# Telecommunications and Travel

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The potential of telecommunications technology to affect travel behavior has been perceived at least since the invention of the telephone. Fiction and nonfiction writers as far back as the 1870s speculated that such technologies would eliminate the need for travel to some extent. The spread of computers and information technology into the workplace, combined with the energy crises of the 1970s, catalyzed the exploration of telecommuting and teleconferencing as ways of reducing travel and, hence, curbing energy consumption. In the 1980s, policies directed toward improving air quality and reducing urban congestion provided the impetus for further study and experimentation, even as rapid advancements in information and communication technology (ICT) such as personal computers and fax machines supplied new enabling infrastructure.

During the 1990s, we have experienced a continued proliferation in technology as the use of mobile telephones, electronic mail (e-mail), the Internet, and electronically enabled commerce (e-commerce) has become widespread. According to Alan Greenspan, chairman of the Federal Reserve Bank, we are experiencing a "structural shift" in which "information technologies have begun to alter the manner in which we do business and create value, often in ways not readily foreseeable even five years ago" (*1*).

However, the so-called information revolution has not been accompanied by a noticeable decrease in travel. Surveys such as the U.S. Nationwide Personal Transportation Study indicate that vehicle distances traveled per capita are growing. Apparently, the relationship between ICT and travel is not simply one of substitution. For researchers who are interested in better understanding travel behavior and for planners and policy makers who need to forecast trends, evaluate alternatives, and possibly influence behavior toward socially desirable ends, it is important to explore this complex relationship further.

To help understand the relationship between telecommunications and travel behavior, researchers have found it useful to view transportation and telecommunications as alternate modes of communication. Specifically, communication can occur in three main ways:

- Face-to-face, involving passenger transportation;
- Through the transfer of an information object (a book, letter, diskette, videotape), involving goods movement of some kind; or
- Through telecommunications (phone, fax, e-mail, teleconferencing).

Furthermore, several different relationships can be identified among these alternate modes: substitution (elimination, replacement), generation (stimulation, complementarity), modification, and neutrality. Complementarity can result from either the use of one mode that encourages or directly involves the use of another mode (enhancement), or from the use of one mode that makes the use of another mode more efficient. It is not only possible but likely that many effects

will occur simultaneously (*2*); this possibility poses a considerable challenge to improving our understanding of this subject.

Forecasting the impacts of ICT on travel involves two stages. The first stage is to model the adoption of the technology by finding the answers to several questions:

- How many people will adopt a certain product, service, or application?
- What kinds of people are they?
- How intensively will the technology be used, and under what circumstances?
- How long will the technology be used?

The second stage is to examine the travel-related effects of adopting that technology: direct and indirect, short term and long term. The next two sections briefly review key findings in these two areas (*3*).

## MODELS OF TELECOMMUNICATIONS ADOPTION

The literature contains many behavioral models of telecommunications-based choices. For home-based and center-based telecommuting, there are models of preference, choice, and frequency; the duration of center-based telecommuting also has been modeled. In addition, there are models of choice of various communications media in business as well as models of teleshopping behavior.

Space does not permit a detailed examination of specific results here, but some common themes can be identified. First, the generalized cost of travel is only one of many influences on the choice between a location-based activity and its telecommunications counterpart. Other influences, such as the quality of the location-based experience compared with the virtual alternative and the ability to fulfill multiple activities at the real location (for example, linking social and recreational activities to a business trip) can result in a preference for the location-based alternative. Thus, either viewing technology choices as primarily influenced by transportation considerations or, conversely, viewing travel choices as mainly influenced by the availability of technological alternatives is too narrow a perspective.

Second, at least after the technology reaches some nominal level of maturity, the availability or cost of the appropriate technology often is not the binding constraint on the adoption of an ICT application. Barriers to adoption are more likely to be psychological, social, or institutional than technical.

## IMPACTS OF TELECOMMUNICATIONS ON TRAVEL: EMPIRICAL STUDIES

Empirical research into the impacts of telecommunications technology on travel falls into three categories. The first category includes macro-scale studies of entire sectors of the economy at regional or higher levels. Studies in the second category focus on a particular application, such as telecommuting or teleconferencing, and are based on disaggregate data. Studies in the third category also use disaggregate data but broaden the scope beyond a single application to include all or most communication and travel activities. This kind of study is the newest on this subject, with few examples to date.

Collectively, these studies provide mixed evidence regarding the central question of substitution versus complementarity—that is, whether telecommunication replaces travel or generates it. For example, one macro-scale study (a time-series analysis of consumer expenditures on transportation and communication) found telecommunications and travel to be substitutes, whereas another macro-scale study (a cross-sectional analysis of industrial

expenditures) found them to be complements. Among micro-scale application-specific studies, evaluations of telecommuting unanimously observe net substitution, whereas analyses of teleconferencing suggest that complementarity dominates. The micro-scale comprehensive studies appear to find complementarity over substitution.

