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For
Sustainable Communities



Research



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EXECUTIVE SUMMARY

RESEARCH ISSUE

Under the sponsorship of the Minnesota Department of Transportation (Mn/DOT), with funding initiated by Congressman Martin Sabo, the State and Local Policy Program (SLPP) at the Humphrey Institute of Public Affairs has examined many aspects of Intelligent Transportation System (ITS) technology and sustainable transportation. This study investigated the political, legal, and institutional issues raised by the application of telecommunication, wireless, and Global Positioning System (GPS) technologies to transportation, with a focus on how these technologies might affect the development of sustainable communities.

The first task included the development and pilot testing of time use diaries by a number of telecommuters and their coworkers, and analysis of this data both by itself and as it related to data collected in previous studies. This assessment also included the development of two surveys in addition to the diary instrument. One survey was administered at the beginning of the research period; participants completed the other survey each day as they completed the diaries. The survey period was three weeks in early September 2001. This task also included an initial scoping paper regarding the transportation implications of e-commerce.

The second task included holding focus groups to assess issues related to GPS and wireless technology use in rural Minnesota and development of scoping papers on: political and legal barriers of wireless telecommunications technologies; potential GPS applications to transit and other “alternative” modes; and, as increased safety is a key goal of deploying these technologies, methods of assessing monetized benefits of a “zero-death” scenario.

The third task considered sustainable transportation “best practices,” especially focusing on how these could be applied to Mn/DOT’s Inter-regional Corridors. This task included a “National Listening Session on Transportation and the Environment,” which was held at the Humphrey Institute and co-sponsored by the University of Minnesota’s Center for Transportation Studies (CTS), Mn/DOT, and the United States Department of Transportation.

RESULTS

- Time use diaries are effective instruments for recording travel behavior but require large amounts of information for assessing whether telecommunications substitutes for physical travel in the case of individual participants.
- Alternative work schedules, such as compressed workweeks, may affect travel behavior as much as telecommuting.
- Telecommunications may have as great or greater impacts on non-work trips than on work trips. Whether this impact will tend towards greater stimulation or greater substitution is unclear, but early evidence suggests greater stimulation may be the final result.
- A correlation may exist with the number of people in the respondent's household, as well as their "time-in-life."
- While e-commerce can increase consumer demand for faster and more efficient product delivery, which are best served by smaller, quicker, and more frequent shipments, consumer travel demand has not yet been greatly affected.
- In deploying new technology to improve transportation safety, rural Minnesota residents prefer implementing affordable, proven, and reliable technologies that they can learn and understand instead of trying to have the "latest technologies" available to them.
- GPS-based, demand-responsive transit service increases the likelihood of use and creating mode shift than traditional fixed-route service, but whether such a system is cost-effective or justifies any necessary subsidy is still unclear.
- The current regulations for wireless telecommunication and GPS transportation applications are still in the formative stage. However, current industry initiatives at protecting privacy and improving safety are encouraging.
- Current practices for monetizing the benefits to society for reducing transportation fatalities rest upon uncertain assumptions. As a result, benefits are best estimated as a range between $1,400,000x + 64,000y + 16,000z$ and $14,000,000x + 640,000y + 16,000z$, where x = fatalities, y = incapacitating injuries, and z = non- incapacitating injuries.
- Increased choice and efforts to decrease dependence on single-occupant automobiles are supported in Minnesota, especially regarding land use patterns.

RECOMMENDATIONS

- *Address Telecommunications Impact at the Household Level*—Telecommunications appears to have a greater effect on household trip making than simply on work commutes. Consequently, a large-scale, household-based administration of the time use diaries could produce solid, reliable results regarding the impact of telecommunications on travel behavior.

- *Enhance Multimodal Focus of the Transportation System to Accommodate E-commerce Growth*—The transportation network must maximize the efficiencies created by the use of e-commerce and information technology, such as increased intermodal freight use, while planning for increased demand for small package delivery service. Maintaining a focus on environmental impacts and location efficiencies will help ensure e-business growth does not create a disproportionate burden on the transportation system.

- *Transportation Technologies Should be Reliable and Intuitive*—In deploying new wireless or GPS-based transportation technologies in communities throughout the state, Mn/DOT should focus on those technologies that are reliable and easy to use, as opposed to those that may provide incremental improvements but may not have a proven track record, and should also ensure that adequate training is provided to those that will use it.

- *Investigate Opportunities for Demand-Responsive Transit Created by GPS Technologies*—Given the environmental benefits, and potential equity benefits that increased transit use can bring to building sustainable communities, further research, including case studies, and field tests of flexible, demand responsive GPS-based transit services should be pursued.

- *Allow Industry Self-Regulation of Wireless Technologies*—In seeking to enhance the safety and privacy of its citizens government at all levels may find it beneficial to follow the self-regulatory lead of the Cellular Telephone Industry Association and the Intelligent Transportation Society of America, at least until the effectiveness of these measures is better understood. At that time, if additional regulation is necessary, government action will be able to build upon the lessons learned.

- *Scrutinize Assumptions for Estimating Increased-Safety Benefits*—In assessing of the benefits to society for reducing transportation fatalities, Mn/DOT should acknowledge the uncertainty of underlying assumptions.

- *Pursue Transit-Oriented Development Strategies on Major Corridors Throughout Minnesota*—Mn/DOT should monitor the development along its inter-regional corridor system, and make sure Transit-Oriented Development (TOD) strategies, including suitable land-use patterns, are implemented where possible.

CHAPTER 1

TELECOMMUNICATIONS AND TRAVEL BEHAVIOR

How Was Your Trip? Exploring the Relationship Between Telecommunications and Travel Through the Time Use Diary

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DRAFT REPORT

INTRODUCTION

The research presented in this article represents a culmination of a multi-year study scoped to explore the potential implications of telecommunications advancements for transportation and community development in Minnesota. The program is collaborative effort between the Humphrey Institute, University of Minnesota, and the Claremont Information and Technology Institute (CITI), Claremont Graduate University, and is an endeavor made possible through a grant by the Minnesota Department of Transportation (Mn/DOT).

The principal objective of this phase of the study has been to develop and pilot-test instruments for use in further in-depth exploration of the relationship between telecommunications-enabled services, such as telework, current access to such services, and consequences for travel behavior. The work builds upon survey and interviews conducted over the preceding two years, as well as recent findings reported in the scholarly literature. These data have informed development of the three instruments including (1) background survey, (2) daily time use diary, and (3) daily survey of attitudes and experiences.

The three instruments were pilot-tested in August and September of 2001. The remainder of this paper will be devoted to describing instrument development and results of the pilot. Results suggest areas for diary design and administration improvement, as well as intriguing insights into the relationship between telecommunications and travel. These suggest topics for exploration in future research.

BACKGROUND

Defining the Study Constructs and their Conceptual Relationship

Telecommunications, as used in this report, refers principally to information technologies. Specific technologies presented and described to respondents include those that provide voice and data transmissions. Voice encompasses both wired (telephone) and wireless (cell phone) forms of communication. Data types include, for example, e-mail and file sharing.

Telecommunications advancements have enabled changes in where and how people work, particularly in the form of telework (a.k.a. remote work). Consequently, the transportation community has often targeted telework in studies designed to explore the implications of telecommunications for travel (7). The link between the two is inherent in early conceptualizations of telework; Nilles originally coined the term to describe substitution of travel by telecommunications technologies.(1) On the current JALA Web site, he defines the construct as “any form of substitution of information technologies for work-related travel... moving the work to workers instead of moving the workers to work.”(2)

Postulated travel effects of telework have been described extensively in the literature and include the possibility of reductions in peak travel with concurrent mitigation of congestion, pollution, and so on. [For a brief review see Ellison, 1999 (7)] The relationship between telecommunications enabled telework and travel behavior, however, is increasingly understood to be more complex than models assuming a direct substitution effect. Research suggests complementary or enhanced travel with increased access to telecommunications and related services.(2; 7)

The conditions under which telecommunications and travel demand might prove complementary, neutral, or subject to joint modification are topics discussed in the scholarly literature.(3) Efforts have been hampered by the complexity of the problem, complicated by methodological issues across studies including a remarkable continued lack of consensus in defining telework. Across research, sampled respondents display a range of behaviors limiting the utility of cross-study comparisons in achieving a clear understanding of the nature of the telecommunications-transportation relationship.(9; Kraut, 1987) Multiple behaviors are subsumed under the telework construct, and may include salaried employees who work at home (generally termed telecommuting), paid employment from a telecenter, home-based businesses, distributed work teams, truly mobile work forms (e.g. mobile sales teams, on-site customer support), geographically dispersed work teams, after-hours work, and so forth.(4) Each of these has the potential to enable changes in community systems, with potential broad ranging connotations for community growth and design, land use, economic growth, telecommunications-facilitated service demand, and use of local travel resources to name a few.(5) Results of previous

interviews suggest that possible effects may be closely linked with the form of telework sampled (e.g. telecommuting versus mobile work).

To be clear then, respondents for the pilot of the instrument include organizational employees who work at home some portion of the workweek, according to a formal agreement between supervisor and employee. As members of organizations, these telecommuters are ideal for the pilot as they provide a circumscribed, identifiable, and accessible population. Note also that previous interviews show the respondent pool used in this research actually exhibits a range of behaviors generally subsumed under telework, including on-site client support work, geographically dispersed work teams, and after hours work. The methodology and instruments have been developed with this range of telework behaviors in mind.

Further, the methodology seeks to develop a better understanding of how telecommunications enables *access* to services (telework, telemedicine), and the relationship of this access to substituted and/or stimulated travel. Access is often seen as the overall objective of transportation, for example, access to goods and services. While it has been postulated that in-home Internet use may improve access, little is empirically known about the extent to which such electronic activity occurs during the telework day or time period and how that might affect travel. This methodology aims to build on this conceptual approach to access and develop some empirical measures as to its nature and extent.

Lessons Learned: Prior Findings Drive the Research Task

The current work rests upon prior case study of two organizations in Minnesota: one public agency and the other a private enterprise. Previous data were collected via employee survey and in-depth interviews of both supervisors and employees.(6)

Year one survey of employees was scoped to explore the potential effect of telecommuting on travel behavior and included a look at organizational and individual constraints and facilitators for telecommuting. Survey findings were explored and developed in-depth through interviews of a small sample (51) of telecommuters, their coworkers, and supervisors in the successive year. In broad terms, three themes emerged across analyses. Themes parallel findings reported in the

literature and have potentially important implications for transportation-related behaviors. These include:

- First, in agreement with postulates in the literature, the relationship between telework and travel behavior is apparently much more complex than a simple one-to-one substitution of remote work for the commute. Survey and interview results from this research program provide support for propositions that relationships between telecommunications and travel encompass a range of effects such as travel modification, generation, or even neutrality.(7) Findings from interviews, in particular, suggest a complex relationship between telecommunications-mediated work largely dependent upon the schedule for telework. Respondents who engage in full-time work at home (truly virtual work) tend to demonstrate the most changed errand-running behavior, for example, and in general conclude errands nearer home and before peak travel periods. Those who engage in work-at-home a few days per week tend to maintain pre-telework behaviors, accomplishing errands on the return from the workplace during peak travel periods.

Further, interview findings suggest that modeling the effect of telework on travel behavior relies upon achieving an understanding of contextual contingencies and a Web of interconnected activities.(8) For instance, responses revealed a surprising combination of telecommuting with flexible or compressed work schedules, with trips consolidated often on flex days rather than telecommuting days. Such findings suggest study factors should be expanded to include a broad based activity approach to better elucidate interactions between the behavioral context (work and beyond) and remote work conditioning outcomes.

- The second theme explicates the imbedded nature of the transportation system within community and the reciprocal nature of travel and community effects. For instance, interview responses suggest that factors conditioned by the wider environment, such as *access* to the appropriate information-enabling infrastructure, become critical to modeling the implications of telecommunications. A number of supervisors and employees noted the lack of appropriate community digital infrastructure has even prohibited the expansion of telecommuting in several instances. The available local infrastructure was simply insufficient to provide necessary data transfers. Such findings indicate the potential impact

of telework on transportation systems is imbedded in local community effects and ultimately revolves around the issue of access. Exploring the implications of telecommunications for community-imbedded systems like transportation should begin with the question: “To what extent does a digital network affect access to information, jobs, and services? And, “How are behaviors then influenced by this access?” Importantly, residential choices may be made in reaction to access.

