Progressive Tourism: Integrating Social, Transportation, and Data Networks.

Abstract: This research examines tourism behavior using Internet-based websites that provide free lodging with local residents. Increases in computing power and accessibility have led to novel e-tourism techniques and the users of such systems utilize an amalgamation of social networks, transportation networks, and data communication networks. The chapter focuses on how the geographical spread of people in a modern, digital social network influences the travel choices of each individual in the network. Activities performed in coordination with this type of system can vary greatly in travel mode, accessibility, mobility, and time, among other factors. This research studies factors that influence a general model describing traveler behavior using a cost-free lodging network. We present an information representation and visualization methodology utilizing time-geographic dimensions.

Keywords: Social / transportation / data networks, e-tourism, web-based cost-free lodging network, time geography, geographic visualization / geovisualization, GIS.

1. Introduction

In recent years the flourishing of technology has brought many conveniences, connections, and frustrations for people across the world. Specific to this research, the digital age provides novel ways for humans to discover geography. Means of mobility have greatly increased over the decades, and we are able to travel farther and faster than ever before; however, travel has also become less necessary in some circumstances through the integration of virtual communication and meetings. Physical presence is still required in many instances, but are we seeing an increase or decrease in *time-space compression* (Harvey, 1989)? Part of our interest in time-space compression is the effect that modern technology has on a human's use of time and capabilities for travel.

Modern, internet-based social networks allow individuals to connect unlike ever before with large, geographically spread, culturally diverse, and yet, maintainable structures. While travel behavior with Information Communication Technologies (ICT), global transportation, and social networks (Larsen, Urry, & Axhausen, 2006) are currently popular research subjects, a geographer's perspective on the interconnectedness of these topics sheds new light as to how all of these impact *spatial behavior*. In addition, specific groups of people utilizing those networks need to be studied to understand how virtual data networks and contemporary social networks link with transportation and cultural exchange. This chapter aims to gain a better understanding of this challenge, and show how to conduct research in this area.

In this chapter the concept of a *synergy of social, transportation, and data networks* is divided into the following sub-questions:

- How does the geographical spread of people in an internet-based social network influence the travel choices of individuals in the network?
- What behavior do these travelers exhibit, when utilizing a novel amalgamation of social, transportation, and data communication networks?

- How can these network levels be visualized efficiently to be utilized as a decision support tool for travelers and cutting-edge e-tourism systems?

All of these questions require individual in-depth research programs; nevertheless, for developing a more holistic understanding of this topic, all three questions should be integrated. In order to tackle this work of geographic complexity we begin at the conceptual level that first investigates each of the critical elements individually, and then analyzes its potential contribution to the system as a whole. Next, a data model will be created to test, explain, and represent different elements of the complete information. This model will be valuable for any researcher studying single or multi-level network architectures; and, on a broader scale, any individual experiencing geography first-hand, through tourism and travel.

Traveling can be a thrilling and stimulating experience; however, it can also be costly and emotionally draining. Presence in a new environment provokes questions, and demands answers to physical and geographical issues. This research focuses on the existence of hospitality and hosting combined with travel. When visiting a new place individuals are more likely to take on distant and exotic travels if there exists a connection with a local host. This can be beneficial for both the host and the visitor, as this can lead to exchange of culture and food, leading to the development of companionship. Traveling for business as well as for leisure can fit into this category, and relate to these principles. Trips made in this fashion have been common for many years through family, friends, friends of friends, and beyond. However, expanding upon these concepts and using newly developed technological resources brings about a more recent form of travel, yet to be studied in detail.

In order to embark upon this research a sound, existing collection of diverse individuals is needed to demonstrate the power of the network amalgamation. This launches the effort to understand and characterize the unique spatio-temporal behavior of these travelers. In this research we utilize an existing online network as a case study. The CouchSurfing (CS, http://www.couchsurfing.com) project is a free, online network of people from all over the world, and willing to share time and their homes with travelers. Users provide each other with a space to sleep such as a couch, floor space, or an extra bedroom. Members may also offer guidance with tours or simply meet.

A key element that holds all of these people together in one system is the use of a *digital social network*. Each member creates a profile containing *volunteered geographic information* (VGI) such as their current city of residence, previous travels, and future travel plans. A profile can also contain personal descriptions, hosting capabilities, languages spoken, and photographs. This social network is increasingly important as the links created between nodes can be used to gather a level of safety for travelers as well as a global map with the geographic locations and places of connected friends. Members began signing up for the CS project in 2004 with hundreds joining per month. By 2005 thousands were joining each month and steady growth has continued over the years right up to 2009, by when over ten thousand people were joining during peak months.

Users of CS now cover a vast portion of the globe with members on each continent. It is a contemporary, emerging form of connection. The world is quickly opening its doors more than some may suspect due to current world news, hence the issues related to traveler safety are included in the proposed research design. Further expansion of this non-profit traveler system is expected to carry on well into the future; therefore any results discovered in this research afford a utility for prospective future developments.

Section 2 presents a background with related work in pertinent fields. Section 3 describes the specific methodologies utilized in this research and provides a conceptual framework on which this research is based, in addition to time-geographic visualizations. Section 4 presents potential areas for future research on this topic, while section 5 wraps the chapter up with conclusions.

