IMPACT OF TELECOMMUNICATIONS TECHNOLOGY, INCLUDING TELEWORK AND TELECOMMUTING, ON TRAVEL DEMAND AND TRAVEL DEMAND MANAGEMENT IN THE NEXT DECADE

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INTRODUCTION

This is an abridgement of a copywritten paper, by E. M. and Linda T. Risse of Synergy Planning, Inc. The complete 47-paper will be available at the November 15-16 TDM Symposium in Rosslyn, Virginia. As well, brief summaries of three other publications on telecommuting have been included as an appendix to this abridgement.

The Risse's paper addresses the impact of telecommunications technology on travel demand and travel demand management in the next decade. There are two primary, interrelated issues considered:

- Indirect Impact
  Telecommunications technology has a fundamental impact on regional pattern and density of land-use, and, thus, trip origins and destinations.

- Direct Impact
  Telecommunications technology may be applied to replace the commute to work (and other travel needs), and thus overcome transportation system deficiencies or locational disadvantages.

An important vocabulary distinction is that between telework, and telecommuting. Telework is a broad category that describes moving work to people via telecommunications, instead of moving people to work. Telework would thus include home-based businesses employing telecommunications, and teleconferencing. Telecommuting has a narrower meaning: replacing the trip from a home to a traditional workplace with telecommunications some or all of the time. Telecommuting is thus a kind of telework.

SURVEY OF CURRENT AND FUTURE TELECOMMUNICATIONS TECHNOLOGIES

When considering the travel demand and TDM impacts of telecommunications technology, one must guard against becoming fascinated by the promise of individual technology applications or being oversold by those promoting technology. It is technology implementation that impacts travel demand. Over the past two decades, it has primarily been the economic, social and physical context that has governed the adoption of technology that impacts travel demand and TDM, rather than the availability of new telecommunications technologies.

Telecommunications technology can be divided into two broad categories:

- Terminal hardware and software: what the terminal operator uses

- Network hardware and software: what connects terminals together

Network and connection technology is what directly substitutes for travel. Terminal technology controls what users do and therefore whether there is a reason to travel. Network technology improvements do not require a user interface and so do not have the same cultural inertia and lag time as terminal equipment.

Before examining these two broad categories of technology, there are two important contextual points to make. First, the medium of the future is digital transmission. What Marconi and Bell invented were analog systems. Digital transmissions employ the binary language that is the communications medium of central processing units of computers.

While both analog and digital transmissions travel at the speed of light, the chief benefit of digital transmission systems is in capacity, which is orders of magnitude greater than analog.

The second fundamental contextual issue is that the terminal of the future is a merger of the telephone, the television and the computer. The capacity of the digital network will make available for every work, service and entertainment application an integration of the information processing and presentation potential of these three technologies. This merger and its application is called telematics.

TECHNOLOGY ADVANCES: TERMINAL HARDWARE AND SOFTWARE

Technological advances have decreased terminal costs, even as power has increased, and size has decreased. Further innovation will increase power and bring down the cost even more, but the size of those parts of a device that interface with a human body cannot be reduced beyond a convenient threshold that may have been already overshot by some notebook and palm-top computers. In fact, the new advances in terminal equipment of importance to transportation will be in applications—the range of useful or entertaining activities that the equipment can perform. Following are some specific applications technologies that have a high potential to impact travel demand.

1. Virtual Reality
2. Teleconferencing Audio and Video and Software and Equipment
3. Groupware
4. Locating Services
5. Caller Identification
6. Personal Communications Services (PCS)

TECHNOLOGY ADVANCES: NETWORK HARDWARE AND SOFTWARE

There are currently hundreds of networks that are "long distance" or interregional. Some are owned by users, some are leased by users, and others are available for a fee to a selected group or the general public. Interregional networks are fiber-optic cable, microwave and satellite, in addition to wire.

There are many thousands of regional networks. They are owned by the "local" telephone companies (wire and cellular), by cable TV companies, and by a range of public and private organizations that provide service to themselves or clients. Most important is a new breed of networks called Metropolitan Area Networks (MANS). MANS are being set up by Competitive Access Providers (CAPS), as well as by traditional wire and cellular telephone companies. CAPS plus the competition among wire, cellular and cable companies are predicted to make regional and subregional systems as competitive as "long distance" carriers before the 90s are over.

Of particular importance to the pattern and density of land use is access via modem over local phone lines to the major commercial on network services, e.g., CompuServe, Prodigy, GEnie. These consumer services allow individuals to access many of the connectivity services and information formerly only available to corporate and agency networks.