- The third emergent theme highlights the continued need to explore the factors upon which adoption and continuation of telework might be contingent. As discussed in the literature, such factors represent important prerequisites to systemic changes.⁽⁹⁾ Previous studies demonstrate telework implications are clearly dependent upon the rate at which remote work forms are adopted—generally noted to be slow due to a number of constraints related to both the individual and the work environment.⁽¹⁰⁾ Interviews with managers, from both the public and private organization, demonstrate management reluctance poses a significant constraint in many instances. A major concern surrounds the potential for remote work to seriously impede spontaneous work-related communications and subsequent knowledge sharing. Telecommunications are considered a poor substitute for face-to-face contact. Respondents to prior year interviews also expressed fear of isolation as a constraint for individual employees in the decision to telecommute or not. Similar findings have been remarked upon in the literature with fear of isolation a notable constraint to work at home (Evans, 1993; Salomon & Mokhtarian, 1997). As in the second theme, the question of *access* again becomes important to understanding constraints and facilitators of telework behavior. Questions might include: How does telecommunications-mediated access across social peers and work groups affect knowledge growth and individual well-being? What are the conditions under which social support and sources of knowledge is sufficiently realized in telecommunications-mediated interactions? Answers will likely condition telework penetration and ultimate long-term systemic effects.

Research Questions

Telework has been described as a potential change agent in broad domains, including: community development (land-use), strategic development and use of local public services and

commercial enterprise (e.g. online government information, e-commerce), and information sharing and acquisition (knowledge management and e-learning). Guided by an awareness of the complexity of the relationship between telecommunications and hypothesized system-wide outcomes, broad exploratory research questions drive this research. Specifically, how does access to telework impact:

- Demand for local services (e.g. local business, local government agencies, libraries, schools). Are there implications for local travel behaviors?
- Residential location and related land use pattern decisions? Again what are the potential affects on local travel behaviors?
- Key factors for organizational and employee success and well-being (e.g. information and social networks, tacit knowledge creation and sharing). What are the implications for telework penetration?

The research questions have been developed to address the changing individual, work, and community environment in which the telecommunications-transportation interaction takes place. As suggested in the literature, the focus of this study is to examine the complex of choices and activities that occur *over time* in order to more accurately model the transportation impacts of telecommunications.(11) Accordingly, efforts in the current year have concentrated on identification and development of an instrument capable of capturing the complex of behavioral choices, activities, and attitudes characteristic of an increasingly telecommunications-mediated environment. Telework provides a bounded microcosm for this examination.

STUDY DESIGN AND METHOD

The challenge for developing predictive models for system-wide effects of telework largely centers on establishing an understanding of the environmental contingencies that condition telework and its expression, as well as causation between factors. Cross-sectional research designs are invaluable in research seeking to establish association between telework and travel related behavior outcomes. However, understanding causality as well as possible variable interactions in complex behaviors ideally uses longitudinal study designs. The research protocol developed for this research establishes a design that provides for comparison between groups of

users and non-users *over time* in an effort to identify cause and affect relationships between antecedents and behavior changes.

Faced with similar needs to explain rather than simply describe behavior, researchers across disciplines increasingly rely upon designs incorporating data collection via various forms of daily diary methods.

Identifying an Appropriate Methodology: The Daily Diary

The daily diary methodology has been used across disciplines for decades to explore cause and affect among complex behaviors. For example, sociologists have long found daily diary instruments extremely helpful in understanding human behavior. Examples of two of the earliest recorded applications were published in 1913 with *How Working Men Spend Their Time* and *Round About a Pound a Week*. In these books, diary methods were used to explore the effects of industrialization in America and England.⁽¹²⁾ In 1977, social scientist John P. Robinson published results from a classic time use diary in *How Americans Use Time: A Social-Psychological Analysis of Everyday Behavior*.⁽¹³⁾ And in recent years, the diary method has been used and advocated as a state-of-the-art tool by transportation researchers (Mokhtarian and Salomon, 1997). The methodology, therefore, has been selected for use in this research program.

The Time Use Diary

There are a number of possible forms the diary may take with subsequent differing labels, for example, travel diaries, action diary, daily activity diary, time use diaries, the closely related experiential sampling method, and so on. The different forms are largely predicated upon the purpose for the data collection. The diary can be constructed as a simple behavior inventory, or it may appear as a more complex, structured instrument, combining behavior inventories with scales developed to tap both attitudes and behaviors.

Transportation diaries typically are structured to obtain an inventory of travel activities. However, notable limitations of travel diaries make this form less suitable for exploring the telecommunications-transportation relationship. Most importantly, targeting travel behaviors alone restricts information gathering to travel, neglecting a large portion of important contextual

information (e.g. extent to which Internet use might substitute for or alternatively enhance travel). Faced with the demands of accurately modeling travel behaviors, Stopher and Wilmot (14) suggest an advantageous design focuses the instrument upon time usage—in time use diaries.(14) This approach more effectively negotiates the issue of under-reported travel—a problem encountered in studies employing the traditional travel diary.

The Stopher and Wilmot adaptation of the time use diary addresses a particular concern in longitudinal research: respondent burden. They argue that the quality of data relies upon easing that burden; the instrument Stopher and Wilmot advocate is accordingly parsimonious and easy to understand and complete.(14) In form, their diary appears similar to a typical day-planner with spaces provided for activities corresponding to hourly blocks of time. It allows participants the latitude to describe their own activities in a format that ensures both efficiency and clarity. Resulting data should be more complete.

The Stopher and Wilmot time use diary appears particularly appropriate to the demands of the current research task. The guiding questions necessitate an instrument capable of facilitating a broad-brush capture of a range of possible antecedents not necessarily directly related to travel (e.g. increased e-commerce behavior, information access via online as opposed to physical sources). The time use diary provides a sufficiently broad net to capture not only travel behaviors, but also telecommunications behaviors (e.g. time spent on line, purpose of on-line occasions, and so on), local services use, information seeking activity, communications and interactions with neighbors, community members and coworkers to name a few. Consequently the diary developed for this task has been largely modeled upon the form developed and advocated by Stopher and Wilmot.

Beyond the Diary: Accompanying Instruments

The time use diary provides a wonderfully comprehensive behavior inventory. However, such an inventory alone does not sufficiently capture demographic data, related contextual contingencies, or individual attitudes and determining experiences. Faced with similar demands, other researchers have combined the diary form together with scales and additional open-ended questions designed to tap psychological and experiential constructs. This combined form tends to

result in a complex instrument with the potential for increased incidence of missing and incomplete data. To ensure a simple design and gather the needed information, two additional instruments have been developed for use separately but concurrent with the daily time use diary—a background survey and daily attitudinal survey. The three instruments are described below.

Background Survey

Data collection was preceded by a kick-off session in which collection procedures and the survey instruments were explained to participants. During that time a comprehensive background survey was administered (see Appendix A). The background survey is an exhaustive instrument, with a 30-minute time for completion, and consists of five sections. It has been developed to gather information regarding respondent characteristics, overall behavior travel and telecommunications usage patterns, and attitudes and behaviors characteristic of more stable “states” (e.g. baseline commuting habits, personal characteristics, work type, job satisfaction). The information provides both points of comparison between individuals and samples, as well as a background and normative behavior context for the diary. The problem of *access* is a particular focus of this survey—questions largely explore the extent to which individuals have access to telecommunications technologies and services (e.g. telework) as well as potential behavioral changes as evident through self-reported respondent perceptions.

Time Use Daily Diary

The core instrument for this research effort—the daily time use diary—is discussed first. For purposes of illustration, a page from day one has been reproduced and is attached as Appendix B. Note that the size of the form has been reduced to fit the constraints of this article. The formatting is different in the actual diary forms issued to respondents with ledger-sized paper (11” x 17”) used to provide sufficient space for responses, and 11-point Arial font for legibility.

Following the Stopher and Wilmot model, the form as adapted here strives toward simplicity of design. Day and night are divided into eight time segments (5:00 a.m. to 7:00 a.m.; 7:00 a.m. to 9:00 a.m.; and so on). This is slight departure from the Stopher and Wilmot model, which provides response spaces based upon hourly division of time. Team discussion concluded that

larger blocks of time might further reduce participant burden and still gather the desired data. Respondents will be queried as to the appropriateness and effectiveness of combined time categories during de-briefing.

Topic categories are provided across the top of the form (Activity details, Travel details, Errands & Service Use, and Communications). These reflect research areas of interest. Respondents are instructed to view the headings as broad guides and areas to particularly consider when reporting their time use.

Underneath these descriptors appear several general questions. Again such design features have been developed to ease-of-use for the respondent as well as ensure that the necessary information is captured. Naturally there exists a tension between capture of behaviors in a manner reflective of respondent perceptions and meeting research goals. In an effort to address this tension, respondents were urged not to feel constrained or limited by the questions, but rather to consider them as points of departure and examples of the type of questions they might ask of themselves when filling out the diary.

Daily Experiences Survey

The daily time use diary is designed to produce an inventory of respondent behaviors. It leaves untapped, however, key daily, personal experiences and attitudes antecedent to behaviors. These have been identified as possible facilitators and/or constraints to telework. Consequently the daily survey has been developed as an accompaniment to the diary. It is designed to capture experiences noted in previous interviews and the literature as particularly relevant to telework participation and effectiveness. For the most part, these revolve around issues of well-being and performance. A reduced form of this instrument has also been attached (see Appendix C). Again, the font size is larger in the actual survey.

The measures used are largely drawn from stress and communications research. Propositions and thematic analysis suggest psychosocial constructs measured through such scales will be affected by changes in the telework environment. Hypothetically, perceptions of stress, isolation, and so on will also vary from day to day, and in accordance to the telework implementation strategy

used. (Work from home, or telecommuting, is often conceptualized as a dichotomous variable. However, it is subject to varying implementation strategies with consequent variance in expression. Earlier interviews revealed that the pilot organization uses at least three implementation strategies—flexible, employee-determined, management-conditioned virtual work, and fixed-schedule partnering schemes. Each of these likely will result in different outcomes related to well-being and performance, providing an opportunity for process evaluation.) (16) Most of the scales used have been developed for use in daily, longitudinal research. Related stable states and characteristics are examined through the background survey (discussed in the next section).

Sampling Procedures

Participants were drawn from the same public organization from which survey and interview respondents were drawn for prior phases of the research program. The use of this same sample pool provided access to in-depth contextual information, most importantly job function and travel behavior. For example, roughly half of the respondents are social workers and are required to have a personal vehicle available to them during the day as a prerequisite to employment. They make non-peak trips during the day as part of their job. Non-peak travel subsequently may be slightly exaggerated among sampled participants than is normally characteristic of the adult Minnesota population. This mobility, however, is considered increasingly characteristic of the anytime, anywhere worker most affected by telecommunications technology and access to associated services. The sample comprised both telecommuters and non-telecommuters. As in prior years, participants were matched along key characteristics such as job tenure, type of work, and so on.

PILOT ADMINISTRATION

Potential volunteer respondents were identified and contacted by the agency's Human Resources department. Incentives of a \$50 gift certificate to one of eight downtown Minneapolis restaurants (participant's choice) were provided to encourage participation.

The initial plan was to pilot-test the instruments with 65 agency employees. However, the final participant rate numbered 35 (background survey) and around 22 (daily survey and diary). The

smaller-than-planned sample occurred largely as a result of unavoidable political events during the recruitment phase. The agency faced a budgetary crisis with potential shut-down looming, and telework was halted temporarily. Recruiting efforts, consequently, were adversely affected from the beginning.

Thirty-five volunteers participated in two orientation sessions (held on Thursday, August 23 and Monday, August 27, 2001). The sessions lasted approximately two hours each. During this orientation, participants completed the background survey. Participants were also given the time use diary forms and accompanying daily surveys (21 of each). Written instructions were included with the diary packets and verbal instructions were provided during the meetings.

Pilot study participants completed the daily diary forms during the period between August 27 and September 23, 2001. They were instructed to fill in the diaries each day for 21 contiguous days within that time frame. Altogether, daily diaries covered 15 weekdays and three weekends and were submitted by 22 respondents. Reminders and follow-ups were provided by e-mail from a Humphrey Institute research assistant. Respondents were encouraged to send questions via email to the research assistant, and a number took the opportunity to do so.

ANALYSIS

Codebooks for all three surveys were developed prior to data collection, and were used for developing data files once the data were complete. Diary coding was a particularly challenging exercise as the diaries were quite detailed, capturing unique and complex behaviors. Four coders were employed in the work; each diary took approximately six hours to code. Throughout coding, inter-rater agreement remained a high priority and the team met weekly and exchanged frequent e-mails to ensure consistency in strategies. The coding process necessitated a number of revisions of the codebooks—critical for efficient data processing in later planned studies.