2. Background

This research focuses on how the geographical spread of people in an Internet-based social network can influence the travel choices of each individual in the network. This innovative behavior revolves around the concept of *place* (Couclelis, 1992) as the setting is continually changing on a wide variety of scales from city to country to continent. The role of place is unique in this system where people are searching for subjective places that are not merely space or location but highly personalized (Cresswell, 1996). In this sense hosts can also point guests to places that are more than simple coordinates as the recommendations contain a degree of subjectivity. Hence place in this research is defined by all three network levels working together to provide travel opportunities, as well as link physical locations and subjective places. These places have emphases on any combination of a traveler’s preferences for language, culture, guidance, and safety among others.

There is a wide variety of ICT tools at a modern traveler’s disposal, and these tools play a major role in their travel choices (Janelle, 2004). Technology affords the participation of distributed individuals in the network to take part in the same project as is done with community modeling (Maechling et al., 2005), public-participation GIS (Keßler et al., 2005), or web-based communities (Pultar et al., 2008). Members of the CS system utilize ICT in combination with *multi-modal transportation:* different modes of transportation such as train, plane, bus, or boat. The use of ICT begins with communication through asynchronous email messages while guest and host are on separate continents. An email request can be viewed at a time convenient to the host, and does not interrupt their regular daily activities. Each member can evaluate the other using the online social network with biographies and references from other members. Further person-to-person communication can be carried out until both parties are satisfied. Later, when the members are on the same continent, more messages may be exchanged until both host and guest are in the same country or city. This is due to the fact that a guest may initially travel to a city in a country such as Berlin in Germany but have a trip planned a week later for Hamburg, Germany. While in Berlin the guest can call their future host in Hamburg to confirm and finalize trip details. After all of this, synchronous communication can occur via means such as a telephone to confirm meeting places, times, and personal descriptions. This process can be seen as taking place in a hierarchy of transportation scales starting at the highest level with cross-continent mobility granted through commercial planes or sea vessels. Below this are forms of travel such as national trains spanning across countries. Another scale lower are local trams and buses in cities until an individual reaches a final destination (Figure 1).

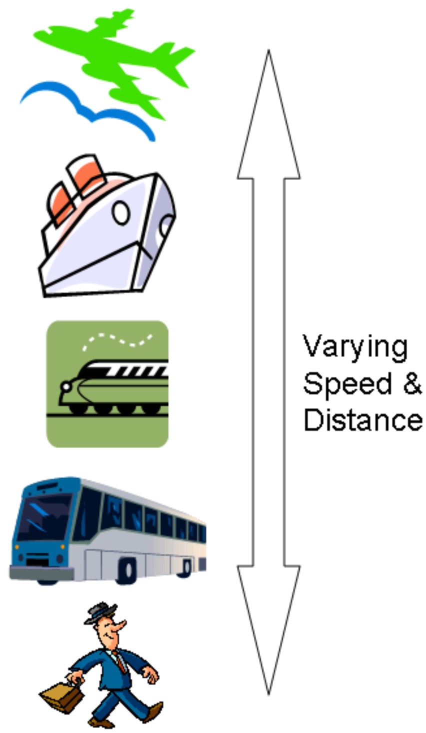

Figure 1. Various transportation modes with different speed and distance capabilities.

Our study concerning the synergy of multiple networks is built upon earlier research in travel behavior modeling, time geography, and visualization. Work in social activity-travel behavior points towards "the main individuals' driver to perform a trip is mostly with whom they interact rather than where they go." (Carrasco, Miller, & Wellman, 2006, p.1) In other words the social aspects of whom a person interacts with in their travels can be a very important factor in determining where a person goes. However, this can be reversed in the CS system, as this electronic network allows people to select a location first and then decide with whom to interact. "A major part of social activity destinations are at homes of specific persons rather than at places that can be 'chosen' depending on attractors such as costs, environment, and proximity." (Carrasco et al., 2006, p.2) This hints at the lack of choice available in many social activity destinations where in using the CS system places can in a sense be 'chosen' based on factors such as environment and location, in addition to other attributes of potential hosts.

Individual space is space about which an individual can move and perform actions while activity space is the space of potential activities available for a person given their characteristics and attributes. Both individual and activity space are important in the CS system, while place plays a larger role if a traveler has a strong desire to be at a specific place. This alters a guest's preferences and threshold level in choosing a potential host. *Place-based* and *individual-based* decisions (Golledge & Stimson, 1997) play a key role in this process and this work seeks to discover thresholds for people's transportation behavior. For example, a CouchSurfer primarily desiring cultural experiences can adjust her plans mid-trip and travel farther (perhaps at higher cost as well) in order to partake in a more desirable trip (e.g., free surfing lessons at a beach house on an island).

Recent contributions combining social networks with travel have been described by Dugundji, Paez, & Arentze (2008). They state that the contemporary changes in urban transportation show a need for policy integration and that the modern approaches to transportation analysis are pushing the capabilities of the underlying theories. Axhausen & Gärling (1992) have presented related work on conceptual frameworks of travel behavior. Golledge & Stimson (1997) provide a collection of spatial behavior knowledge and models that describe general spatial behavior. These models present a general method for investigating the steps and factors that contribute to travel behavior.

