life visualisation. Visualising tools are important for time geography but ontology in their background is crucial. Precisely this deeper dimension of time geography allows us to transform our view of the world and approaches to its study. Shaw (2009) reflects on three key advances in time geography from:

- from an "aggregate" approach towards a "disaggregate" approach;
- from a "static" approach towards a "dynamic and real-time" approach; and
- from a "space-centric" approach towards a "space-and-time-centric" approach.
- Although some modification of time-geographical concept have been suggested in this paper, there still remain many unanswered methodological and conceptual questions. The most important ones are:
- How can be the concept of space-time prism perceived (defined) in virtual space?
- How can be concept of stations perceived (defined) in virtual space? How do we represent such virtual locations to best support analysis of human activities and interactions?
- Does time geography avail of adequate theories, models and methods capable of capturing the changing individual data records?
- Can we extract the hidden spatio-temporal patterns and relationships in the individual space-time records?

Time geography is a powerful conceptual framework for understanding the spatio-temporal constraints on human activity participation. As noted by Miller (2005:39), "it is less successful as an analytical framework since its fundamental components and relationships have never been stated in a rigorous and consistent manner." But the qualitative improvements in the field of computer technology, the spread of mobile communication, satellite navigation systems and accessibility of spatially referenced data contribute new incentives to time geography. Researchers in this field thus receive powerful hardware and software tools for processing and analysis of great volumes of spatial data.

An appropriate tool for processing and interpretation of time-spatial data becomes GIS. The possibilities and capabilities of GIS have grown significantly over the past two decades, so now is possible to overcome several limitations of traditional methods of time-space research of human behavior. GIS allows the integration of both time, the physical space and also virtual activities of individuals. Using GIS we are able to capture activities and interactions of individuals as "processes" anchored in time and space. The GIS environment is also powerful visualization tool. Another impulse for further research is the Global Positioning System (GPS). This revolutionary technology provides new possibilities of collecting individual spatial data in the detailed resolution and simple data collection as never before. The use of GPS for spatio-temporal research of everyday activities became an area of interest of authors of this paper. Based on several test records of everyday activities (see Madajová and Šveda 2012) we point out the possibility of using GPS devices for individual data collection. The contribution has a character of pilot test study and provides methodology for the collection and processing of individual spatial data. Using GPS and GIS allows new options for the collection and processing of data complex analysis of time-space movement and spatial patterns of human behavior.

A meaningful time-geographical analysis though, also needs along such powerful tools a firm conceptual methodological hinterland. In the near future, a dynamic development of time geography and increasing efforts in its application is expected. The topical challenge is creation of such conceptual and methodological framework which will be able to cover the new phenomena emerging in the present postmodern society and information/communication technologies such as fragmentation of everyday activities, virtual mobility or multitasking. In case of successful affronting the outlined challenges, geography of time may become the key (not only) geographical approach able to capture, analyse and comprehend the ever more complex life of individuals.

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Résumé

Meniace sa koncepty geografie času v ére informačných a komunikačných technológií

Geografia času si za štyri desaťročia svojej existencie vybudovala nielen prepracovaný konceptuálny a metodický aparát, ale aj uznanie v rámci negeografických vedných disciplín (psychológia, sociológia, dopravné štúdie), ktoré prebrali viaceré jej východiská a výskumné techniky. Avšak od čias formulovania prvých konceptov geografie času sa spoločnosť a život človeka výrazne zmenili. Súčasná postmoderná spoločnosť charakteristická masívnym využívaním informačno-komunikačných technológií prináša viacero nových fenoménov, ktoré menia charakter, ale aj dynamiku každodenného života človeka. Virtuálny priestor, paralelné vykonávanie aktivít či fragmentácia činností rozrúšajú tradičné pevné väzby medzi aktivitami človeka a ich časovým a priestorovým ukotvením. Čoraz aktuálnejšou sa preto stáva aj potreba revízie konceptov geografie času, ktoré je nevyhnutné prispôsobiť novým podmienkam postmodernej spoločnosti (mobilná komunikácia, internet, hypermobilita). Príspevok prezentuje nový pohľad na základné koncepty geografie času, medzi ktoré zaraďujeme časovo-priestorovú cestu (*space-time path*), stanice (*stations*), obmedzenia (*constraints*) a prizmu (*prism*). Vychádza pritom z prác renomovaných odborníkov v tejto oblasti a predstavuje niektoré významné konceptuálne zmeny, ktoré zohľadňujú vplyv informačných a komunikačných prostriedkov na každodenný život jednotlivcov.