Given the small sample, inferential statistics were not possible using data from the background survey. The same is true of the diary portion. However, the pilot of the background survey provided data sufficient to estimate reliability of scales used in the instruments. Results of reliability analyses appear in Appendix D. In addition, descriptive results from all three

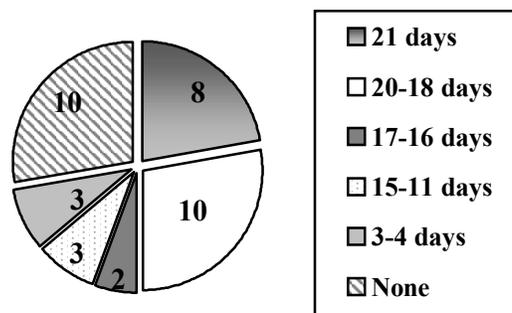
instruments do provide valuable insights into the complex relationship between work, travel, and the role of telecommunications access and telecommunications enabled services. Findings also provide an initial look at the hypothetical relationship between telecommunications access and residential choice. Exploratory results altogether are reported in the next few sections; they suggest possible hypotheses for future study.

PILOT TEST RESULTS

Participation Rates

As noted earlier, 35 employees completed the background survey. However, participation levels declined during the diary portion of the study as shown in Figure 1.1. While 18 of the initial participants completed at least 18 daily instruments (eight completed all scheduled 21), 10 did not complete any diaries. Another three left the project after completing all or a portion of the first week.

Figure 1.1 Participation Levels



Participation levels in the diary declined for at least two reasons. First, while the strategy developed initially called for diary data collection during two separate one- or two-week periods, the delay encountered in recruiting necessitated a revised timetable. Consequently data collection periods were combined into one longer, three-week period. Five respondents indicated they found the process to be too time-consuming and subsequently left the study. In addition, the September 11, 2001 tragedy occurred in the middle of data collection efforts. A number of

respondents reported they were greatly affected and the event likely led to additional drop-outs and other consequences for final results.

First-week participation rates were comparatively quite high. Of an initial 35 participants, 18 completed a diary for each day of the work week (five days), five completed four, and two completed three or fewer diaries. Note again that 10 respondents elected not to complete the diary portion of the study once completing the background survey. Given the comparatively high participation rates, week one (beginning August 27) of the diary period is highlighted throughout reporting of results. This week was selected as being the most representative of a “normal” workweek. Week two included Labor Day holiday (September 3), and week three, the September 11 tragedy. Neither week can be considered representative of typical travel patterns and work behaviors.

Participant Characteristics

Background survey participants are reportedly primarily Caucasian women, who are married, have children, and with spouses who work full time (Table 1.1). According to interviews with top management, this demographic profile seems to accurately portray characteristics of employees in the source public agency.

Table 1.1 Background Survey Participant Demographics, N=35

<i>Gender</i>	Women	31
Marital status	Married	18
	Single	10
<i>Household and family</i>	Children living at home	22
	Under 16 years of age	13
	Spouse works full time	14
<i>Ethnicity</i>	White	31
<i>Education level</i>	College graduate	12
	Graduate/ professional degree (e.g., MA/MS, Ph.D.)	11
<i>Income</i>	More than \$35,000 but less than \$50,000	13
	More than \$80,000 but less than \$100,000	6

Demographics from a representative day of the daily diary and daily survey (N= 22) show similar characteristics. Again, most respondents are women, with children.

Table 1.2 Daily Survey and Diary Participant Profile, N=22

Gender	Women	19
<i>Marital status</i>	Married	9
	Single	5
<i>Age</i>	Late 20s and early 30s	4
	Forties	10
	50s and early 60s	8
<i>Family</i>	Children living at home	16

Employment and Work Schedule Characteristics

According to findings from the background survey, more than half of respondents are long time employees with the agency. This is their only form of paid employment. Other employment characteristics are shown in Table 1.3.

Table 1.3 Employment Characteristics, N=35

Number of paid jobs	One (agency only)	29
<i>Job tenure</i>	Fewer than 5 years	9
	10 to 20 years	11
	20 years or longer	8
<i>Work hours</i>	Work 40 hours in a typical week	24
<i>Work type</i>	Professional/paraprofessional	21
<i>Flexible work schedule participation</i>	Work from home-telecommute (all or partial work week).	16
	Work from a telecenter	1
	Compressed work week (e.g. work four, 10 hour instead of five, 8 hour days)	7
	Flex time (e.g. change start and quit time on a daily basis)	19
	Job sharing (e.g. 2 people sharing a single job)	2
	Part time work	2
<i>Tenure in flexible schedule participation</i>	More than 2 years	14

Indicated in the table, many respondents engage in flexible work schedules. These are not early-adopters and most have participated for more than two years in such work arrangements. Note too that participation rates do not equal 35, as there is considerable overlap among flexible work schedule types. Participation in such work schedules is not mutually exclusive—employees may enroll in two simultaneously and in several instances telecommuters also participated in flexible arrival/departure and compressed workweeks.

Similar use of flexible work schedules occurred among daily survey and diary participants as seen in Table 1.4.

Table 1.4 Flexible Work Schedule Participation

<i>Flexible work schedule participation</i>	Telecommute	10
	Work from a telecenter	0
	Compressed workweek	3
	Flexible arrival/departure	12
	Job sharing	2
	Part time work	1

As before, respondents show a propensity to combine different forms across workweeks. In fact, eight telecommuters also engage in flexible arrival/departure. Note too that four telecommuters never go into the office—home is their full time workstation, and they do not travel to the traditional work site except for occasional meetings.

In the background survey, participants were asked to explain why they engage in flexible work schedules. The most frequently given reasons reflect a desire/need for personal flexibility. The top three include: *It provides me with the opportunity to schedule my own work hours* (10 respondents), *I can better organize my childcare commitments* (8), *I can take care of personal errands more easily* (7). *I have a long commute* was the sixth most frequently given reason by participants for engaging in flex schedules (5).

In terms of personal or organizational disadvantages of flexible work schedules, respondents did not perceive any negative personal effects. They also characterize such schedules as primarily

beneficial to their employer; the most frequently supplied benefits relate to *cost reductions* and *happier employees*.

Most participants in these alternative work schedules view the arrangement as a long-term. When queried, 13 participants indicated they plan to continue from 15 years through retirement.

A total of 10 respondents do not engage in any sort of flexible work schedules. The reasons for their non-participation vary widely, ranging from organization constraints (not offered to employees in certain positions, policy, and selection processes) to personal constraints (e.g. rides with husband to work).

Most non-participants have coworkers who do participate in flexible scheduling. Of perceived disadvantages to themselves, coworkers noted an increased burden in work coverage for employees out of the office. In terms of disadvantages or advantages to the organization, non-participants pointed to several, from inadequate supervision to more work completed.

Access to Telecommunications and Related Technologies

According to responses given in the background survey, most agency employees have access to computers and the Internet at home and work. They also have access to cell phones, which several use for business contact at home and while commuting.

Table 1.5 Technology Use, N=35

Computer access	Home	28
	Work	34
<i>Internet Access</i>	Internet at home	28
	Home connection via modem	24
	Internet at work	34
<i>Internet use frequency</i>	Home-several times each day	13
	Work-several times each day	26
<i>Cell phone</i>	Owns a cell phone	23
	Uses cell phone to make business calls	14

Asked to indicate activities they engage in on their home computers, responses suggest a range from work to shopping, information gathering, and communications; e-mail correspondence tended to be the most frequently mentioned. Several telecommuters noted part of the work at home guidelines provided by Hennepin restricted activities to “work only” on the home computer dedicated to work.

In the background survey, respondents were asked to indicate the frequency (1= never to 5= always) with which they use specific communications modes to contact family, friends, coworkers, and supervisors. Results from this sample show:

- Respondents tend to make contact across groups the most frequently via telephone.
- E-mail was also used frequently; interestingly phone contact with supervisors was infrequent, but e-mail contact between supervisor and employee is reportedly frequent.
- A number reported frequent cell phone use to contact friends and family, but cell phones are used infrequently to contact supervisors or co-workers.
- Finally, participants reported frequent contact across groups via face-to-face contact, but infrequent use of written documents (fax, letters) for contacting any group.

When asked to indicate which communications mode they preferred to use to contact co-workers/supervisors, most respondents chose e-mail (21) or face-to-face conversation (9). The reasons for choosing e-mail tended to relate to efficiency, while face-to-face was preferred because of the “human touch” and decreased danger of misunderstanding. Of the 33 respondents who agreed they do sometimes use e-mail to substitute for face-to-face communications, many noted they did so because e-mail is less time consuming/faster.

Home Telecommunications and Access to Telework

In interviews conducted earlier in this program, a number of would-be telecommuters indicated lack of community infrastructure prohibited them from engaging in remote work. To further explore this finding, respondents to the background survey were asked to indicate to what extent their home Internet connection speed would *limit* the likelihood they would telecommute. Only two said they *did not* currently work from home *but would* if their connection was faster.

Another 10 noted that they *do* currently telecommute and would *continue regardless of connection* speed. Nine other respondents *don't telecommute* but would like to *regardless of* their home Internet speed.

Asked about the relationship between Internet speed at home and the likelihood of their taking work home to do after hours, many participants (15) noted they do *not* take work home (some because of policy) and *will not* regardless of speed. Another 10 *do* and will continue regardless of speed, while four indicated they *do* take work home and *would more frequently* if they had a faster connection.

Travel Behavior

Results from the Background Survey

Respondents use a number of modes during a typical two-week period for the journey to and from work. While many do drive (12/35), more than half combine drive-alone with other modes or take alternate modes exclusively (bus or car/vanpool). Travel modes remain relatively consistent across winter and summer in this sample.

Table 1.6 Mode Use To and From Work, N=35

	Winter (Dec. thru Mar.)	Summer (June thru Sept.)
Drive only	12	12
Carpool/Vanpool only	3	3
Bus only	4	4
Bicycle, motorcycle, walk, run or skate only	0	0
Telecommutes only (e.g. <u>never</u> drives to work)	0	0
Combines drive and bus	3	3
Combines car/vanpool and bus	1	1
Combines drive and telecommute	6	5
Combines drive and work from a remote center	1	1
Combines car/vanpool and telecommute	1	1
Combines bus and telecommute	1	1
Alternates drive, car/vanpool, and telecommute	2	2
Alternates drive, bus, and telecommute	1	2

In the background survey, respondents estimated a combined total of 249 commuting trips during a typical *two-week* work period. Assuming a “normal” work period encompassing 10 days, and all 35 individuals engaged in physical travel to work, the combined total commute occasions should be 350. The discrepancy of 101 between the actual and predicted travel frequency is accounted for by telecommuting (56 days) and other flexible work schedules (e.g. compressed work week, part time, job sharing). As noted earlier, most respondents take advantage of the liberal opportunities to engage in one or more of the available flexible work schedules such as telecommuting and flexible arrival time. As a result, only 13 of respondents actually journey to-and-from work *every* work day.

Many respondents do drive alone to work during at least some portion of the workweek. Facilitating single occupant commuting is the ready availability of parking near the workplace—22 participants reported there are parking lots adjacent to their work building. In addition, many of the respondents are involved in social work or other professional/paraprofessional work. Earlier interviews revealed company guidelines for such occupations require car availability at the workplace as a condition of employment.

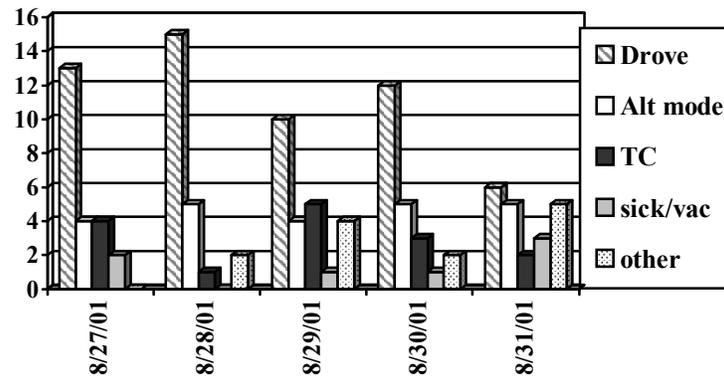
Of *telecommuters* who alternate work at home with commuting alone, very few journey along neighborhood or secondary roads. Instead they tend to travel via highway. Across participants, those who drive long distances to work (more than 20 miles) typically spend the bulk of the trip on highways.