The STARCHILD conceptual framework (Root & Recker, 1983) is an activity-based approach in which individuals are assumed to choose options with optimal utilities. The model characterizes travel behavior elements into pre-travel and travel stages. This classification is used in the conceptual model presented in this chapter, where an individual's pre-travel actions (as well as during, and post-travel actions) include extensive use of ICT in the form of data networks and digital social networks.

The SCHEDULER framework (Gärling, Säisä, Book, & Lindberg, 1986) fits desired activities into a specified time interval. In scheduling, fitting the activities into the timeframe is a key objective of most travelers – apart from others, such as minimizing the travel time or distance. Nonetheless, some travelers may look for the maximum amount of travel for the available time, in order to see as many places as possible, and experience the maximum number of diverse events. Explicit influence of ICT systems on travel behaviors is a modern phenomenon, and is therefore covered in our research.

Another field of research related to this topic is that of *time geography*, i.e. how time and location are related to each other. In general, people and resources are available at a limited number of locations for a limited amount of time. Time geography defines the space-time constraint for being present at a specific location and a specific time (Hägerstrand, 1970). This possibility of being present is determined by one's ability to trade time for space, supported by transportation and communication services.

Space-time paths depict the movement of individuals in space over time. Such paths are available at various spatial and temporal granularities, and can be represented through different dimensions. All space-time paths must lie within space-time prisms (STP). These are geometrical constructs of two intersecting cones (Lenntorp, 1976). Their boundaries limit the possible locations a space-time path can take (Figure 2). The time budget is defined as $\Delta_t = t_2 - t_1$ in which an agent can move away from the origin, limited only by the maximum travel velocity. From a network perspective (Figure 3), such as taken in this research, movement is limited by the network geometry and the maximum travel velocity, which can vary for different edges and times. The geometry of the STP in a network therefore forms an irregular shape. Algorithms for calculating the network time prism (NTP) can be found in (Miller, 1991) and (Raubal, Winter, Teßmann, & Gaisbauer, 2007). A generic procedure involves (1) calculating shortest paths from the travel origin up to a cumulative impedance (e.g., travel time) along each path, and (2) testing, for each edge, whether traveling from the origin over the edge and to the destination is possible within the cumulative impedance.

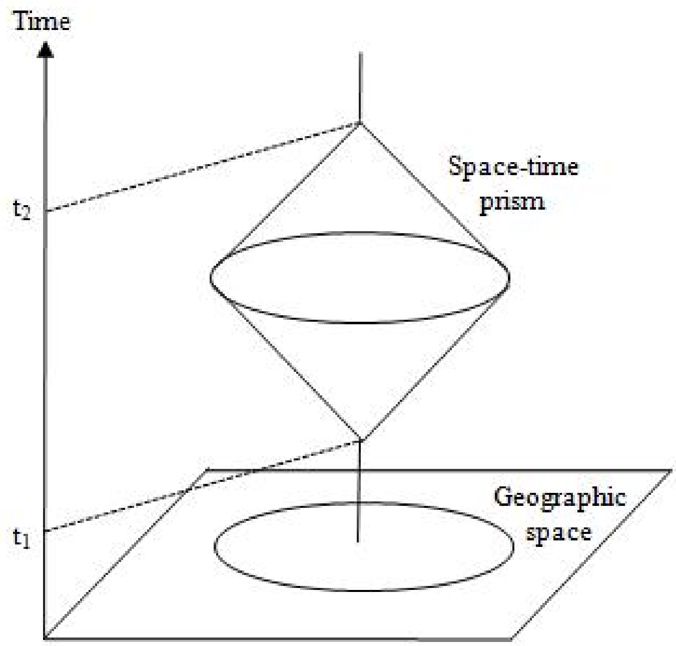

Figure 2. Space-time prism as intersecting cones.

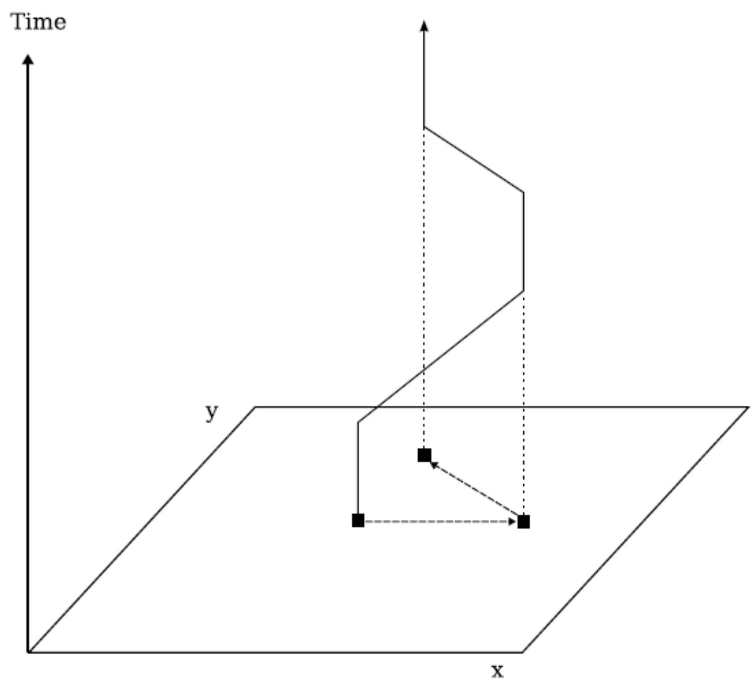

Figure 3. Space-time path from a network perspective.