To tie the networks, terminals and connections together, there is strong political support to create a National Electronic Super Highway. While many electronic communications networks already exist, it is clear that a "system" of electronic superhighways will move information faster. If one can believe the promotion for the National Electronic Super Highway by the private sector and the media coverage, most of the content will be entertainment. To facilitate the creation of the Electronic Super Highway, there is pressure to create, as a national policy, fiber optic cable "to the home." This means that the entire telecommunications cornucopia will be at every telephone jack in every home.

There are a range of connection technologies that will facilitate access to networks and services, without full installation of fiber optics all the way to the user. One, ISDN (integrated services digital network), despite early promise, has been little used. There are now less complicated technologies that will enhance the capacity of standard

local wire phone circuits and transfer high volumes of digital information. By acronym, these include ATM, SMDS, B-ISDN, and ADSL.

Another connection technology of importance is the direct satellite link. Although costly, this can provide immediate, high-band-width digital capacity, and is useful where the need justifies the expense.

FACTORS INFLUENCING IMPLEMENTATION OF TELECOMMUNICATIONS TECHNOLOGIES

There are some fundamental social, economic and physical factors that have influenced and will continue to influence the implementation of telecommunications technology. In turn, the nature of travel demand will be changed by these socio-economic factors and the telecommunications developments that they trigger. This will have a direct bearing on the type of travel demand management measures needed in future.

There is now underway a global change in the way that work is done. Specialization of work and organized markets first emerged in neolithic agricultural and trading communities. From that time until the Renaissance, human economic activity was done at or close to the residence of the worker. The second significant pattern of human economic activity was created by the Industrial Revolution, which made necessary an agglomerated workforce located in close proximity to others working on the same task. This urbanized almost all non-agricultural economic activity. Telework, moving work to people by telecommunications, instead of moving people to work, represents a third, fundamentally different way that work is being carried out.

Telecommunications and telework have made concentrations of office jobs viable in locations separated from the central cores of our industrial centers. Jobs were moved closer to where people live and shop, and farther from where others doing related tasks were located. This created the so-called "Edge Cities." New locations for work are now moving outward from Edge Cities, with technology allowing even further dispersion in the location of work.

The need to be competitive is the primary cause of the fundamental changes that are restructuring the workplace. U.S. enterprises have been striving to become more efficient and effective to keep up with European Community and Pacific Rim competitors. Whatever else the future holds, it will be more competitive.

The need to be competitive, as well as the recent downturn in the economy, has created three trends in the workplace that impact and will be impacted by telework and telecommunications.

1. More efficient office layouts

2. The move to cheaper office space

3. Fewer traditional office space users

As a result of these trends, there are dramatic changes in the potential use of existing structures, and thus tremendous changes in transportation demand. For example, currently a building with 200,000 square feet of space could have 800 employees going to work there every day. In five years, there could be 1,600 people working from that space with only 400 people there on a given day.

Changes, in additional to the need to be more competitive, which are driving organizational restructuring include:

1. Demographics of the persons entering the workforce between now and 2010.

2. Deterioration of the transportation infrastructure.

3. Growing child or elder-care responsibilities of members of the workforce, coupled with the mushrooming cost of this care.

4. The 1990 Clean Air Act Amendments that will either substantially raise the cost of doing business, or cause organizations to relocate outside of non-attainment areas.

5. The 1990 Americans with Disabilities Act and other new workplace regulations that raise the cost of doing business in existing structures.

TELECOMMUNICATIONS IMPACT ON TRAVEL

Telework Impacts on Pattern and Density of Land Use

Telework involves moving work to people via telecommunications, rather than moving people to work. Most of the research to date exploring telework's impact on transportation has focused on reducing peak period demand via one aspect of telework-telecommuting. Telecommuting involves employees who use electronic communication as a substitute for the traditional commute to work.

The broad category of telework has had, and will continue to have a much more profound impact on transportation system performance than peak period transportation/telecommunications trade-offs from telecommuting. Well over 50% of the total office workforce has relocated in the past 20 years to "Edge Cities" and more recently to even more widely-scattered sites. What has moved are primarily organic components of private and public organizations. These moves were driven by economic factors, but many could only have taken place because of applications of telecommunications technology. Telecommunications has thus enabled a development pattern frequently called "sprawl."

