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Abstract

Although there has been considerable discussion about how telecommunications will affect the demand for transportation, most studies have focused on substituting telecommunications for transportation. For example, telephone and video conferencing can replace travel for meetings; electronic mail can replace postal service. More importantly, people can telecommute part-time or full-time using telecommunications instead of traveling to work. There are many other examples of reducing or eliminating travel by telecommunicating, but what may not be as obvious is how telecommunications stimulates travel. As the volume of telecommunications traffic increases, travel has been stimulated in a number of important ways. Increased telecommunications has fostered economic growth that has, in turn, increased travel. With increased use of telecommunications, people move farther apart so economic and social trips become, on the average, longer. To ensure that society continues to benefit from this stimulation, the government will have to devote considerable attention to developing the telecommunications infrastructure and to supporting appropriate telecommunications policy. In particular, governments must learn to allocate resources and attention reasonably to ensure that systems support economic and social growth.

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Introduction

Telecommunications is widely seen as a substitute for transportation. For example, telephone calls and video conferencing frequently replace travel to meetings. Electronic mail and facsimile very often replace courier or postal delivery. A more important example of substitution is telecommuting or using telecommunications to replace commuting between home and work.

Telecommuting has become a way of expanding employees' work locations in those circumstances where it yields both improved organizational performance and employee satisfaction. As of 1994, approximately

9.1 million workers in the United States telecommuted, and the numbers are expected to continue to increase in the long run, although the count dropped to 8.2 million in 1995 according to the annual survey by the respected international research firm, FIND/SVP.

It would appear, then, that telecommuting would lead to significant reduction in the demand for travel. Despite the significant benefits expected from telecommuting, however, its impact on the total demand for transportation is expected to be rather small. The United States Government, Department of Transportation has estimated that telecommuting by the year 2002 will only reduce the annual total vehicle miles traveled (VMT) by 0.7–1.4% below the level if there were no telecommuting. A similar study by the United States Government, Department of Energy suggests that the reduction in mileage is likely to be even less. This relatively small impact is explained by a number of factors:

- Telecommuters are not yet a large fraction of the workforce
- Telecommuting is normally a part-time or temporary practice
- Commuting is a small and decreasing share of surface travel even during peak rush hour periods

Benefits of Communications to Society

Although telecommuting is a very visible example of travel substitution by telecommunications, it is only one of a growing list of important areas where communications is having a major impact on services. In most of these cases, travel reduction is not the major consideration. The societal benefits from enhanced services greatly outweigh the savings from travel reduction.

- **Medicine**—An electronically networked system of specialized national medical centers, regional hospitals, and smaller rural and neighborhood clinics can deliver appropriate levels of care (open-heart surgery, appendectomies, or immunizations) and personal attention at the appropriate location. In each place, appropriately trained medical professionals are all teleworkers. They are supported by teleprocess access to patient medical histories and by teleservices that expand local medical know-how on symptoms, treatments, and outcomes.
- **Education**—The tradition of widely dispersed community schools and face-to-face interaction for socialization and learning will continue in public education, but local teaching and learning can be enhanced by teleservices providing access to people and information in the next county or on the other side of the world. Teleservices are also key resources for extending learning environments into homes, offices, libraries, and community centers.
- **Government**—Other government services and processes, from field inspections to forms processing, are amenable to revision through applications of voice, data, and video telecommunications. These applications can be designed to improve quality and access and can reduce or avoid costs. Sometimes agencies can use information technology to deliver

hours or days, and by telephone rather than in person. Other examples include querying remote air quality monitors and utility meters by phone, checking geographic databases from the field, writing and transmitting reports to computer files from the field, and maintaining surveillance of unstaffed facilities from miles away via remote video.

- **Manufacturing**—Modern manufacturing teleprocesses increase the responsiveness of production to the immediate needs of purchasers by putting more raw materials and finished products into computer-coordinated shipments with location-tracking systems, rather than depending on large inventories in warehouses and storerooms. The agile, just-in-time methods of manufacturing are beginning to be adopted in the service sectors of the economy as well.

Improving the availability and performance of telecommunications leads to gains in organizational performance and overall economic development. These gains from enhancing the telecommunications infrastructure do not necessarily lead to simultaneous reductions in travel.