Time geography defines different constraints that limit a person's activities in space and time. Fundamental physical restrictions on abilities and resources are summarized as *capability* constraints. Not having access to a car in order to trade time for space efficiently is one example for this type of constraint. *Coupling* constraints refer to the requirement for a person to be at a specific location at a certain time or for a fixed duration. For example, if two persons want to meet at a physical location, they have to be there at the same time. Certain domains in life are controlled by *authority* constraints, e.g. a person can only shop at a mall when the mall is open, such as between 9am and 8pm.

Time geography has been extended to the area of geographic information systems (GIS) regarding transportation networks to model and measure space-time accessibility (Miller, 1999; Wu & Miller, 2001), and for the analysis and theoretical understanding of disaggregate human spatial behavior (Kwan, 2000). It has also been suggested that it is possible to use time geography in GIS and location-based services (LBS), to achieve more user-centered systems (Miller, 2005b; Raubal, Miller, & Bridwell, 2004). Further applications of time geography include the structuring of dynamic pathfinding environments (Hendricks, Egenhofer, & Hornsby, 2003) and the modeling of *geospatial lifelines*, which represent movement as a time-stamped record of the locations an individual has occupied over a period of time (Hariharan & Hornsby, 2000). Analytical formulations of basic entities and relationships from time geography are presented by Miller (2005a).

Visualization methodologies based on time geography can be utilized to display and analyze the integration of social, data, and transportation networks presented here. Several methods for computing and geographically visualizing human activity patterns based on time geography have been proposed and successfully employed (Kwan, 2004; Ren & Kwan, 2007). Space-time paths allow for depicting both the movement of individual travelers in space over time, and their utilization of the social and communication networks. Yu & Shaw (2008) have presented an adjustment of the STP and utilized a 3D-GIS representation to support visualization and analysis of human activity patterns in physical and virtual spaces. The paths are available at various spatial and temporal granularities, and can be represented through different dimensions. It is important to note that such dynamic spatio-temporal behavior requires attention to the concept of scale with respect to both time and space (Montello, 2001).

3. Impacts, Approach, Methodology

This research makes a contribution to the study of multiple, interrelated network levels in relation to the field of time geography while making use of *volunteered geographic information. Volunteered geographic information* (VGI) is a relatively new area of research targeted towards enabling general audiences to author and submit information about their environment, complementing existing information sources and services with a user volunteered web of places. People should not only be enabled to access spatial information about their current location, but also to author and edit such data, and to interact with systems and friends that are physically separated. This encompasses a seamlessly integrated environment, where the real world is intertwined with the digital, and mobile devices serve as portals and handles to this digital world. The information flow is directed mainly from the user to a growing and distributed set of databases that integrate the volunteered information. The field of VGI has seen tremendous growth in the 21st century (Goodchild, 2007). Previously, information has been volunteered by Internet users across the globe via structures such as Wikipedia. Now those elements are gaining a useful geographical element (Hecht & Raubal, 2008).

3.1 Conceptual Model of Travel Behavior in a Cost-Free Lodging Network

Conceptual Model

Figure 4 shows a conceptual model of travel behavior, it highlights the critical elements and factors that affect a user's decisions. This flowchart helps in visualizing each step, in addition to presenting how the whole process fits together. Travel choices are made in a variety of locations and are heavily affected by the synergy of ICT tools, international transportation networks, and web-based social networks. In the absence of any one of these crucial networks the traveler's behavior would be greatly altered. Therefore, this type of travel is quite unique and highly dynamic, and does not lend itself for analysis by traditional travel behavior models. The application of this system is further described in the rest of this section.