Finally, respondents were divided as to whether or not they perceived an impact of telecommunications on their commute (16 = yes, 16 = no). Among those who said “yes,” they suggested changes occurred primarily as a result of the ability to engage in flexible schedules.

Results from the Daily Survey

The daily survey began with a question asking whether the respondent drove to work that day. Possible responses explored use of personal vehicles or alternative modes in the respondents' travel to work, as well as possible substitutions such as telework (from home and client's office), use of sick/vacation leave, or "other" modes. During week one, most respondents indicated they drove to and from work—of 23, 13 drove on Monday, 15 on Tuesday, 10 on Wednesday, 12 drove Thursday, and 6 on Friday. Few respondents engaged in telework on any given day during this first week; the maximum number of participants working from home (5) occurred on

Figure 1.2 Mode Choice



Wednesday. As a mode choice, telework is eclipsed by "other" on Tuesday and Friday; it occurs as the second most frequent mode choice of all forms on Friday as seen here in Figure 1.2 (N=23, min=21, max 23).

The "other" category noted for travel modes tended to overlap with the large number of flexible scheduling options offered to these employees. Agreeing with data from the background survey, many respondents indicated they participated in one or more flexible option including telecommuting, compressed workweek, flexible arrival/departure, job sharing, and part time work. In fact, it is difficult to isolate the effect of telecommuting on behaviors or attitudes given the frequent combination of telework with at least one other flexible work schedule option. Table 1.7 shows flexible work participation frequencies across the study period. Note that flexible

work scheduling did not apply to weekends or the Labor Day holiday (September 3), consequently these data have been combined and collapsed into single rows. Very few respondents (two to six) participated in the last week for data collection, so data from it too have been collapsed into a single row.

Table 1.7 Flexible Work Participation, August 27 to September 23, 2001

Date	Total #/day	Total "flexers"	Compressed Workweek	Flex	Tele-commute	Job share	Part time
8/27	24	13	1	6	4	1	1
8/28	23	9	1	7	1	0	0
8/29	24	12	2	4	4	1	1
8/30	23	11	3	2	3	1	2
8/31	21	8	1	2	2	1	2
9/1-9/3	21	0	0	0	0	0	0
9/4	22	10	0	5	4	1	0
9/5	21	8	1	2	2	3	0
9/6	21	6	1	1	3	1	0
9/7	20	6	0	2	2	1	1
9/8-9/9	20	0	0	0	0	0	0
9/10	19	10	2	2	5	1	0
9/11	19	7	2	2	3	0	0
9/12	18	11	1	4	5	1	0
9/13	18	11	2	2	5	1	1
9/14	15	5	1	1	3	0	0
9/15-16	14	0	0	0	0	0	0
9/17-23	2-6	5	3	0	1	0	1

Comparing Travel Behavior in the Background and Daily Survey: Convergent Validity of Instrumentation

The background survey asked respondents to estimate mode use during a typical two-week period. Though no two weeks of those sampled through the daily survey can be considered entirely typical, work weeks one (8/27-8/31) and two (9/3-9/7) were close to normal and so provided an opportunity to explore convergent validity of the background and daily survey. That is, we were able to explore the extent to which data collected retrospectively using a cross-sectional methodology might agree with those collected longitudinally and concurrent to the actual travel behavior.

Table 1.8 compares the two instruments. Only the 22 respondents who completed both the background survey and daily survey for two weeks were included in the comparison.

Table 1.8: Comparing Background Survey and Daily Survey Mode Frequencies

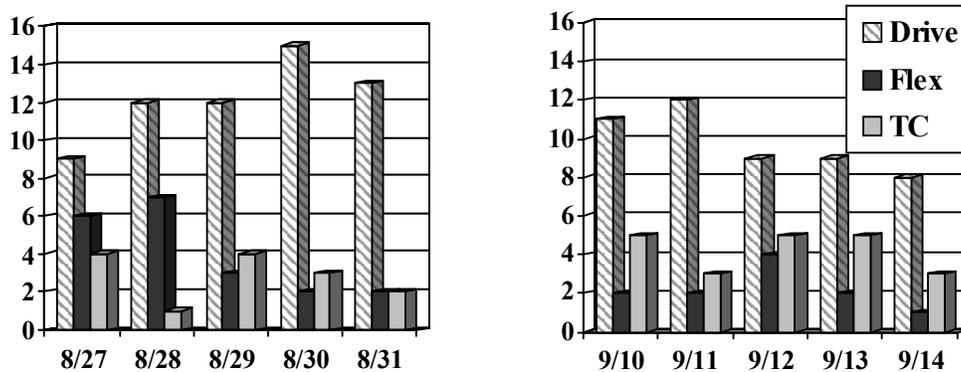
	Drive	Telecommute	Alternative mode (car/vanpool, bus)	Flex (job share, part time, compressed)
<i>Background survey</i> mode frequencies	88	34	62	14
<i>Daily survey</i> mode frequencies	106	26	39	19

Note, frequencies likely underreport mode use among daily respondents, as data were available for only nine workdays rather than the 10 respondents were asked to consider in the background survey. There were also a number of sick/vacation (seven) days taken by dairy participants. Nevertheless, results show respondents’ reports of telecommuting and other flexible work schedules largely converge between the two instruments.

The estimates given for “drive” and “alternative modes;” however, likely differ more than can be reasonably accounted for by the shortened work period for the diary participants. Respondents in this sample tended to over-estimate alternative mode use while under-estimating commute trips via personal automobile, an occurrence noted across travel mode studies. Such outcomes are likely a function of the propensity across people to provide more “socially desirable” responses. Public transportation, for example, is likely perceived as more socially desirable given the publicized environmental benefits.

Finally, it must be pointed out that the events of September 11 clearly had an impact on travel behaviors reported in the daily survey. As can be seen in Figure 1.3, telecommute participation increased after September 11. Similar episodic effects have been noted following other disasters, such as the 1994 Northridge earthquake in Southern California.

Figure 1.3 Comparison of Mode Distribution Between Weeks 1 and 3.



Additional Travel Observations from Daily Diary Analysis

The time series analysis appropriate to analyzing longitudinal diary data requires 50 observation points. Thus, as was the case with the background survey, the sample size was too small to satisfy the assumptions necessary for the planned inferential analyses and modeling. The qualitative data, however, do provide an in-depth perspective on telecommunications and travel behaviors and suggest potential areas for further investigation. In addition, the process of instrument development and implementation provided lessons learned and information, both of which will be used to refine the instruments and the data collection process for planned future research.

Travel Characteristics—First, across dairies, respondents report an early start to the workday. Most commute to and begin work during time period one (5:00 a.m. to 7:00 a.m.). On any given day, most respondents reported that they journeyed to work, with the clear majority of trips made via car, driving alone. While 11 diary participants reported that they telecommute, telecommuting occasions reported on individual days were actually small with six the maximum number reported. Morning trips to work on the whole were simple—respondents typically went straight to work. Afternoon trips, in contrast, tended to be more complex. Participants often combined the afternoon commutes with errands, becoming more complex tours. (Trip chaining was coded in the diary using the classification scheme developed by Dr. Kevin Krizek,

University of Minnesota. Trips are coded, for example, as simple work [e.g. home to work], complex work [home to work location 1 and then work location 2...], or a combination of work plus maintenance [e.g. home to work to the grocery store...]. This classification scheme captures the complexity of trips described by diary respondents.(17)

Off-peak Travel—Many respondents also engaged in off-peak trips during the workday. Much of this travel was accomplished as part of respondent work duties—a finding that underscores the important moderating role of job characteristics in understanding travel behavior. Many of the diary respondents are social workers and core duties include client home visits and trips to hospitals and courthouses. Consequently, they tend to make relatively frequent off-peak trips during the day whether from home or work. These trips cannot be substituted by telecommunications. Note, however, during off-site visits, a number of social workers made use of cell phones for work and personal calls. Access to such telecommunications technologies reportedly appear to accomplish multiple functions—enabling communications with other clients/co-workers (and perhaps substituting or streamlining other trips), facilitating trip-chaining, or even perhaps stimulating additional trips as emergencies arise and are communicated by on-site coworkers.

Mobile Work and Substitution/Stimulation of Travel—As suggested above, throughout the agency, employees who make off-site visits are eligible to telecommute. These “mobile employees,” therefore, provided an interesting look at the role of telecommunications in facilitating multi-location work. Across diary entries, mobile respondents reportedly used access to technology and flexible work arrangements in combination to handle the demands of multiple site work locations—in a number of cases, with the added advantage of reducing or streamlining trips. For example, on Friday, August 31, six respondents began the day working at home. All six reported using at-home computers and the Internet to connect to the workplace and answer incoming co-worker, client, and supervisor messages. Around 9:00 a.m., one of these “telecommuters” commuted into the traditional work site, suggesting this participant took advantage of telecommunications to get a head start on the workday before leaving home, as well as miss the congestion of peak commuting. Two others worked at home before driving to client sites around 9:00 a.m., after which they drove to the main office site during late morning. In

these two instances, telecommunications has substituted for some of the trips that would otherwise have been made by these two respondents. In each case, access to home Internet allowed both people to be in touch with the main office prior to traveling to an off-site work appointment, thus eliminating at least one trip into the office.

Other diary entries, however, suggest telework may also function to stimulate trips. In some instances, respondents who were not social workers also tended to report increased travel via personal vehicle when working at home. For example, analysis of data from the first week revealed one full time, non-social worker home worker (virtual employee) typically left the house during the lunch hour (period four, 11:00 a.m. to 2:00 p.m.) to drive to either a restaurant or local maintenance destination. Other telecommuters reported similar behavior across the study period.

In another instance of increased non-peak trips with telework, one home worker remained at home all day without leaving the house on 8/31. Around 4:00 p.m. (period five) this individual then got into the car and drove to a non-local restaurant for dinner with friends. Across telecommuters throughout all diary weeks, this same behavior was repeated.

Although rationales were not provided for reported non-peak telework trips, it may be they were made to seek social contact and escape the isolation of home. The problem of social isolation for telecommuters is frequently commented upon across the available literature. Isolation in this instance may lead some people to make additional trips during lunch or after the workday in order to find companionship. Note too, in several instances, telecommuters who journeyed most frequently during the day were also single. In any event, telecommuter respondents did typically make fewer peak-period trips but did not appear to greatly reduce non-peak travel. In this sample, the telecommunications-enabled service, telework, seems frequently to modify rather than substitute for travel.

Drive Alone May Increase with Telework—In terms of mid-day (lunchtime) errands, findings from the diary suggest telecommuters while working at home, engage in fewer errands than their traditional work site counterparts. However, when errands are run during work-at-home days,

these tend to be accomplished in a personal vehicle driving alone. Work at the traditional work site seems to facilitate the use of alternate modes, particularly walking, for restaurant visits, banking, and so on. Further, mobile respondents, including those working from home and those working from the traditional office site, tend to chain together mid-morning or early afternoon client visits with lunchtime activities into more complex tours. Both also tend to chain together client visits with morning and afternoon work commutes.

“Phase of Life” Conditions Non-peak Travel—Further, in this small sample, travel behavior outside peak commuting hours seems to be largely conditioned by the respondent’s “phase of life” and related personal factors. That is, younger (late 20s to early 30s), single respondents in this sample tend to make more frequent after-work, entertainment-related trips (e.g. restaurants, exercise, visits to friends’ homes) as compared to older, married peers. Diaries from younger participants suggest access to telecommunications services such as e-mail and cell phones may also serve to stimulate trip-taking as evening plans are made easily throughout the work day with a minimum of work disruption through these telecommunications media. Similarly, couples with young children also tend to make more trips and are particularly likely to exhibit trip-chaining in their errands and commute. On the other hand, older respondents without children make fewer trips in the evening and tend to run errands nearer their homes. In addition, they do not appear to be as likely to report using the Internet as a tool to identify entertainment events and plan social outings as younger participants do. Consequently, an initial look at these diary data suggests “life phase” is an important factor in understanding the relationship between telecommunications and travel behaviors.