Travel Stimulation from Telecommunications

When telecommunications substitution for transportation works well, it typically evolves into a growth in telecommunications volume that explodes beyond what transportation is capable of providing. Furthermore, as telecommunication volumes build independently of direct substitution for transportation, there begins to be an opposite effect, namely, travel stimulation. The expanding millions watching sports or the arts on television provide a growing pool of people who begin to consider going to the stadium or to the theater and concert hall occasionally. Intensive telephone, video, and fax interchanges between people who barely know each other creates desire for follow-up face-to-face meetings.

United States Government, Department of Energy Study

The United States Government, Department of Energy conducted a study that identified a number of important travel-stimulation effects:

- The development of a telecommunications infrastructure stimulates economic growth, productivity improvement, and income growth at the individual, organizational, and societal levels. Extensive databases and powerful computer-based econometric techniques have recently allowed this causation to begin to be empirically demonstrated. More money means more travel.
- As the economy grows, the communications infrastructure expands the number and geographic scope of economic and social relationships in which people and organizations engage. Electronic mail and toll-free telephone numbers are examples of relationship-expanding communications technologies that generate travel in addition to telecommunications volume.
- Telecommunications makes people aware of additional general audience events and opportunities that are reached through travel, such as political rallies, professional conferences, entertainment events, and shops.
- Telecommunications permits geographic decentralization of residential settlement and of organizational activity locations. Decentralization leads to higher travel consumption because trip origins and destinations tend to be farther apart.

- The development of a communications infrastructure speeds up the pace of economic activity, as futurist Alvin Toffler writes in his book, *Powershift*. He describes how wealthier nations simply operate at higher speeds than less developed countries. The same idea is expressed by business consultants in the phrase "time-based competition." The acceleration of commerce tends to generate customized, single-purpose trips that leave immediately and go by single-occupancy vehicles and small trucks.
- Telecommunications enables rapid response systems that dispatch customized vehicles to meet personal and organizational needs. Several examples of this are just-in-time logistics, home delivery of fast food, overnight package delivery, and temporary employment services.
- Telecommunications enables a wide variety of new last-minute information flows that generate personal travel through attractive invitations and compulsory orders to attend.
- New telecommunications functionality, resulting from digital switching and fiber optics, supports the urbanization of rural communities, together with associated growth in economic activity. This pattern typically causes more local automobile traffic and a flow of visitors using transportation from distant locations.
- Telecommunications makes travel time more productive and more feasible for travelers; use of wireless mobile phones while traveling is the leading example.
- The communications infrastructure makes the transportation system work more effectively and efficiently. Examples of this are air traffic control, computerized airline reservation systems, and Intelligent Transportation Systems (ITS, also called smart highways).

Puget Sound Regional Council Study

A recent study by the Puget Sound Regional Council also looked at the relationship between travel and the rapid growth of telecommunications technologies. The report concluded that this relationship is influenced by a wide range of factors such as land use, parking costs, and regional transportation capacity. In the end, it is not clear whether telecommunications is likely to increase or reduce demand for transportation and travel. It is clear, however, that per-capita travel demand is showing very strong growth in advanced and developing economies. Travel growth occurs even as telecommunications volumes grow. Growth in travel is of course influenced by current policies and prices affecting transportation. When travel on the usual routes becomes impossible, such as when bridges and roads were made impassable in the October 1989 and January 1994 California earthquakes, telecommunications usage and telecommuting soar until the roads are restored; but, after both quakes, some new telecommuters continued the practice part time even after conditions returned to normal.

Modifying Public Policy to Address Communication Needs

The argument for explicitly modifying public policy to push deployment of broadband for travel substitution derives from the idea that higher bandwidth and the associated higher cost-effectiveness of applications would accelerate trip substitution; but do currently available telecommunications functions that are usable on existing high-speed communications networks make remote access as good as "being there," thus making travel less necessary? Experiments with these communications technologies and functions to date do not provide any hint of this result: in fact, the opposite is

between two Xerox Corporation laboratories in different states concluded that the arrangement was not an adequate substitute for face-to-face experience.