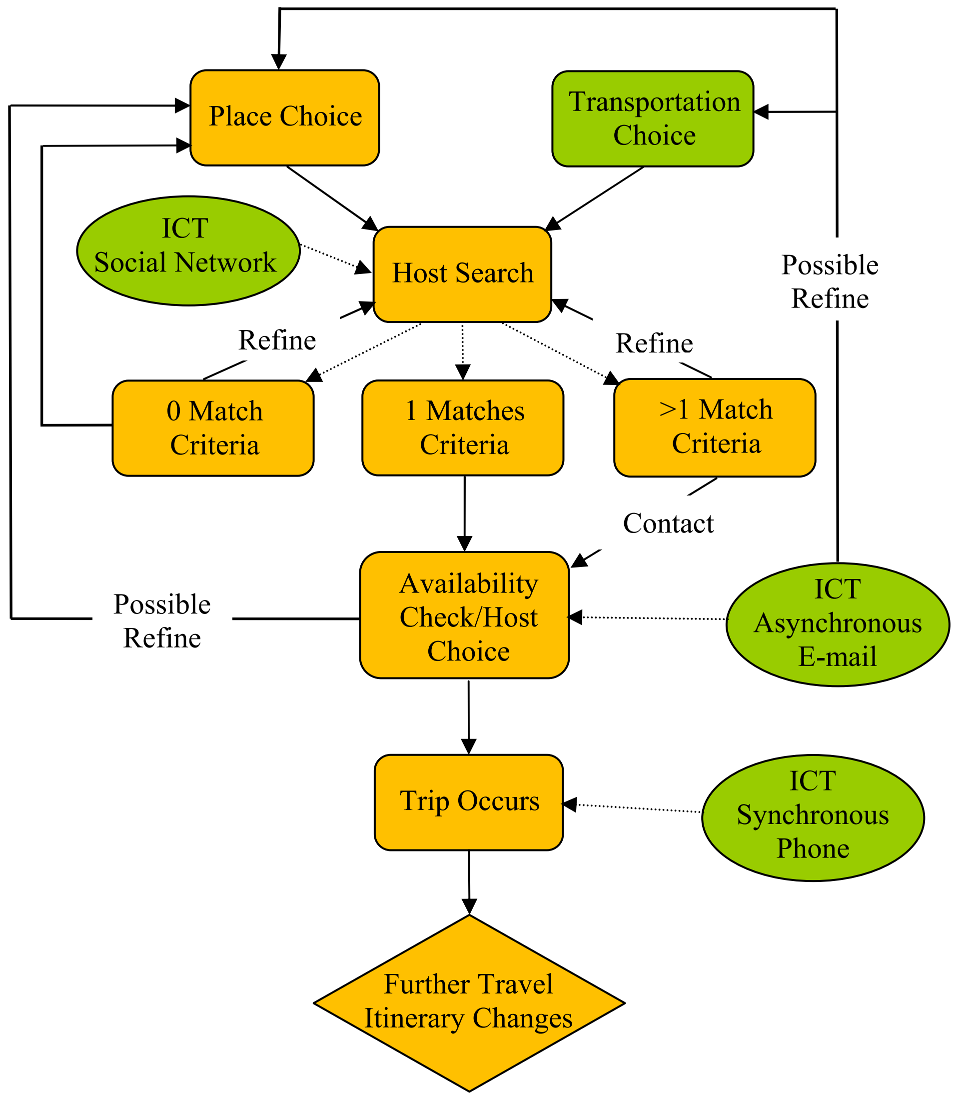

Figure 4. Conceptual model of spatial behavior utilizing three network levels. Green elements are explicit networks utilized in the framework: data, social, and transport networks.

Initially a user chooses a place to travel. The individual's choice may be for any purpose including vacation, cultural, and/or business. The concept of scale is important with the initial place decision as users may vary in their desire to visit a specific city, country, or continent. The results and further refinement of their decision behavior will move through various scales (both virtual and physical) before reaching street-level with corporeal presence between guest and host. At this point an initial transportation mode choice may be made or hypothesized by a user but further potential refinement is necessary in this highly dynamic model.

Utilizing any level of initial place and transportation choice the traveler will perform a host search based on their individual criteria. At this step user-based trip preferences are gathered including desired place along with any combination of language, age, verification level, and gender among others. Following criteria specification, possible hosts are generated that match the desired characteristics. This may return no results and require the user to further refine their criteria and search again until at least one host match is found. If one host matches the specified criteria the user can choose that host and move to the next step of checking availability. If more than one host matches the criteria a user may further refine her search to narrow down the results or may choose to contact multiple potential hosts. Also with more than one potential host generated the user has the ability for further evaluation (before contacting via e-mail) by utilizing characteristics of a modern Internet-based social network. These include profile information, number of ‘friend’-links, personal references left by other members, and photos. The weights a person applies to each of the criteria vary widely between users. For instance, one traveler may place more weight on staying with a host of a specific gender versus another that may be more concerned with finding a host within a particular age interval.

Once a traveler has chosen to contact a possible host about availability then the asynchronous ICT tool of e-mail is utilized for initial communication. At this step a guest contacts a host that is local to the desired area of travel. Here the highly dynamic nature of this travel behavior is demonstrated as advice may be given that alters a user's transportation mode choice and potentially their place choices at various resolutions. Next, availability is verified and if both parties are satisfied the trip occurs. At this step the model maintains its flexibility as users may check e-mail at an airport and choose different standby flights based upon the current situation potentially leading to a new place choice or other changes in itinerary. This also relates to the mid-trip itinerary changes described in the next section with sample travel scenarios.

Typically, the travel network infrastructures work as an *enabler* allowing mobility options with planes, trains, and buses. It is important in this system to also consider the potential *barriers* of the transportation network with employee strikes or a natural disaster event. With this system a user can quickly change her place choices and find a new host where there are no transit barriers. Upon arrival at a desired destination travelers may find synchronous ICT technologies such as telephones useful to verify initial meeting locations and acquire personal descriptions. Guest and host meet face-to-face in physical space at this later step making the transition from virtual to corporeal presence. After an individual completes her stay the framework allows for further travel along with itinerary changes. For example, hosts may have strong recommendations of places to see and/or connections with other potential hosts the guest had not originally planned. Here again we see the appropriateness of the highly dynamic and flexible model provided for this travel behavior. The individual may continue travel to any number of places for any time period starting at the top of the framework with a new place and transportation choice. The conceptual framework presented in Section 3.1 and Figure 4 provides a starting point for how this behavior can be modeled and raises further research questions such as those of traveler safety but especially those of model evaluation. Additional real world accounts such as those given in the next section entitled “Sample Scenarios” may further justify the creation of this new conceptual model. In conclusion, this model serves as a basis for further inputs, datasets, and adjustments into the future.