To synthesize these results, researchers have pointed out that the substitution effect is more likely to be short-term and direct and to occur within the boundaries of the process being studied, whereas the complementarity effect is more likely to be long-term and indirect and to occur outside the scope of the studied process. For example, a short-term study of the direct impacts of telecommuting on travel will not identify long-term effects on residential location and indirect effects of induced demand for additional communication and travel. On the macro scale, it may be that the substitution effect found for consumer expenditures—using data no more recent than 1986—may weaken or even reverse as continued technological advances strengthen the enhancement and efficiency effects of telecommunications on travel for consumers. This speculation is supported to an extent by the more recent micro-scale comprehensive studies, which have identified complementarity as the net effect.

## DIRECTIONS FOR FUTURE RESEARCH

Much of the research into the relationship between telecommunication and travel has been colored either by the assumption or the hope that ICT would solve some of the transportation problems society faces. However, it has become clear that businesses and individuals do not always see ICT in the same terms. The first focus of future research should be to improve our knowledge of the fundamental relationships between ICT and transportation; we then will be better able to identify opportunities for ICT to provide transportation solutions as well as meet other important needs.

On the threshold of the new millennium, a snapshot of the landscape of telecommunications and travel behavior research suggests several areas in which additional knowledge would be especially valuable.

### Substitution Versus Complementarity

For some researchers, the substitution versus complementarity debate has been settled, with complementarity the winner. The preponderance of evidence suggests that when the scope of inquiry is broad enough, the net impact of ICT is to generate more communication, including new travel. Nevertheless, even if complementarity is accepted as the right answer qualitatively—and some people would contest that—we are not yet able to assess it quantitatively. We need to understand better how multiple effects combine to produce an observed net outcome. We also need to improve our understanding of the full range of influences (i.e., other than the need to communicate) on the travel and communication choices individuals make, which may affect the utility of the alternatives in less obvious ways. To these ends, new comprehensive studies at both the macro- and micro-scales are required. Micro-scale methods in particular are relatively primitive, and the early studies should be repeated with more precise measurement instruments, larger and more representative samples, and longitudinal data collection.

### Mobile and Self-Employed Workers

The adoption and short-term effects of conventional telecommuting (that is, salaried employees of an organization working at home or a nearby center, usually for only part of their work time) on travel have been studied extensively. Some perhaps unexpected findings include the observations that telecommuting has not been adopted as rapidly as some have predicted and

that even once adopted, it is only a temporary choice for many (a median telecommuting duration of 9 months was found in one study).

The choice of whether to telecommute depends on both external constraints (lack of job suitability, management willingness, or appropriate technology) and internal constraints (desire for workplace interaction, insufficient self-motivation, concern about visibility for advancement). Given these inherent barriers, telecommuting may continue to be a relatively small phenomenon in terms of the number of people doing it on any given day and hence affecting traffic, even though external constraints diminish over time and more people are given the option (*4*). Less formal attention has been paid to project-based telecommuting, where the reduced trips may be clustered within a short time span rather than distributed more evenly across a long period.

At the same time, the adoption of mobile work and self-employment (often in home-based businesses) and especially their effects on travel have been understudied to date (*5*). Although we have been focusing on the shift of work from one specific place (the regular office) to another specific place (home or a telecenter), a much greater transformation might be occurring, toward working "anytime, anyplace." Self-employment, for example, has increasingly been enabled by ICT and stimulated by corporate downsizing, the growth of an affluent service-oriented economy, and demographic changes in the workforce. Within the context both of self-employment and conventional salaried employment, work has become more mobile.

Our understanding of this shift to anytime, anyplace work is limited and complicated by the confusing use of ill-defined terminology such as "teleworking" to mean different things in different contexts. We need answers to basic questions such as the following:

- How extensive is mobile work?
- Does it affect the typical office worker, or mainly the high-level executives and professionals who project their own experiences and see a revolution?
- Can different types of mobile and self-employed workers be identified, with an assessment of the size and growth trend of each category?
- How do the effects on transportation, both local and long-distance, differ by category?

**Teleshopping and E-Commerce**
As commonly used, the terms teleshopping and e-commerce represent intersecting but not coincident concepts. From the consumer's perspective, teleshopping refers to the use of ICT to obtain information about or purchase consumer goods, or both; pre-World Wide Web services such as home-shopping channels on cable television, specialized early systems such as the Minitel in France, and even telephone orders from a catalog mailed to the home are included in this category. Now, teleshopping also includes the use of the web for obtaining information, comparison shopping, placing orders, and even downloading digital products electronically.