With respect to work at home, Link Resources, a New York based research firm, states that the number of people over 18 years old in the United States who have full- or part-time home-based businesses or who work at home full or part time as company employees increased to 41.1 million in 1993, up 5.4% from 1992. This includes telecommuters. The current 41.1 million homeworkers is 32.4% of the total workforce. This number is forecasted to reach 50 million by 1996.

Telecommuting Replacement of Commuting Travel

Telecommunications technology may be applied to replace the daily journey to work to overcome transportation system dysfunctions and locational disadvantage, and in the process change transportation demand. This is telecommuting.

According to Link, there are currently 7.6 million telecommuters in the United States, up 15.2% from the 6.6 million reported in their 1992 survey. 7.6 million telecommuters is 6% of the total U.S. workforce. Of this 7.6 million, Link reports that 5.12 million are pure corporate telecommuters, up 22% from 1992. These "pure" telecommuters are regular salaried employees doing job-related work at home during normal business hours. The others are contract workers.

Beyond the overall numbers, there is very little good data on telecommuting. Most of what there is pertains to large firms, although Link Resources reports that 77% of all telecommuters come from firms with under 100 employees.

It is easy to oversell telecommuting, and also easy to parody it. In fact, telecommuting may not have a significant impact on total vehicle miles traveled, or on total vehicle trips at the national level. Telecommuting, however, can have a significant impact on travel in a specific subregion or corridor suffering from transportation and clean-air dysfunctions. The validity of this approach was shown by the traffic mitigation program implemented in Los Angeles during the 1984 Olympics. Telecommuting should thus be carefully considered as a TDM tool in congestion management and air quality planning.

CONCLUSION

Telework and Travel Demand

The contemporary transportation system has created job, housing and trading opportunities in disbursed locations. The use of these disbursed opportunities has been facilitated by telecommunications technology. The resulting widely scattered regional pattern of land use cannot be supported by the current transportation system. We have now reached a point where it is clear that prosperous economic activity and a sustainable environment cannot be maintained in a dispersed urban form if we move people to their work the way we have in the past.

Telework and Telecommuting are not the solution, but they can be a bridge to the future; they can assist us in retaining our economic viability while we:

- Rebuild our urban areas,
- Recreate a rational balance between intensive and extensive uses of land, and
- Establish a sustainable relationship between land-use pattern and density, and the transportation system that supports it.

Telework Center Strategies

We are only now beginning to look at ways to spend transportation construction dollars to cut demand, rather than expand capacity. Using the flexible-funding features of the Intermodal Surface Transportation Efficiency Act, we can explore ways to provide access via telecommunications, instead of adding more transportation capacity at ever greater cost. This must be done in a way that creates supportable pattern and density of land use. For example, there is no public payback for putting telework centers into office buildings surrounded by parking lots and thus insulated from human needs by asphalt. Once the car is the easiest way to get to work, and a car is needed to do anything in addition to getting to work, low density super sprawl occurs. Therefore, there should be a public strategy to locate telework centers within walking distances of services, and to encourage center workers to live in communities.

Data Needs

There is a need for more, better and/or different data before we can fully address the telecommunications impact on travel demand. Information on land-use is particularly important.

Current transportation models typically input "land-use data" from municipal government. These are projections of future development activity, often derived by applying a formula to construction activity "in the pipeline." Like any extrapolation, these data may be unreliable, but they also are based on changes in the amount of particular uses of land (demolitions and new construction) and not on changes in the use of existing structures. Therefore, although there are major changes taking place in the market that will have profound impact on regional transportation systems, the current modeling processes will not reflect these changes.

Telecommunications and Telework Research and Policy

For years, federal and state transportation agencies have been conditioned to deal with pattern and density of land use:

- As a given,
- As driven by free market choices, and/or
- As driven by municipal decisions,

or for other reasons beyond the purview of transportation research, planning and review. The staffs of the regional Metropolitan Planning Organizations (MPOs) have been foreclosed from considering these issues.

Much of the current dysfunction in the transportation system stems from a pattern and density of land-use created in part by transportation facilities and telecommunication technology.

On the other hand, telecommunication technology provides enterprises, institutions and citizens an alternative to the dysfunctional transportation system infrastructure. If allowed to go unchecked, however, individual optimization and self-interest will further exacerbate a sprawling land use pattern, making it impossible to provide a functional transportation system at a cost that society can afford in time or money. This makes it imperative to conduct far more research on the impact of telecommunication technology on travel demand, and to incorporate the relevant information into travel demand forecasting models.