Sample Scenarios

This section provides travel scenarios using the CouchSurfing system to further demonstrate the necessity for a novel conceptual travel behavior model. Two types of travelers are presented: the first has little to no constraints and the second has many constraints. Different levels of constraints are possible and further apparent as a result of the scenario descriptions, which exemplify the capabilities of this highly dynamic, multi-network system.

Sample North American traveler A desires a trip to Europe to experience different cultures. Using ICT and the dynamic system described here the individual is able to purchase minimal tickets, use a flexible itinerary, and minimize lodging fees. At the start of the trip the individual plans on spending one week in the Netherlands but after three days decides to visit the nearby city of Antwerp in Belgium. A suitable CS host is found the day before who welcomes the arrival, leading to unique food, music, and history knowledge. The traveler discovers discount airline tickets from a previous host and books an inexpensive flight to Brno, Czech Republic. Leading up to the departure of the flight multiple potential hosts have been contacted but final plans are not solidified. Checking e-mail at the airport less than an hour before departure instantaneously reveals solidified plans of what people and places will be visited. Castles, casemates, and college campuses are all part of the tour given by a local but they are only able to host for two days. Traveler A examines a map and notices Vienna, Austria, is nearby. The tourist only has time to record some phone numbers of potential hosts to call once the train arrives in Vienna. The individual calls members of the modern social network and finds a place for the evening and from there is able to call others to stay with for the next nights. The hosts provide museum recommendations, sack lunches, and travel tips for the area increasing the traveler's mobility, efficiency, and overall cultural experience. Traveler A moves north and stops in a small Czech town. She wanders into a local festival and is seen by a friend of a previous host who provides accommodation. After this a member of the network provides accompaniment and knowledge of the buses and trains on an excursion to a national park for a few days. At the end of traveler A's tour a host in Poland gives a knowledgeable tour as the host is training to become a tour guide. After a thorough journey around town the tourist returns home with a multitude of unique experiences in diverse places.

Travel via the CS network can be done for a variety of purposes such as business, leisure, study, culture, and language. The following is an overview travel description of a CS trip for primarily business but provides other purposes as well. Sample South American professor (traveler B) wishes to attend a conference in Barcelona, Spain, where he will give a presentation on a paper he wrote. Since he has never been to this location before, the individual decides to spend some days before and after the conference in Barcelona to gain more experience of the new culture. The traveler discovers a CS host of the same age who has lived over half of his life in Barcelona. The guest and host send each other a series of e-mails to arrive at an initial plan of activities that is convenient for both parties. The host then takes the guest to local museums and eateries not in traveler B's travel guide, but he is pleasantly surprised. After the trip occurs both parties are satisfied with the exchange of culture and experiences and hope to reverse the roles of guest and host in the near future.

3.2 Time-Geographic Visualization of Travel Behavior and Options

The research presented here utilizes VGI as a key component for collecting geodata that are visualized as 2-dimensional static spatial maps in a GIS. With the existence and necessity of this multi-network architecture demonstrated, this section focuses on how all of this relates to the field of *time geography*. Table 1 demonstrates sample concepts from time geography and how they relate to this work.

Sample Time Geography Concepts	Multi-Network Traveler Examples
Authority constraints	A host provides a guest with information about operating hours of sites in addition to a sequence in which to visit.
Capability constraints	Host shares local and international transportation capabilities as well as the current status.
Coupling constraints	Initial corporeal meeting between guest and host; also synchronicity between a traveler and any mode of transportation.
Fixed vs. flexible activities	Traveler wants to mountain climb meaning the possible locations and schedule are flexible vs. a traveler designating a fixed activity such as visiting the Louvre.
Potential path areas and prisms	These are created using a traveler's desired travel destinations in a specified duration of time along with available modes of transportation.
Space-time stations	Various tourist activities such as a historic church or a host's residence are space-time stations.

Table 1. Time geography concepts linked with multi-network travel behavior**.**

This investigation provides a unique application of user-centered time geography (Raubal et al., 2004) as the travelers have a wide array of journey preferences such as length of stay, gender of host, accessibility to public transport, and host's age among other factors.

Once data has been collected, the information can be further analyzed and visualized via static 2-dimensional individual network maps (Larsen et al., 2006). However, travel is a dynamic activity varying in both space and time, leading to a necessity for more advanced methods of visualization made possible by a recent boom in geospatial technology. For maximum cross-platform utility, a visual portion of these research results is exhibited by means of 3-dimensional space-time maps in a virtual globe environment such as Google Earth (http://earth.google.com/). The extensive information repository of world data currently available in this software makes it an ideal platform to demonstrate and visualize results. This offers the possibility for interactive visualizations of space-time maps with tools affording the ability to control spatial and temporal variables. Of specific importance in this context is the Keyhole Markup Language (KML, http://www.opengeospatial.org/standards/kml), an eXtensible Markup Language (XML) geospatial data file format accepted by the internationally-recognized Open Geospatial Consortium (OGC, http://www.opengeospatial.org/). Using this language environment, the appropriate Features, Placemarks, LineStrings, and other data types are created via scripts based on a given user scenario. This information representation provides a highly flexible and efficient technique for working with modern spatio-temporal data. Once representations have been created, conversion between various geospatial data types can be automated with the Geospatial Data Abstraction Library (GDAL, http://www.gdal.org/).

Exploring *time geography* in this novel way supplies useful visualization and analysis tools for geographers and spatiotemporal researchers as a whole.