Weekend Travel—Diary data also provided an interesting look at weekend as well as weekday travel. Surprisingly perhaps, more leisure activity related travel was accomplished on Saturday, while more maintenance type tours were completed on Sunday. For both days, travel tended to peak around late morning (around 11:00 a.m.) and again in later afternoon between 2:00 and 4:00 p.m. More maintenance trips, especially grocery shopping, were conducted during the afternoon peak period. Somewhat surprisingly, those who engaged in telecommuting and compressed workweek scheduling did not appear to engage in maintenance related errands with any less frequency than those who did not participate. However, holidays and the events of 9/11

were both factors that did seem to impact trip purposes and trip frequency. Not surprisingly, more leisure-related trips, including a greater number of long distance trips, predominated during the days of Labor Day weekend.

Unusual Events Influence Travel—Comparing the days following 9/11 with the same days during week one revealed a number of intriguing differences as well. For example, trip destinations during the afternoon and evening of 8/29 tended to be made for maintenance or other related activities. In contrast, trips made on 9/12 tended to be for leisure or pleasure. In addition, trips on 9/12 were reduced when compared with those on 8/29 despite a similar sample size (8/29, n = 18, 9/12, n=19). Note too that reports of television viewing and personal phone calls increased dramatically during the week of 9/11 as compared with the preceding two weeks. A comparison of 8/30 with 9/13 reveals a similar pattern and also shows a decrease in car trips during the typical evening “errand-running” period (4:00 p.m. to 7:00 p.m.).

Table 1.9 Comparing Diary Car Travel During the Afternoon/Evening of August 30 versus September 13, 2001

Time period	Total number of car trips (combined commute and errand-running)	
	August 30	September 13
Period 5 (2:00-4:00 p.m.)	4	6
Period 6 (4:00-7:00 p.m.)	12	5
Period 7 (7:00-9:00 p.m.)	6	7
Period 8 (9:00 p.m.-5:00 a.m.)	2	3

Beyond Telework: Electronic Shopping versus Physical Travel—Researchers are increasingly interested in the extent to which the access to telecommunications might eliminate physical travel for shopping. Stimulus questions used in the diary to target participant responses probed for potential electronic substitution for physical travel for shopping. While the background survey suggested respondents do shop online, very little evidence of such behaviors was exhibited in the context of the daily diary. On 8/28, one participant reported on-line booking of

travel reservations, as did another on 8/29. Such “shopping” is more likely to substitute for a telephone call to a travel agent than a car trip.

Respondent Residence and Neighborhoods

Finally, in a topic related to telework, improved access to telecommunications is hypothesized to relate to residential choices, which in turn affects communities and transportation system demand. Questions were included in the background survey by way of exploring the relationship between travel, residences, and the intervening potential of telecommunications access.

First, as shown in the maps in Appendix E, most respondents reported they live relatively near the workplace—from 1 to 10 miles (n=17) to 11-20 miles (12). A rough comparison of frequencies suggests telecommuters may be more likely to live somewhat further away than non-telecommuters. Households typically have one or two drivers (n=29) with either one (13) or two cars (20) per home.

In terms of neighborhood tenure, participants range from relative newcomers of one to five years in residence (16) to long term, 11 to 20 years (12). When asked if they ever considered moving from their current location, 18 respondents replied “yes.” Only four, however, have actually looked for a new home. Asked to what extent the desire to move was based on flexible work participation, most replied it was not. One participant did note, however, while s/he desired to move, a fear of losing telecommuting prevented the planned relocation. Infrastructure in the new location was not adequate to meet the guidelines of the agency telework policy.

Residence and Potential Access to Remote Work

In the background survey several questions also explored the appropriateness of the respondents’ home and residential environment for work at home. Participants were asked to evaluate both the importance and adequacy of features/services generally purported to facilitate telework.

- In terms of importance, many respondents rated a *dedicated home office space* (21) and *quiet areas for concentration* (24) as “critical” to work at home. Judged as “not at all important” were *places to meet with people of similar professional interests* (18), and *local social gathering spaces* (19).
- Estimations of the adequacy of neighborhood features/services reveal a similar response pattern: 23 judged *quiet areas for concentration* as “completely adequate” for work at home as was the *dedicated home office space* (21). While other items revealed a wider range of responses, in each category, the highest rating (“completely adequate”) was chosen most frequently.
- In a comparison of frequencies, more telecommuters than non-telecommuters rated *local social gathering spaces* and *places to meet with people of similar professional interests* as “important” and “critical” features. Note, however, these two features were still more frequently rated as “not at all important” or only a “little important” across both telecommuters and non-telecommuters.
- Ratings of neighborhood and home feature/service (e.g. dedicated home office space, nearby fax and office supply sources) adequacy also revealed differences between telecommuters as compared with non-telecommuters. As a whole, more non-telecommuters rated services as “totally inadequate” or “inadequate.” On the other hand, more telecommuters than non-telecommuters provided ratings of “adequate” or “totally adequate” for most services/features.

Participant Reactions: Lessons Learned from the Follow-up Session

Finally, the summary of instrument pilot tests would be incomplete without a report of respondent reactions to the process. Participants were asked to convene for a follow-up session held early in December 2001. During this meeting, they were asked to provide opinions and suggestions for improving all levels of the study—from orientation sessions, to time for the

study, administration details, as well as the form and design of the survey instruments used. Findings from this session are summarized on the next page.

- Respondents were asked to first consider the orientation sessions. Responses suggest that while meetings were very helpful, improvements would have included a trial-run completion of the daily survey and diary during the session.
- Asked to consider the period of administration (independent of September 11), a number of participants stated that four, separate one-week data collection periods would have been easier to handle than a single, longer period. They argued administration separated by a span of time would have better captured “typical life.” Others disagreed suggesting it became easier to fill out diaries with the passage of weeks.
- Asked whether on-line survey administration would have been simpler, respondents were divided in their opinions. Some noted on-line administration would have facilitated the process while others suggested a paper form was better as they could take the form with them and fill it out during the day at both work and home.
- Asked how they managed diary completion, most said they filled it out at night. Others took notes throughout the day so they could remember important events.
- Queried about the potential usefulness of other enabling technologies (e.g. GPS), participants replied that GPS might have been useful to collect information about number of miles, but would have been ineffective for collecting other forms of information. Odometer readings would have been difficult to use unless tracked for work trips only.
- Asked to provide general comments/opinions about the survey instruments (e.g. length, ease of use), comments suggested the daily survey was the most difficult to manage. Specifically, the instrument appeared oriented toward work and was not applicable to weekends as a result. In addition, the closed-ended queries were perceived as too restrictive. On the other hand, some participants indicated the open-ended format for the daily diary, made it difficult to judge the level of detail required. Some asked: *What was an appropriate cut-off point?* Respondents also noted it was difficult to catch up once days were missed.
- Recommendations for improving the instruments included combining the daily survey and daily diary into one instrument made up of a mix of fewer closed- and open-ended questions.

Others suggest a combination of on-line, GPS, and daily survey would have been the most helpful approach with the greatest potential to reduce respondent burden.

DISCUSSION AND CONCLUSION

While the number of respondents to the pilot study was small, the detail and richness of data provided through use of the multiple instruments and diaries provided a provocative look into the tangled universe of daily travel. Data analyses revealed a number of intriguing possible relationships between telecommunications access, telecommunications-enabled service, and travel. Findings underscore the complexity of the relationships and, in fact, offer evidence for both substitution and enhanced travel through telecommunications. For example, while telework certainly tends to substitute for peak-period commuting, it may serve to enhance non-peak trips as telecommuters find occasion to engage in trip-taking during the day. Many of these trips, however, are made within a few miles of home and may serve to stimulate local business as others have suggested.

As in prior year research, findings again underscore the importance of context in accurately conceptualizing the interface between telecommunications and travel. These data suggest specific contingencies related to external personal and work environment may function to moderate and/or mediate the telecommunications-travel relationship. For instance, in this sample, travel effects of telecommunications-enabled telework are difficult to isolate in part due to the characteristic widespread bundling of alternative work schedules. Telecommuters, for example, often engaged in flexible work arrival/departure and compressed workweek schedules. In total, flexible scheduling options tend to impact non-peak travel, for example through shifting errands. However, identifying direct effects with any one form or determining which flexible schedule form has the greatest effect is difficult to discern given the propensity to bundle multiple approaches.

The propensity to engage in flexible schedules may be related to other factors such as phase of life. Findings suggest this micro-context factor may also interact with telecommunications usage to determine travel-related outcomes. Noted earlier, younger, single individuals may engage in

substantial off-peak travel, often facilitated with telecommunications tools such as cell phones and Internet access. Their more “settled” counterparts, in this sample, seem to engage in fewer, off-peak social-event related travel.

Finally, as the events of 9/11 demonstrate, the larger external environment beyond the workplace also plays an important role in determining the interplay between telecommunications and travel. Findings and reported respondent comments show 9/11 clearly had an impact on travel behaviors reported in the daily survey. Telecommuting occasions, in fact, increased after 9/11. Similar episodic travel effects have been noted following other disasters, such as the 1994 Northridge earthquake in Southern California. Such observations have led a number of researchers to suggest a major utility of telecommuting in the workplace is to provide employees with the opportunity to work when they might otherwise elect or be forced to use personal leave instead.

Getting the Most Out of the Diary Method: Lessons Learned

Perhaps the most important findings from this pilot test relate to development of the measurement instruments themselves. The information gained through coding, analysis, and feedback for participants suggest areas of improvement related to instrument design, revisions of sampling procedures, and study administration and implementation procedures. These are considered in turn below. This information will be used in planned future research efforts.

Instrument Development

The three instruments developed for this project satisfied different objectives but appeared to work effectively in concert. For one, the background survey provided necessary demographic and “access” information for expanding upon and understanding diary data. These data provided insights again into the critical role of context.

Implementation of the two daily instruments—attitudinal survey and diary—provided an opportunity to explore the comparative utility of structured versus more qualitative, less structured forms similar to Stopher and Wilmot’s earlier work. In the case of the daily survey,

the structured approach provided more complete data. There were far fewer instances of missing data using this form than employing the daily diary. However, questions arose in the course of analysis concerning daily survey data quality. In several instances responses were identical across days suggesting respondent fatigue and potential transfer of responses from one day to the next.

In terms of data quality, note too, responses to the daily survey were confined to information indicated as relevant and important in prior interviews and the literature. The possible range of individual experience and unique expression was consequently curtailed when compared with the daily diary. In addition, behavior explanations were not as likely to be captured through the more structured approach making attributions of causality difficult.

Data quality too, suffered in the diary but for different reasons. For example, as observed by Stopher and Wilmot, missing data poses a decided problem. Although the form used included “stimulus” questions, respondents did not always answer in the manner or with the information sought. Key information such as rationale for behaviors was often omitted, as were miles traveled for a trip tour, duration of important activities, purpose of telecommunications use, and so on. Note too, that the quality of responses deteriorated during the final week of data collection. Instances of missing data increased and provided information became briefer, sketchy, and altogether not so well considered.

The Sample

This pilot sample was limited to agency members only and data were gathered from these individuals alone; however, findings agree with the literature and suggest the diary would have ideally been administered to the employees and their families. Diary respondents rarely mention family member travel behavior—important information to fully understand the role of telecommunications-enabled services like telecommuting and travel. Earlier interviews showed telecommuters’ children and spouses often made use of respondents’ cars when s/he was working at home, thus negating any substitution effect of telecommunications. Such events were not recorded by respondents in the current diary.

Administration and Implementation Strategy

Probably the more important lessons learned through this initial pilot test concerned implementation strategy. Findings suggest revisions at this stage could well address some of the previous issues addressed such as missing data. First, while it was useful to collect the background data during the orientation meetings, a more effective use of time would have been to conduct a detailed walk-through of the diary forms. Researchers would have had the opportunity to highlight types of information sought as well as address participant questions as a group. In future research, perhaps a better way to handle completion of the background questionnaire would be to mail/e-mail the survey one week prior to the introductory meeting and request it be brought completed to the initial meeting.

In addition, a discussion list and/or weekly e-mailings to respondents would perhaps have served to improve morale and address common questions. Again this strategy should serve to improve data quality and decrease dropout rates. It will be used in planned future research.

Data quality also may have been compromised because of the length of administration. Respondent comments suggested the three-week data collection period was simply too long. Future research should employ the strategy initially planned: separate weekly collections. The shorter administration time frame would ostensibly reduce respondent burden thereby improving participation rates and data quality. It would also provide researchers an opportunity to review initial efforts and identify problem areas in diary completion. Follow-up e-mails could then be used to address areas of concern such as columns/questions with the most missing data. More frequent administration with shorter time periods would also allow researchers to better control for seasonal differences and history effects (e.g. 9/11).