Jedným z najvýznamnejších problémov, ktorými sa potýka súčasná geografia času, je hľadanie metodických a analytických nástrojov, ako inkorporovať virtuálnu mobilitu do konceptu časovo-priestorovej cesty. Východisko je porozumenie ľudským aktivitám prostredníctvom konceptu individuálnej extensibility (Janelle 1973), ktorý zohľadňuje schopnosť človeka prekonať „odpor vzdialenosti" prostredníctvom technológií ako je mobilná komunikácia a internet. Extensibilita neznamená len prístup k vzdialeným miestam (osobám, staniciam), ale aj možnosť prístupu k informáciám a schopnosť participovať na sociálnych aktivitách naprieč geografickými regiónmi a historickými epizódami (Kwan 2004). V súvislosti so snahou zachytiť aj virtuálne aktivity jednotlivcov predstavuje Adams (1995) rozšírený časovo-priestorový diagram (*time-space extensibility diagram*), ktorý je založený na vizualizácii aktivít a interakcií jednotlivca ako viacnásobných vetiev časovo-priestorových ciest (space-time path) v troch dimenziách. Môžeme tak znázorniť časový a priestorový súlad/nesúlad rozličných aktivít. Vzhľadom na narastajúcu zložitosť časovo-priestorového správania sa jednotlivcov navrhuje Couclelis (2009), aby sme sa pri časovo-priestorových analýzach odpútali od trojdimenzionálneho priestoru a uvažovali o multidimenzionálnom priestore, ktorý popri aktivitách vo fyzickom priestore zahŕňa aj aktivity vo virtuálnom priestore. Couclelis (2009) navrhuje, aby boli analýzy individuálnych trajektórií v čase a priestore realizované v separátnych štruktúrach, modeloch a príbehoch. Príkladom práce s viacrozmernými dátami je technika paralelných dejov (*parallel coordinate plots*).

Postmoderná spoločnosť a informačno-komunikačná revolúcia si vyžiadali transformovať tradičné koncepty geografie času. Treba však poznamenať, že nie je nutné len upraviť „geometriu" časovo-priestorových nástrojov a konceptov, ale aj celkovú paradigmu nášho prístupu k tejto problematike. Zmeny v správaní jednotlivcov sú do veľkej miery nezávislé na priestore a „neviditeľné". Na rozdiel od cesty do obchodu alebo práce, on-line nakupovanie a teleworking nie sú určované tradičnými princípmi fyzickej dostupnosti a najkratšej vzdialenosti a nezanechávajú pozorovateľnú trajektóriu v priestore. Podľa Lenntorp (1999), *nová geografia času* ponúka myšlienkový prístup, ktorý umožňuje konsolidovať priestorové a časové perspektívy výskumu rozličných vedných disciplín. Zároveň prináša pevnejšiu platformu pre výskum než tradičný prístup zohľadňujúci výlučne fyzický priestor vďaka čomu sa geografia času často „degraduje" len na určitý zjednodušujúci aparát na vizualizáciu života jednotlivcov. V tejto súvislosti Shaw (2009) uvažuje o troch kľúčových posunoch v geografii času:

- od agregovaného prístupu k dezagregovanému,
- od statického prístupu k dynamickému (prebiehajúceho v reálnom čase),
- od priestorovo orientovaného prístupu k časovo-priestorovo orientovanému.

Geografia času poskytuje prepracovaný konceptuálny rámec pre porozumenie časovo-preistorovému správaniu jednotlivcov, sociálnych či etnických skupín, ako aj celej spoločnosti. Avšak analytické možnosti tohto multidisciplinárne orientovaného vedeckého smeru boli až doteraz výrazne limitované možnosťami na zber, spracovanie a analýzu individuálnych časovo-priestorových dát. Kvalitatívne zlepšenia v oblasti výpočtovej techniky, rozšírenie mobilných komunikačných zariadení a satelitných navigačných systémov prináša do geografie času nové impulzy. Výskumníci v tejto oblasti tak dostávajú silné hardwarové a softwarové nástroje na spracovanie a analýzu veľkých objemov priestorovo-referencovaných dát. Otázkou však naďalej zostáva sfunkčnenie konceptov geografie času v ich analytickom zmysle a vytvorenie takého metodického a výpočtového aparátu, ktorý by umožnil sofistikované analýzy zachytávajúceho nielen pohyb jednotlivcov v priestore a čase, ale aj ich zložité fyzické a virtuálne interakcie. V prípade vysporiadania sa s načrtnutými problémami (výzvami) sa geografia času môže stať kľúčovým (nielen) geografickým prístupom schopným zachytiť, analyzovať a porozumieť čoraz zložitejšiemu životu jednotlivcov, ako ja fungovaniu celej spoločnosti.