The 1990 Federal Clean Air Act Amendments, the Intermodal Surface Transportation Efficiency Act and federal economic growth policies will accelerate policies and actions to substitute telecommunications services for travel demand. If widespread application of telecommunications and telework are to be encouraged, we should first understand their impact on travel demand.

DISCUSSION OF THREE PUBLICATIONS ON TRANSPORTATION IMPACTS OF TELECOMMUTING

1. Patricia L. Mokhterian, "Telecommuting: What's the Payoff?," ACCESS, Research at the University of California Transportation Center, (Spring 1993).

Telecommuting is defined as "working from home, or a location close to home, instead of travelling to a conventional work location." Telecommuting has become an item on the policy agendas of public agencies as a possible way to reduce travel, energy consumption, and automotive emissions, while also providing human resource and economic development benefits. Telecommuting has been introduced for government employees in California and Washington state, and the federal government has begun a pilot program for its employees.

While telecommuting should, in theory, reduce travel, it is possible that a person working at home might have increased non-work travel. It is also possible that telecommuters would be more likely to drive alone on the days that they commuted to work, rather than carpool or use transit. Another possibility is that telecommuters might move to a home farther from work, since they need to commute to work less often, and this could result in increased VMT.

Empirical studies, notably from the California and Puget Sound demonstration project have shed light on the transportation impacts of telecommuting. Findings include:

- Total VMT, including non-work travel, decreased on telecommuting days.
- There was no aggregate increase in non-commute travel.
- Reductions in emissions and fuel use were proportional to reductions in VMT.

These studies appear to confirm that telecommuting reduces travel in specific, small-scale settings. Some have found these findings to be inconclusive, as they are based on small, non-representative samples. For example, telecommuters studied so far have substantially longer trip lengths than the average.

A clear research need is to learn more about why people will or will not choose to telecommute. This will allow better policy formulation, and a clearer understanding of what level of telecommuting might be achieved in future. We also need to learn more about long-term impacts on residential and job locations.

2. **Daniel B. Rathbone, "Telecommuting in the United States," Transportation in the ISTEA Era, Issue Papers for the ITE 1993 International Conference, Orlando, Florida.**

A survey of the known telecommuting programs in the U.S. was conducted, with 16 organizations responding. There was also an analysis of which occupations are suitable for telecommuting. From this the following is concluded:

- Survey respondents reported that telecommuting has a number of non-transportation benefits, e.g., increased employee productivity and job satisfaction.
- For a single employer, a 25% reduction of peak period vehicle trips is possible; at a subarea level, a 10% reduction is possible; and at the regional level, a 5% reduction is possible.
- For traffic impact studies, a 20% reduction of home-to-work vehicle trips attracted by new development is recommended, provided that there is a binding agreement for the implementation of a telecommuting program.
- Metropolitan Planning Organizations can play an important role by disseminating information about telecommuting. Documentation should be developed to support their future activities.

3. **US Department of Transportation, Transportation Implications of Telecommuting (April 1993)**

This 104 page report surveys the current state of knowledge on the topic of future impacts of telecommuting on transportation, the environment and energy use. Following are, verbatim, the principal conclusions of the report:

- Telecommuting is now practiced by approximately 2 million workers and could reach 7.5 to 15 million within a decade.
- Estimates of the future level and impacts of telecommuting are highly uncertain.
- Telecommuting has the potential to provide significant transportation-related public benefits in this decade.
- The actual amount and impact of telecommuting in any particular region will depend strongly on the local transportation environment and travel demand measures.
- The congestion and air quality improvements potentially attainable through telecommuting could be substantially diminished if telecommuters removed from the highways are replaced by the emergence of latent travel demand.
- Direct energy, air quality, safety, and time benefits of telecommuting will be increased as the degree of congestion is reduced.
- Telecommuting could stimulate urban sprawl and have other adverse impacts on land use and public transportation.
- Factors which will impact the rate of growth of telecommuting include uncertainty of benefits for employers and the considerable time and effort inherently required to bring about major changes in workstyles and ways of doing business.
- Telecommunication services and equipment are adequate for most current telecommuting, but high-bandwidth capabilities will be needed in the future and would be beneficial now.
- Government agencies can play a significant role in facilitating and encouraging telecommuting.
- Telecommuting can be an effective tool for travel demand management, but cannot be mandated.
- Continuing research is needed to clarify telecommuting costs, benefits, and future impacts.