Next Steps and Future Research

Discussion and plans are underway to expand the current research program to explore the implications of telecommunications and land use for travel in two Minnesota suburban communities. Piloted instruments from the current project will be incorporated, but with

revisions suggested from current findings. Any other use of the three instruments piloted in this study should likewise include improvements. Suggestions for revision are offered by way of conclusion below.

The Instruments

- The background survey is satisfactory as a stand-alone instrument. However, if it is used in conjunction with the other two instruments, it will be more effective if shortened. Depending upon context, the number of work-related queries should be curtailed.
- In terms of the daily survey and daily diary, findings and respondent input suggest the two might be more effectively combined into a single instrument. Respondent comments reveal the two forms may prove redundant in a couple of instances (e.g. communications sections), plus the use of separate instruments makes data collection cumbersome. On the other hand, comments made during the follow-up session suggested divided preferences for the open-ended design of the daily diary versus the closed-ended questions of the daily survey. Integration of the two forms into one is the remedy proposed for future planned research. The number of closed-ended questions will be shortened and redundancies eliminated. Stimulus questions will similarly be modified to more accurately target responses to the information desired.

Sampling Strategies

- Limiting the sample to individual organizational employees did not allow the opportunity to capture unintended side effects of telecommunications use (e.g. potential use of the telecommuting respondent's car by other family members during work at home). Accordingly, diary administration beyond this pilot should ideally target households rather than individuals in order to capture the "true" implications of telecommunications for travel behavior.
- Findings from this pilot study suggest alternative work schedules, such as compressed workweeks, may significantly affect travel behavior. Future sampling strategies should stratify and match telecommuters and non-telecommuting samples along other work schedules that may impinge upon travel behavior.

Administration

- Findings reported at January 2002 Transportation Research Board (TRB) suggest electronic administration of daily diaries on the World Wide Web reduce respondent burden and result in more complete data. Comments made in the context of the pilot follow-up suggest agreement. Future research should include at least the option of electronic survey/diary administration. Daily electronic completion would also reduce coding burden and ensure data reflect true concurrent day events, rather than a retrospective perspective.
- Pilot study findings also suggest a long time frame for data collection results in respondent fatigue increasing the likelihood of participant dropout, missing data, and overall reduced quality of data. Future data collection efforts should be limited to single, multiple weeks separated in time.

Implications of E-Commerce for the Surface Transportation Network: A Scanning Paper

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ABSTRACT

This paper analyzes how the new digital economy has changed the way the transportation industry moves goods from business to business (B2B) and from business to consumers (B2C). The electronic economy, based on instantaneous Internet access, real-time commercial transactions, and door-to-door overnight package delivery, is substantially affecting the nature and form of economic transactions. At the micro-level, electronic commerce offers greater choices, faster service, and lower prices for consumers. At the macro-level, electronic commerce can affect the nature and location of jobs and businesses, as well as the use of communication and transportation systems to support these transactions.

The use of e-commerce transfers logistical empowerment from businesses to consumers by allowing consumers to directly influence the product purchasing decisions and product delivery modes. For the transportation industry, this shift creates increased demand for smaller, quicker, and more frequent shipments. These fundamental changes in the commercial flow of products and goods have triggered the need for the transportation industry to seek and implement the use of information technology and logistics collaboration in order to gain efficiencies and to enhance product delivery systems. The use of value-chain enrichment processes to accommodate the increased demand for modified product distribution is essential to the industry's ability to meet increased consumer demand for faster and more efficient delivery of products.

In terms of consumer travel demand, the impact of e-commerce appears to be having a more subtle impact than at first predicted. While certain types of goods and services can be purchased electronically, the general trend has been toward an interplay of electronic and physically-based activities. Research is just underway to develop more sophisticated models and data on the types of activities (and combination of trip activities) that will result from increased use of e-commerce activities.

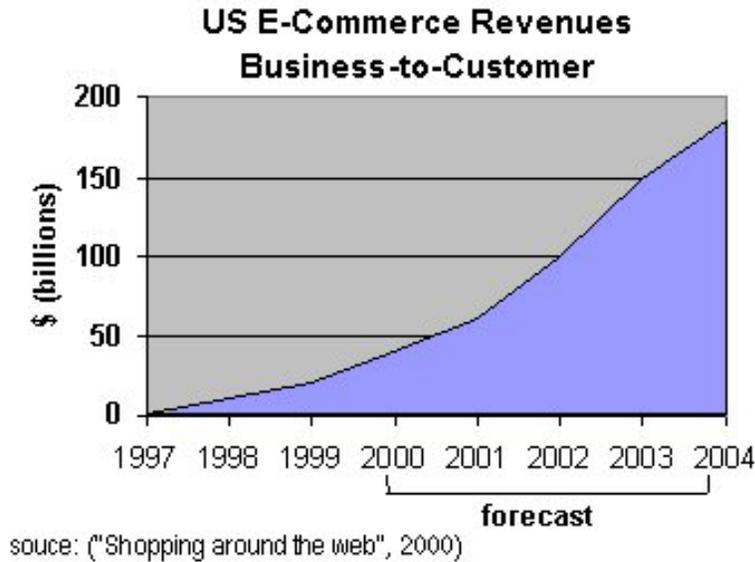
While the net impact on transportation services will unfold overtime, Departments of Transportation should closely monitor the rise of small-package delivery demands, increased pressure for seamless intermodal transfers, and economic growth opportunities for new forms of e-commerce employment and distribution developments. Drawing upon findings from a recent national e-freight conference, the paper closes with ten suggested actions at the state and local level aimed at making the freight aspect of e-commerce as efficient, effective, and environmentally responsive as possible.

Keywords: E-commerce, transportation industry, transportation network, logistics, value-chain modification, digital economy.

INTRODUCTION

Electronic commerce, despite the original hype and its failure to live up to predicted performance, is fundamentally affecting the nature of economic transactions. Business and customer expectations and behaviors are undergoing changes, which will affect the transportation network. To better understand these effects, it is important to first understand how e-commerce is changing the economy and then how the transportation industry is reacting. This paper will define e-commerce and the impact it has had on the economy, describe the implications of e-commerce on the transportation sector and discuss additional issues to consider for the future.

Figure 1.4 U.S. E-Commerce B2C Revenues



E-Commerce

The hype of the “dot.com” bubble has now become the stuff of late-1990s legend. Future anthropologists may point to the 2000 Super Bowl as its zenith. Commercials for Internet and technology companies made up 50 percent of the total ads shown.⁽¹⁹⁾ Forrester Research, a great proponent of the e-commerce boom, estimated that by 2002 travel and computer-hardware online sales would be at the \$26 billion and \$10 billion levels respectively.⁽²⁰⁾ Total e-commerce revenues were predicted to amount to more than \$50 billion by 2001 with estimates that by 2010, electronic shopping will account for 15 to 20 percent of all retail sales.⁽¹⁹⁾ The scenario was that as more people shopped online, more retailers would see the value of being on the Web, and more products and services would come to be offered.⁽²¹⁾ To some extent, the scene did play out. Everything from investment and financial services to groceries and pet supplies became available on the Internet.

However, with the demise of many expensive dot.com companies, so, too, went the earlier predictions of e-commerce’s role in the retail economy.⁽²²⁾ Total online retail sales in the past four quarters amounted only to less than \$30 billion, or about 1 percent of total retail sales with a

significant drop occurring at the beginning of 2001.(23) This is well below the figures forecasted earlier.

Do these early failures imply that e-commerce has become nothing but a mere fad? A quick view of the dot.com companies and high tech stocks would certainly indicate that this trend is true. But other cases in history that followed the same meteoric rise and plunging fall as the e-commerce industry can illustrate the future course of e-commerce. A similar phenomenon occurred in Britain in the 1840s. Share prices for railway companies soared, then suddenly tumbled with many lines failing to deliver on their anticipated profits. During that time, it was thought that the railway industry was a passing fad that grew suddenly and then quickly faded away. As we know, long after the original hype of the rail boom was over, railways continued to function, playing a major role in the development of the industrial age, and still continue to be a significant force in today's economy.(24) The latest dot.com crash represents a mere correction of over-valued companies and can be attributed to the normal growing pains of the embryonic e-commerce economy (it should also be noted that these failures were also the result of the mismanagement of capital among many new CEOs of these new companies who gained easy access to too much money too quickly). As an example, Webvan's failure was the result of poor implementation of a generally solid idea: online purchasing of groceries. According to Pricewaterhouse-Coopers, 43 percent of Americans would shop for groceries online if operated by a regular supermarket.(25)

It is our premise that despite these early growing pains, e-commerce is transforming the way business is conducted in today's marketplace, and as such, is here to stay. Indeed, the Internet and information technology were responsible for a significant portion of the growth in the U.S. economy in the past ten years (26) and will continue to be a major factor in shaping the economy.

Definition of e-Commerce

Electronic commerce is traditionally viewed as commercial transactions that occur via the Internet. However, this definition is too simplistic for our purposes and should instead, be viewed as a more complex elucidation encompassing three separate and distinct classifications: pure e-commerce, traditional e-commerce, and secondary e-commerce.(27)

Pure E-commerce

Pure e-commerce relates to commercial purchases whereby the entire transaction—from price comparison, product purchase, and product delivery—occurs on-line.(28) Pure e-commerce offers the greatest potential for travel and transportation cost savings as the product or service is “dematerialized” to a completely electronic transaction.(29) One of the industries that has been the most successful in this area has been banking and travel, which represent two of the highest retail online sales (in dollars) behind the computer hardware and software industry.(30) Pure e-commerce offers tremendous cost savings to companies. A bank transfer that involves the assistance of a bank teller typically costs about \$1.27. The cost of this same transaction would be reduced to 27¢ if done at an ATM, and would cost only 1¢ if conducted over the Internet.(24)

For Minnesota, pure e-commerce has helped fuel the growth of several business sectors, such as financial and travel services and related business and computational services. For example, the financial services (e.g. Wells Fargo) and the travel services (e.g. Carlson Wagonlit) sector has been a major beneficiary of pure e-commerce transactions (in terms of e-tickets, though ironically it does create travel). Similarly, the printing industry—another major economic cluster in Minnesota—is migrating to a more diversified product mix that includes digital production.(31) In short, the Internet is both strengthening and reconfiguring Minnesota’s key industrial sectors.

The Effects of Pure E-commerce on the Transportation Industry

The most lasting and relevant effects of pure e-commerce on the transportation industry involve a company’s ability to totally eliminate any involvement with traditional distribution channels. Pure e-commerce allows customers to reduce trips to banks and local bookstores and allows businesses to eliminate the physical movement of electronically distributed goods. Several reports have highlighted the potential environmental impacts of pure e-commerce. For example, Romm (32) estimated that introduction of pure e-commerce could have a demonstrable impact on vehicle miles traveled (VMT) reduction and energy savings. He used the study on the following page by Pataganio on the energy costs of travel as a simple example of travel and energy savings:

Table 1.10 Estimated Energy Costs for Alternative Product Deliveries

Mode:	Fuel Consumed:
20-mile Round trip to shopping mall	1.0 gallon
1,000-mile shipping, by truck	0.1 gallon
1,000-mile shipping, by plane	0.6 gallon

Based on these and related assumptions, Romm (32) estimated that e-commerce could make a positive contribution to energy and environmental sustainability. To quote from his recent congressional testimony:

“According to our findings, the Internet economy itself seems to be generating both structural and efficiency gains. If companies put their stores on the Internet, rather than constructing new retail buildings, which would represent an Internet structural, gain. If that same company used the Internet to more effectively manage its existing supply chain, it would be an efficiency gain.

Clearly, both sorts of activities are taking place, with major energy implications. In business-to-consumer e-commerce, for instance, a warehouse holds far more product per square foot than a retail store and uses far less energy per square foot. We calculated the ratio of building energy per book sold in traditional bookstores versus on-line retailer Amazon.com to be 16-to-1. Internet shopping uses less energy to get a package to your house: Shipping 10 pounds of packages by overnight air the most energy-intensive delivery mode still uses 40 percent less fuel than driving roundtrip to the mall. Ground shipping by truck uses just one-tenth the energy of driving yourself.”(33)

Analyses such as by Romm have unleashed a stream of symposiums, conferences, and reviews on the energy savings from e-commerce. A common theme of these reports is that while pure

and traditional e-commerce will reduce unnecessary trips, this activity will continue to represent a fairly small (but growing) percentage of the overall economic transactions.

Traditional E-Commerce

While the idea of pure e-commerce suggests a dramatic effect on the transportation network, most goods are not (yet) capable of assuming a digital form.(34) Furthermore, bandwidth and piracy protection issues, as well as customer reluctance to do away with the physical manifestation of purchases, limit the widespread implementation of e-distribution.