In fact, some travel-saving applications work better in lower-bandwidth environments. Collaboration in writing between distant cities requires low-bandwidth sharing, not high-bandwidth videoconferencing. Many psychological counseling sessions work better over a voice phone than with the distraction of the counselor and the patient seeing each other. A big help in telehealth would be a pager that reminds people to take their pills. No fiber optics needed!

Furthermore promotion of infrastructure enhancement is not necessarily going to lead to applications that reduce travel if the infrastructure also supports applications that support, enhance, and promote travel. On the other hand, applications like telecommuting can start at today's level of infrastructure and then migrate technically path toward enhancement that will lead to better applications *and* a demand for better infrastructure.

To change to a different developmental path from that followed in the past, governments must learn to coordinate public policy on telecommunications, transportation, land use, and capital facilities investment in light of the interactions described here. The overall challenge is to allocate resources and attention reasonably across the entire spectrum of public facility systems that provide support for the transactions and relationships comprising economic and social life. Such systems include the cables and computers of the National Information Infrastructure; the roads and airports of the transportation system; and physical locations like schools, libraries, clinics, and meeting halls where people interact directly with other people.

One important government strategy deserves higher visibility at the state and metropolitan-area levels and the encouragement of national and local governments. A more explicit inclusion of telecommunications in planning processes for improving the overall transportation system. Telecommuting and other telecommunications related applications, if considered as part of a broad set of supply and demand determinants and solutions, could assist state and metropolitan regions in meeting the air quality and mobility goals mandated by federal legislation (the Clean Air Act Amendments and the Intermodal Surface Transportation Efficiency Act in the United States). This new consideration would fit well into a least-cost, integrated resource planning framework. Integrated resource planning would be a transfer to the transportation arena of ideas and methods that are now successfully used in electric energy planning.

Also, government policy could focus on promoting and ensuring telecommunications-based alternatives to travel for the inevitable future periods when travel becomes difficult or expensive because of disruptions from special events, weather, disasters, or oil supply interruptions. In the United States Government, we recommended that the Department of Energy have a special role in planning for this last eventuality.

Those in charge of coordinating transportation and telecommunications policy need to work on developing more understanding about telecommunications-transportation interactions and on disseminating this understanding to professional and political leadership. Then, this knowledge needs to be joined with politically acceptable public transportation goals in a policy-making process aimed at specific transportation outcomes, such as reducing peak-period traffic volumes.

In the greater Los Angeles area of Southern California, one of the authors recently participated in a study that proposes an approach to telecommunications-based travel reduction that works selectively on expanding telecommunications applications that logically and clearly substitute for

substitution. For example, if a municipal government uses the Internet primarily to tell citizens about meetings and hours when government offices are open, this public information application will stimulate travel. If, on the other, hand, the government establishes Internet applications that lets forms be obtained, filled out, and submitted electronically from homes and offices, or if input to the City Council can be made via electronic messaging, then there is the prospect of travel substitution.

Targeting of effort based upon a more thorough understanding of the relationship between telecommunications and transportation is an important requirement for decision makers in both the telecommunications and transportation sectors. Without this understanding and focus, the deployment of more capable communications infrastructure is likely to exacerbate present trends of worsening traffic congestion, even while other benefits occur.

Conclusion

Government policy intervention to accelerate the deployment of higher bandwidth and other more powerful telecommunications capabilities cannot be justified by the potential for travel savings alone. Still, there are many other government roles in communications technology and applications that lead to productive uses of limited resources. These include:

- Development and deployment of government teleprocesses that deliver more service for less money and make use of existing and pending communications capabilities.
- Support of infrastructure improvement in disadvantaged geographic areas and for socially important applications that the market leaves behind despite the economic cost to society at large.
- Legislative and rule-making action to eliminate barriers to the deployment of teleservices for health care, education, and general government teleservices.

In short, government leaders must shift their focus beyond telecommuting to a much larger set of telecommunications-related processes that are increasingly changing the patterns of activity and location for both organizations and individuals. Only through a growing understanding of the new information technologies and their patterns of use will this nation discover ways to minimize the costs and increase the benefits to our society and economy from the parallel growth of transportation and telecommunications.