From the vendor's perspective, e-commerce encompasses business-to-business and business-to-consumer transactions that take place through ICT networks, whether private systems or, increasingly, the Internet. It includes virtual supply-chain management activities (production and distribution) as well as demand-chain activities. Electronic retailing is the subset of e-commerce that caters to an individual consumer (who participates by teleshopping). This segment is growing exponentially; consumer spending via the Internet is doubling annually. The ubiquitous coverage and instantaneous information capabilities of the Internet are generating entirely new forms of transactions, such as electronic auctions and last-minute sales of surplus goods and services. Airlines are now using the Internet to sell otherwise-unused airplane capacity.

Our understanding of the impact of e-commerce and teleshopping on travel is limited, and many questions can be identified for additional study. Here, we focus mainly on the consumer-related effects:

- What kinds of people engage in teleshopping, how often, for what kinds of goods, and under what circumstances?
- To what extent does teleshopping replace or supplement store shopping, and how does that vary by the factors just mentioned?
- What are the impacts on travel?

With regard to the last question, several different trends, which operate in different directions, can be postulated:

- To the extent teleshopping supplements store shopping, travel (for manufacture and delivery) will increase.
- To the extent teleshopping replaces store shopping, travel by the consumer will directly decrease by an amount depending on the extent to which shopping was chained to other activities.
- Second-order consumer effects should not be neglected: It is possible that the time saved by not traveling to shop and the increased time spent on the in-home activity of teleshopping will be partially compensated for by additional out-of-home activities that require travel.
- Replacing store shopping with teleshopping shifts the travel required for delivery of the purchased goods from the consumer to the provider, with an uncertain net impact. Provider-side delivery trips may be more efficiently organized than consumer-supplied deliveries—or not, depending on both the extent to which the consumer trip was chained to other activities and the provider-side tradeoffs between efficiency and timeliness of delivery.
- Because the Internet offers global reach even to small providers, manufacturing and delivery travel may increase as consumers and businesses order products and services from distant providers.

These counteracting effects clearly illustrate the complex nature of the impacts of teleshopping on travel, even without examining long-term impacts on the spatial and institutional organization of producers. Some of these are mentioned briefly below.

**Spatial Impacts**
The impacts of telecommunications on office location and urban form have been the subject of formal study for some time, but here, too, the relationships are complicated. Some researchers have observed that technology is a facilitator or enabler of location change but that other factors (for example, cheaper land or labor) actually drive the change. Thus, the attribution of "causality" to telecommunications is somewhat delicate. It also has been noted that technology can facilitate increased centralization as well as decentralization, possibly both simultaneously at different scales (for example, decentralization at the metropolitan scale but centralization at the superregional scale).

Several of the research questions raised earlier have spatial components. For example, little evidence exists regarding the effects of telecommuting on residential location. With adoption slow and temporary, the effects of conventional telecommuting on metropolitan areas are likely to be small. The answer may be different, however, for mobile workers and in smaller areas.

Anecdotal evidence suggests that "lone eagle" professionals and "high flyer" small-scale employers are moving into rural communities in numbers large enough to affect real estate markets and alter the character of the communities. Emerging but incomplete evidence from empirical studies of this phenomenon is that face-to-face modes of communication continue to be vital, despite reliance on electronic modes—with attendant transportation impacts (*6*).

Similarly, we are not aware of any rigorous studies of the spatial impacts of the Internet, particularly e-commerce. ICT has long facilitated the separation of managing, marketing, back-office, manufacturing, and warehousing functions to geographically distinct locations when doing so made business sense. It is likely that the Internet will catalyze the development of organizations that are even more virtual; however, face-to-face interaction probably will retain unique advantages, even as technology continues to improve the virtual reality of telecommunication. Minimizing transportation costs certainly is one important consideration in a firm's location decisions, and to the extent that this factor is paramount, we might expect travel to decrease on some per-unit basis as ICT continues to weaken the requirement of physical proximity. However, to the extent that ICT contributes to expanding economic opportunities, travel probably will increase overall.

## CONCLUSIONS

The study of telecommunications and travel behavior is inherently complex. Its complexities stem from not only the intricacy of the relationships themselves but also the changes in the environments around these relationships. Against the slower-moving demographic and organizational changes that may be occurring naturally, the highly volatile technological environment and attendant consumer response speed up some of these natural changes and bring about entirely new ones. Above all, we cannot underestimate the ability of people to surprise the "experts" in their responses to change.

Thus, improving our understanding of these processes is a moving target, and no sooner do we think we have made progress in answering one question then we realize that the question has been rendered obsolete or unimportant by environmental shifts. In a climate of rapid change, timeliness in identifying key issues and trends and in pursuing insight into those areas is more critical than ever. The research community has eagerly embraced this challenge. Its collective efforts toward designing and conducting scientific investigations already have brought considerable insight into this dynamic area, and we have every reason to expect continued progress in the new millennium.

## ACKNOWLEDGEMENTS

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