Traditional e-commerce involves the purchase of non-digital goods via the Internet, where product data, price comparisons, and purchase transactions are all performed on-line.(28) However, the distribution of the purchased goods follows traditional modes, whereby on-line companies aggregate orders and use the players in the freight transportation arena to deliver the goods to customers. While these transactions represent a small portion of all retail sales (35), the figures are growing.(26) As e-commerce matures in the coming years, it is estimated that 5 percent of all retail sales will be performed via the Web, with this figure increasing to 15 to 20 percent by 2010.(19)

Traditional e-commerce appeals to both customers and retailers. Consumers appreciate the ability to obtain instant price comparisons and enjoy the convenience of on-line shopping. A generation of young people, who have grown up with the Web, will find that shopping online comes naturally for them. Additionally, goods purchased online are, on average, 10 percent cheaper for customers (24) While this figure is a bit unreliable, as most online retailers have yet to post profits, price savings are clearly available to Internet customers. Retailers find traditional e-commerce appealing because it allows them to gather rich customer data while the customer shops.(26). This information proves invaluable to businesses as it provides the ability to analyze sales, target customer needs, plan purchases, and pass cost savings onto customers. Additionally, businesses realize gains by cutting out storefront costs and eliminating the need for intermediaries.(34) Dell Computers is a good example of how a company that manufactures computer systems can also be the company that markets, sells, and supports these systems, thus eliminating the need for intermediaries. With traditional marketing strategies, there is often a

tradeoff between the size of the target audience, a company's ability to customize services, and the degree to which a company is seen as responsive to customers' interests and needs. However, through the use of the Internet, the traditional e-commerce model eliminates these and other constraints of the physical world, offering companies the ability to target huge audiences with customized advertising campaigns tailored to the individual customer. Furthermore, the Internet expands a company's ability to track and be responsive to customers' needs.(36)

Effects of Traditional E-commerce on the Transportation Industry

Traditional e-commerce creates many changes for the transportation industry. These changes include creating less need for customers to make frequent trips to stores to purchase goods. This, in turn, creates an increased demand for the transportation industry to provide pick-up and delivery services for businesses and customers.(37) Customers are becoming more demanding as they come to expect more responsiveness from businesses, including the delivery of their purchases in a timely and reliable manner.(37; 38) The Internet, along with such companies as UPS and FedEx, has created a global market where customers need not consider the actual physical origin of the goods that they are purchasing.(36) Regardless of where customers purchase goods, the expectation is that delivery should occur quickly and effortlessly. In fact, many products that were once considered too perishable to be marketed globally now have the ability to take advantage of the global market through the use of the Internet. For a good steak, just surf to OmahaSteaks.com and you can have a 10-oz. Top Sirloin delivered to your house tomorrow.

As the Internet encourages changes in the traditional value-chain of retailing, businesses are requiring a more flexible and responsive transportation network.(38) As we will see later, the trend will be toward more frequent, but smaller, shipments. Parcel carriers are well positioned to address these needs.

Secondary E-commerce

The effects of e-commerce go beyond actual purchases. Secondary e-commerce is where the consumer uses the Internet to gather information, including price comparisons, but chooses to make the actual purchase transaction via traditional means, i.e., going to the store to purchase the

product.(28) Unlike the previous views of e-commerce, this form of online shopping does not eliminate a trip to a physical store. Nonetheless, it is important to our discussion because of its impact on the competitiveness of markets. A component of perfect competition is the abundance of information. By improving the flow of information between buyers and sellers, the Internet makes markets more efficient, requiring businesses to re-examine their value-chain.

Changes in the Structure of Business

Our definition of e-commerce, to this point, has focused on retail transactions over the Internet. However, it is important to consider a more broad definition. Typically, businesses set prices. However, such companies as Priceline.com are shifting the paradigm by allowing customers to set their own prices (customer-to-business or C2B). While the benefits of such an auction system can be debated, they do represent the trend toward customer empowerment, a theme prevalent in the Internet economy, supporting the pressure for companies to re-think their value-chain.

Online customer auctions, like those run by eBay, extend the idea of the weekend flea market to a more global level (customer-to-customer or C2C). The obvious effects are on the demand for parcel carrier services. In 2000, eBay had more than 22 million users, a year's growth of 125 percent.(39) Items sold reached more than 5 billion, up 93 percent over the previous year.(39) Almost all of these items were shipped using one of the top four parcel carrier services.

At present, the largest volume of online trade is business-to-business (B2B).(34) There are great cost savings that can be realized through B2B e-commerce.(40) For routine office purchases, online purchasing costs a tenth as much as traditional methods.(41) Several technology companies, including Oracle and Cisco, have transferred almost all of their purchasing to the Web. General Electric has created the largest private online supplier exchange. However, only one-third of American manufacturers in 2000 were using the Internet to sell or purchase products and services.(41)

Business-to-business e-commerce cuts costs in three ways (24):

- 1) Makes it easier for companies to find the cheapest supplier
- 2) Allows for better supply-chain management
- 3) Makes it possible for businesses to have tighter inventory control.

Current estimates place the savings of B2B purchases at \$2.3 trillion globally.(42) With the potential for reducing costs and the fact that e-commerce is still in its infancy stage, it can be expected that business-to-business e-commerce will flourish in the coming years. A recent GartnerGroup forecast suggests that B2B sales online could reach \$4 trillion in 2003, compared to less than \$0.4 trillion of B2C online sales.(24) The cost savings associated with business-to-business e-commerce is estimated to cause a permanent increase in output. In a Goldman Sachs study, the effect of B2B online activity will translate into an average increase in GDP by 0.25 percent a year for the next ten years.(24)

Thus, the Internet will transform the marketplace, by making it easier to acquire market information (e.g. prices), reduce transaction costs and reduce barriers to entry. The most significant of these changes, with respect to their effect on the transportation network, include the shift toward globalization and the reshaping of the supply-chain.

With the Web broadening the reach of companies, businesses can now more efficiently participate in the global market for both selling products and purchasing supplies. Companies must rethink both distribution and supply channels to take advantage of a wider client base and more choices in suppliers.

Companies' will reshape their supply-chain as they vie to compete in the new economy. Some of the practices we can expect to see become more prevalent include just-in-time supply-chains and made-to-order manufacturing systems. As seen with Dell Computer, inventories are reduced dramatically and even eliminated as companies move toward a manufacturing environment that reacts to customer needs. Furthermore, intermediaries that do not add to the value-chain are removed as businesses sell directly to the customers.(43) In the future, businesses will depend upon collaborative logistic systems that are reliant on e-business technology. As a percentage of GDP, the logistics expenditures have been cut in half as a result of incorporating technology and restructuring business process methods to include electronic means—declining from 20 percent in 1960 to 10.5 percent in 1996.(44) As transportation is one of the most critical supply-chain processes, accounting for 60 percent of total logistic costs, it has a significant role in the speed and reliability of the order cycle, as well as the quality of the customer experience.(44) As

businesses reshape their supply-chains, there will be considerable pressure on transportation suppliers to function as partners and to produce, share, and manage information while providing higher levels of service in terms of speed and reliability.

IMPLICATIONS FOR THE TRANSPORTATION SECTOR

This hyper-competitive economy requires that the transportation industry adopt new practices and even redesign itself. The demands on transportation begin with local package delivery to the end-consumers and become most significant as expected changes in business practices alter traditional logistics.(38)

Retail e-commerce (B2C and C2C) requires speedy and reliable delivery of goods to businesses' and customers' doorsteps. The parcel carriers are the most suited to fill this need as the quantity of packages purchased over the Internet increases.(36) Currently, the top four parcel carriers (UPS, FedEx, Airborne Express, and U.S. Postal Service) have experienced rates of change in both revenues and number of packages delivered only slightly greater than changes in GDP. With retail e-commerce representing only 1 percent of total sales, the impact of B2C and C2C online sales is not as apparent as it will be when e-commerce begins to play a more significant role in sales.

For example, in Minnesota, parcel delivery increased from 14 percent to almost 20 percent of all goods delivered in the state, representing one of few areas of significant growth.(45). Moreover, Minnesota has significant intermodal linkages including surface, rail, airport, and port connections.

Table 1.11 Percent Change in Freight Travel 1993 to 1997

Source: Commodity Flow Survey, 1997 (46)

Mode of Transportation	Value	Tons	Ton-Miles	Average Miles per Shipment
<u>All Modes</u>	9.2%	14.5%	9.9%	11.4%
<u>Single Modes</u>	6.4%	17.0%	11.5%	-6.4%
Truck	4.0%	20.6%	17.7%	-0.1%
Rail	18.7%	0.4%	8.5%	3.0%
Water	13.1%	11.5%	-3.8%	n/a
Air	13.1%	11.5%	55.5%	-2.5%
<u>Multiple Modes</u>	31.2%	-4.0%	6.8%	10.5%
Parcel, USPS, or courier	39.7%	25.4%	36.8%	10.7%
Truck & Rail	-16.3%	33.5%	47.5%	-3.9%
Truck & Water	-19.4%	-51.2%	-14.4%	-10.7%
Rail & Water	-55.2%	0.1%	10.5%	74.1%

As the Internet eliminates distance as an issue in the procurement of products and supplies, the transportation industry will feel pressure to react to the demands of the emerging global business environment. Demand for shipping longer distances will require shippers to use intermodal mechanisms for delivery as well to as to develop and employ efficiencies designed to reduce the complexities associated with moving goods from one country to another.(47) Parcel carriers have done well to combine air, tractor-trailer, and local delivery trucks into a seamless operation providing two-day (and even next day) overseas service. Just-in-time supply-chains and made-to-order manufacturing require movement of goods in smaller quantities on a more frequent basis. In these pull supply-chain strategies, the delivery of supplies is more time sensitive, making reliability and real-time tracking a necessity. Changes in the manufacturing models indicate an increase in the quantity of individual (albeit smaller) shipments.(35) This Commodity Flow

Survey found a substantial growth in intermodal linkages between 1993 and 1997 and these are expected to remain strong if not grow further over the next coming years.

Disintermediation and the inventory centralization will reduce the number of times a product is transported. Distribution channels will move toward a more direct manufacturer to customer model as those intermediaries that do not add value to the product are eliminated.(35)

A recent survey suggests that companies want to use transportation providers that are fast and reliable (asset based players) as opposed to “virtual” Internet companies (who merely coordinate transportation activities). This favors the established companies and suggests that the fastest modes of transportation will grow at the expense of slower modes.(48)

Thus, online retailing, globalization, pull supply chain strategies, and disintermediation generally result in shifting large shipment movements to smaller, more frequent shipment movements. This may mean a shift from rail to truck, truckload to less than truckload (LTL) and LTL to parcel carrier service.(37; 47)

SURVEY FINDINGS (in brief)

- o Higher Automation Level
- o Faster, More Frequent, Smaller Shipments
- o Modal Shift
 - more parcel/express envelope
 - more less-than-truckload (LTL)
 - more local trucking or courier.
 - less railroad transportation
- o E-commerce Connectivity Requirement.
- o Lower Costs and Prices
- o Fewer Carriers
- o FedEx & UPS Ranked Best Companies

*Source: Valentine, 2001 (48)
See appendix F for details.*

Transportation Industry Reaction

As businesses adapt to the new economy and consequently require more service from freight carriers, the transportation industry must react. Most significantly, continued efficiency gains through cooperation and adoption of technology will allow carriers to better meet the demands placed on them. Innovations in use of wireless technology, electronic documents, and information technology are helping the freight industry become more competitive and are increasing the efficiency of the transportation network.(26)

Parcel carriers have drastically reduced the cost of moving an express package from \$70 in 1975 to \$6 in 1999, a drop of 91 percent.(49) Despite these gains in productivity, intense competition within the parcel carriers industry requires each player to devise innovative methods to remain competitive.(38) UPS is spending \$100 million in technology to make their package sorting warehouses more efficient. It is expected that this outlay of expense will be recovered in only 16 months through gains in speed and reliability.(50) The United State Postal Service (USPS) has an agreement with FedEx such that the USPS exclusively uses FedEx's air fleet to ship all overnight packages. This inter-carrier cooperation is beginning to increase the efficiency of the transportation network.