The visualizations will also be useful for travelers planning a trip. These e-tourism tools will further allow users to see potential paths and therefore their many travel options given their individualized constraints of space and time. The results of these tools can also aid further analysis via utilization of spatiotemporal queries available in a dynamic Geographic Information System or GIS (Pultar et al., forthcoming 2009). Another key feature of this approach to space-time geography is the wide accessibility to persons of all socio-economic status due to the no-cost software platform of Google Earth. As an experiment of capabilities and proof-of-concept, the sample physical travel scenario described in Section 3.1 is visualized in Figures 5 and 6. In this example each location has a temporal attribute that corresponds with a time slider tool in addition to the visible height variable. Utilizing an intuitive user interface, any traveler will be able to input their preferences, constraints, and capabilities to acquire a 3-dimensional time-geographic representation of their possibilities. For example, the figures also demonstrate a potential solution for a journey involving 6 stops. Given a starting and ending location a traveler recommender system (TRS) (Ricci, 2002) could return this option for travel order based on a user's preferences. The traveler has a space-time prism with height boundaries decided by the traveler's available time. The lowest height represents the beginning of the trip and is bounded above by the ending time of the trip. With respect to the lodging system in this research, different optional sequences may be shown based on host availability. In taking a trip this visualization methodology aids a traveler in making choices and changes in a travel itinerary. These tools exemplify ways of how we see this research contributing to the development of future cutting-edge e-tourism systems (such as a TRS) and also providing high-utility tools for spatio-temporal researchers.

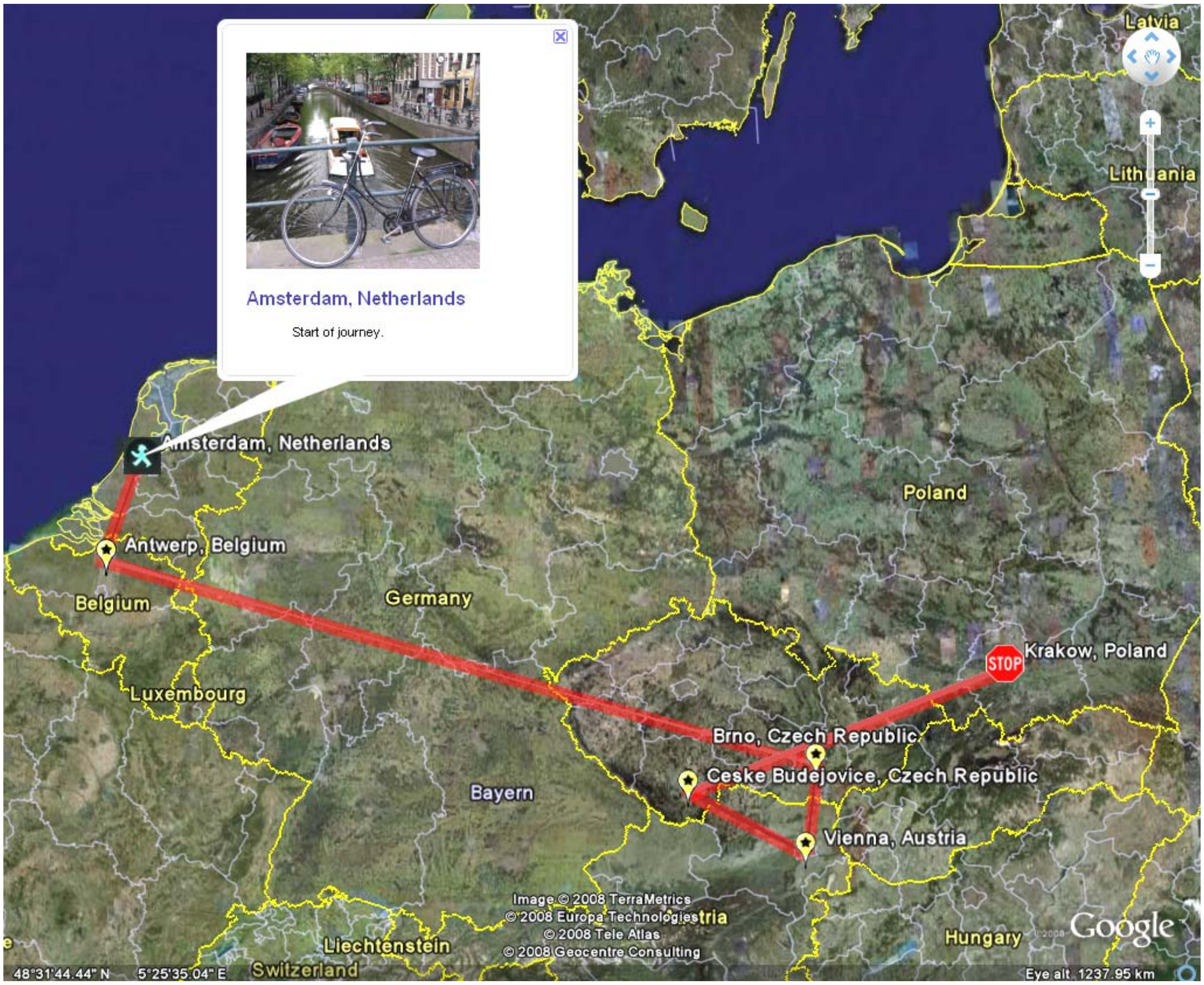

Figure 5. Space-time path of example traveler scenario in section 3.1.

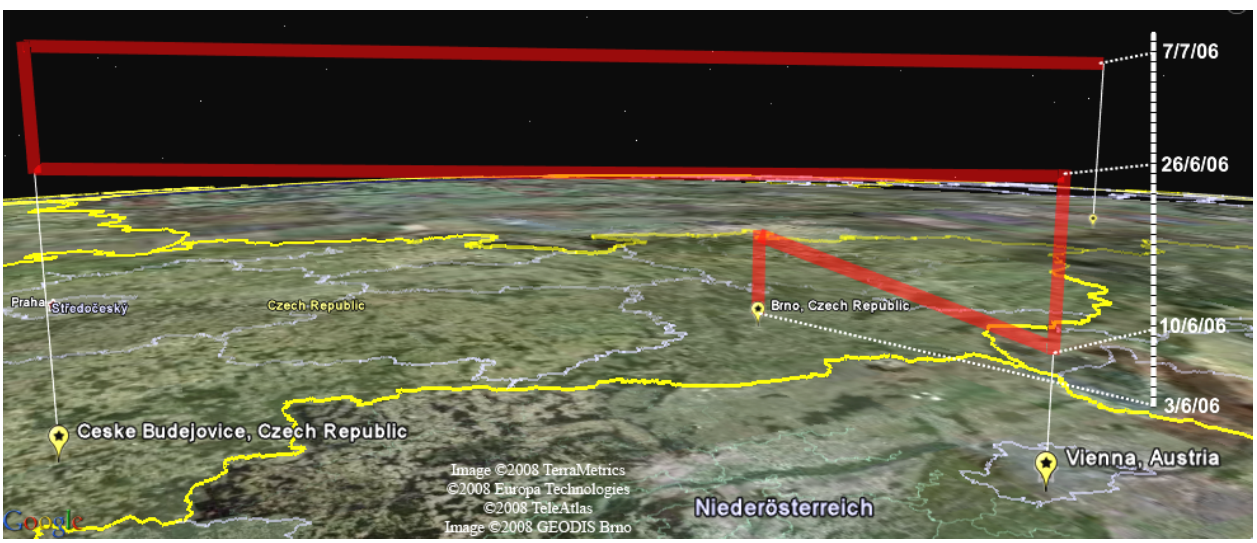

Figure 6. Tilted view of a space-time path showing temporal visualization with height.

4. Future Trends

In this chapter we have laid a foundation for tourism making extensive use of social, transportation, and data networks. This contemporary form of e-tourism involves cost-free lodging as a novel way to connect travelers and hosts. The behavior makes extensive use of the Internet, which is an important note as the structure of this global system would have to be quite different without the presence of intercontinental data networks. This hints towards further research on the enablers and barriers concerned with this topic. These were mentioned in the context of transportation networks but can also be extended to include the fact that data and access to digital social networks are not ubiquitous worldwide.

On the technical side, the applied methods for visualizing the interaction of the three network levels can be exploited for the design and development of cutting-edge e-tourism systems. Such systems will eventually help to provide higher access to low-income and minority groups to physically experience the geographical world due to lessening the financial burden for traveling by utilizing the type of travel discussed in this chapter.

The approach presented here utilizes qualitative and quantitative techniques in order to collect, evaluate, and visualize the triple network system design. The specific details of going about this task involve VGI. Geographic, anonymous CouchSurfer data can be utilized for spatio-temporal analysis and visualization. City and country of residence, gender, age, and network connections provide an excellent starting point to aid in answering the posed questions. Along the lines of social capital, members of this social network specify a depth level of each connection. This will be valuable in examining the relationship between distance and strength of ties in a social network. Additional discoveries pertaining to network capital could also become evident through the results of a survey.

As a preliminary list we foresee VGI and future interview techniques to include, but not be limited to, the following information:

- Age, gender, relationship status, occupation, place of birth, nationality;
- geographical distribution of social network (strong vs. weak ties);
- categories for travel purpose (e.g., business, leisure, language, culture, among others) as called for by (Larsen et al., 2006, p.41).

This list of information provides a starting point for future model evaluation utilizing VGI.

5. Conclusion

A conceptual model for traveler behavior heavily utilizing ICT and multiple networks was presented in Section 3. This forms a prototype but this ongoing research will be aided by further review of travel behavior methods and importantly model validation with real world user data. The next step for this involves survey techniques to learn even more about these hosts and guests from all continents of the world. In-depth survey methods will provide a means to further test this behavioral model in addition to providing input for a tool such as agent-based simulation (Frank et al., 2001). Modeling with agents can be useful for validation and verification as well as guidance for model calibration.

The further development of the time-geographic concepts presented here will provide additional tools for spatio-temporal researchers. With a user able to customize the inputs to the tool using a graphical user interface (GUI) any combination of space and time attributes will be allowed. In the prototype presented here the physical location is taken into account in the geovisualization while the explicit influence of each network needs to be further studied.

In conclusion, these technologies are in a state of constant change and it is important to stay current with the factors mentioned here, all of which play a role in travel informatics. We have presented a unique form of international travel that focuses on personal connections while utilizing multiple network structures. We have begun the groundwork for studying this behavior and will continue to improve upon the designs into the future.

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