As mentioned earlier, customers, both retail and business, are demanding the ability to track shipments. To remain competitive, carriers are establishing online tracking mechanisms. Wireless technology, including GPS devices, allows companies to keep better track of trucks as well as the packages being carried. A survey of the major parcel and freight transportation providers reveals that all have methods for automatic order tracking and many offer proof of delivery (POD) online via the Web, or automatically, via e-mail. Additionally, companies are using wireless technology to aid in providing more optimal routing, thus, reducing delays and making delivery more timely and reliable.

Further reductions in delays are being achieved through the use of electronic documents. As the freight and parcel carrier industries move toward online procurement of their services, they will realize a reduction in errors associated with traditional methods of purchasing. Additionally, the

use of e-documents allows for a reduction in complexities associated with the movement of goods, including easing the process of obtaining licenses (51) and speeding trucks through highway scales.

It has been estimated that nearly half the trucks on the highway are empty with many others traveling with less than full loads.(26) However, advances in information technology are resulting in efficiency gains, including better collaboration for intermodal transportation.(37; 38)

Last year, the trucking company J.B. Hunt combined with six of the largest publicly held truckload companies to form Transplace.com. This “Supermarket for Transportation Solutions” provides a full spectrum of global transportation services, including: carrier management, freight exchange, total logistics management, Web hosting, and fleet services.(52) The difference between Transplace.com and other logistics competitors lies in the fact that the participating companies are established, are trusted, and already have a well-established market presence.

As will be outlined in the rest of this section, the public sector is beginning to grapple with the multitude on intermodal linkages needed to ensure support for the new pressures for just in time delivery and other time critical distribution systems. At the federal level, intermodal linkages in support of economic activity have been recognized through the DOT Office of Intermodalism. In Minnesota, the Interregional Corridor initiative has provided an investment and public policy forum to consider the important role of freight and intermodal linkages in the delivery of high-value goods and services. Moreover, Minnesota Statewide Multimodal Freight Flows Study (53) was completed in an effort to benchmark the emerging pressures on the transportation system in Minnesota. For example, while truck traffic accounts only for some 6 percent of registered vehicles, it represents more than 80 percent of movement of manufactured goods in Minnesota. The study found of the 395 million tons moved in 1997, this movement included substantial within state transport (120 million tons) as well as substantial outbound movement (135 tons). As Minnesota continues its growth in high-technology business, these inbound and outbound deliveries are predicted to carry high-value materials.

CONCLUSION

Although undergoing growing pains, e-commerce is here to stay. Business on the Internet, along

with productivity gains from information technology, has been compared to the effect that the railroad had on American output in the late Nineteenth Century. One difference between these two significant catalysts to change is that today, the effects are coming at a faster pace than those realized by previous revolutionary advances in industry (e.g. railroad and electricity). Prices for computers and telecommunication are falling faster than for any previous technology, allowing the number of firms adopting the Internet to rise quickly. With only a third of companies on the “net” and only 1 percent of sales coming from e-commerce, there is tremendous room for growth.

E-commerce is changing customer behavior. With instant access to price and product comparison, shoppers exert influence on businesses including demand for a more responsive transportation system. Furthermore, customers of e-commerce sites are replacing trips to local shops and banks with online experiences. But, these pure e-commerce transactions are only one aspect of the business to consumer relationship. In other cases, the Internet stimulated trips to purchase items that have been researched via the Web. In still other cases, the Web results in averted browse-shopping trips, yet stimulates a more efficient trip to purchase.

E-commerce is changing the way business is conducted including the way shippers operate. As consumers turn to the Web to conduct business, there will be an increase in local delivery of goods as customers use UPS, FedEx, etc. to deliver their online purchases to their door. However, the impact on the big shippers (full load and LTL) is not as easy to predict. Business supply-chains will require a more responsive shipping sector that can meet the demand for smaller, quicker, and more frequent supplier shipments. The result appears to be a movement away from rail with more demand for LTL and parcel carriers. Globalization equates to a greater reliance on intermodal shipping including air and truck.

The result for the transportation network is less clear. With the increased reliance on smaller, more frequent shipments and the use of parcel carriers, it can be expected that more trucks will be on the road and in local neighborhoods. While claims of disintermediation suggest a reduction in the total number of trips associated with a given product, these claims are based on the elimination of those intermediaries that do not add value to the product. As these intermediaries

redefine themselves by adding worth to the value-chain, the effects of disintermediation may be less than previously believed.

Changes in demand on the freight transportation industry must be viewed in light of changes in the industry. Technology and collaboration are allowing carriers to realize gains in efficiency and reduce the number of trucks with empty or partial loads.

While the net effects on the transportation network are uncertain, it is clear that transportation and economic growth are fundamentally linked. E-commerce is changing the way business is conducted and is having a positive effect on the economy. Therefore, it is important to identify ways in which the transportation network can foster further expansion of the digital economy and not be a hindrance.

CONCLUSIONS AND RECOMMENDATIONS

This paper has analyzed the general effects of e-commerce on the transportation industry. Specifically, there will be changes in demand for freight and its movements as a result of the Internet's influence on the economy.(26) Furthermore, it can be expected that changes in personal travel patterns will result as consumers respond to pure, traditional and secondary e-commerce. To realize the positive economic effects of the Internet, it will be necessary to for the transportation network to support, and not hinder, growth in electronic commerce. To this end, several issues must be addressed:

- There is a need for a more detailed understanding of the many ways in which e-commerce can influence passenger travel. In the case of pure and traditional e-commerce, research is needed on how Minnesota businesses could encourage trip substitution, as well as support efficient product delivery and other forms of environmentally responsive electronic commerce. In terms of secondary e-commerce, the extent to which pre-purchase e-shopping affects shopping trips is not fully understood and could benefit from in-depth inquiry.
- There is a need for more timely and accurate data that will reveal changes in commercial transportation patterns. The Commodity Flow Survey (CFS) is published every four years (1993, 1997, 2001) and reveals important trends in the growth of freight in the United States. Specific data, as contained in the CFS, needs to be compiled yearly. Furthermore,

data that indicates changes in traffic patterns at the highway, rural, and community level will aid transportation planners in making more informed decisions.(26) Additional research could address the question of “How can the data collected on the transportation network provide more meaningful information on the effects of e-commerce to aid policy makers the decision process?”

The technology revolution is changing the economy at a dramatic rate. However, changes in transportation infrastructure require a great deal of lead-time for both planning and construction. This discrepancy may require changes in the criteria used to make transportation infrastructure choices. How can the transportation policy makers be more anticipatory to the infrastructure requirements that are created as a result of the influences of the digital economy?

Ten Steps to Consider

Recently, Horan (54) participated in an e-freight conference that focused on the intermodal challenges to e-commerce.(54) The following ten recommendations (see text box) were developed by conference participants and provide a useful point of departure for the Minnesota Department of Transportation to consider when thinking about e-commerce related freight strategies.

1. *Create a Freight Distribution Advisory Group*—The e-freight conference concluded, “Carriers and planners work together, but very often the shippers and the customers, also key stakeholders, are not engaged in the planning dialogue. Planners, carriers, shippers, and delivery customers should be engaged in creative problem solving.” In Minnesota, the recent recommendations of the Minnesota Freight

Ten E-Freight Recommendations:

1. Create Advisory Group
2. Pursue Curbside Management
3. Value Price Curbside Space
4. Location-Efficient Siting of Distribution Centers
5. Encourage Delivery Consolidation Strategies
6. Create Incentives for Carriers Who Address Sustainable Delivery Goals
7. Engage the Carrier Community in Creative Sustainable Solutions
8. Enhance Policies for Intermodal Hubs and Connectors
9. Improve Incident Management
10. Adopt E-Freight Smart Growth Plans

Source: <http://www.intermodal.org/FIRE/e-freight.html> (55)

Advisory Committee (55) represents precisely the form of dialogue that is needed to ensure future transportation developments recognize the pressures on the freight industry in Minnesota. The parcel and small package delivery business is one of the most dynamic aspects of e-business and transportation planners and management need to maintain a dialogue with the sector to understand how transportation facilities can best be devised to accommodate e-business (while at the same time achieving other equally important environmental and social goals of transportation).

2. *Pursue Curbside Management*—In many major metropolitan areas, downtown streets have become overwhelmed by competing parcel and freight delivery systems. The e-freight conference recommended local officials be proactive in understanding the demands on curbsides and how this may be interrupting traffic (and pedestrian) flows. While this may be a phenomenon limited to the downtown sections of the Twin Cities in Minnesota, it can be a significant frustration to urban businesses that are working under tight service delivery constraints.
3. *Value Price Curbside Space*—While value pricing has been hotly contested in the Twin Cities, at a national level, e-freight conference attendees recognized the potential value of applied pricing at key delivery locations. To quote: “When there is high demand for curbside space, the city and the carrier community might want to consider creating a value pricing approach that allows delivery vehicles to pay a fee for assured availability of curbside space at peak times.”
4. *Location-Efficient Siting of Distribution Centers*—The conference noted the importance of understanding the impact of distribution centers on travel demand. Minnesota is home to several major e-commerce or just in time delivery enhanced companies (Best Buy, Fingerhut, Target, Medtronic) that rely on the transportation system (Tinklenberg, 2000). There are innovative means to locate distribution and e-commerce centers to enhance land use location efficiency. The conference featured a case study of a brownfield conversion in Northern New Jersey (Hummer, 2001). In this case, Newark created a strategy to convert in-town brownfield sites for warehousing, the goal of which was to “reduce net delivery miles and generate employment opportunities in the urban core.”

5. *Encourage Delivery Consolidation Strategies*—As noted on the previous page, the business to consumer side of e-commerce continues to grow despite recent downturns. This has given rise to concerns over efficient package delivery to residents (as well as small businesses). The e-freight conference recommendation to consolidate delivery strategies centers on efforts that can be made through public-private partnerships to encourage architectural, development, and land use designs—as well as community organization solutions—that allow for one-time drop offs by parcel and freight deliverers. Local community groups in Minnesota can play an important role in devising innovative delivery facility (e.g community drop boxes) for e-commerce deliveries.

6. *Create Incentives for Carriers Who Address Sustainable Delivery Goals*—The rise of delivery services for e-commerce has led to concern over the environmental performance of these transportation modes. This e-freight conference recommendation was to create incentives for clean fuel and environmentally friendly vans, as well as provide other incentives for off-peak and trip efficient delivery patterns. Given Minnesota’s long standing commitment to sustainable transportation systems, developing program elements for the delivery and freight element would seem a natural extension of existing policies.

7. *Engage the Carrier Community in Creative Sustainable Solutions*—The conference reported on the activities of the Dutch Transport Ministry to reduce the impacts of truck travel.⁽⁵⁶⁾ A range of options were considered including more delivery slots, dedicated truck lanes and improved geometrics for road improvements. In Minnesota, truck traffic remains a core transport mode for agricultural and non-durable products and in this sense its importance transcends the issue of e-commerce. Nonetheless, the general recommendation of the conference was to create a set of policies whereby the delivery of goods used technology to produce as “green” a transport and distribution model as possible. (This recommendation follows on an early finding by a New York Academy of Sciences panel.⁽⁵⁷⁾)

8. *Enhance Policies for Intermodal Hubs and Connectors*—Minnesota contains several intermodal transfer points (air, freight, port) that need to remain vital as business and

services operate in electronically-mediated business activities. The e-freight conference focused on interconnections between rail, port, airport, and ground transportation and highlighted the economic pressures to retain timely access. Similar findings were noted in the Statewide Freight Freeflows study (1999) that recommended improvements in the connections between ground transport and the Minneapolis Saint Paul Airport (MSP).

9. *Improve Incident Management*—Just in time delivery systems require certainty of travel times. The e-freight conference identified the negative impacts accidents can have on travel and delivery reliability. Similar concerns were raised in Minnesota by the Minnesota Freight Advisory Committee (58), who recommended improved and accessible travel information to aid in commercial development. Again, while the issue of timely access transcends e-commerce related activities, the basic point is with merit: much of the products of e-transactions result in delivery or transportation, and the efficient travel of items is critical to competitive growth of Minnesota.

10. *Adopt E-Freight Smart Growth Plans*—While most smart growth plans have focused on residential development (e.g., housing, light rail), commercial development is a key part of the overall spatial dynamic. Given the modest substitution impact expected from “business to consumer” e-commerce, the second order impacts of e-commerce on land use may be more dramatic.(59) These impacts include the growth of technology-related business and the land-use impact of their spatial location. For example, Minnesota has witnessed considerable growth in call and fulfillment centers; these centers are possible through the advent of advanced information and communication technologies and often serve an e-commerce related function. Understanding how these e-business functions are spatially locating themselves is an important component to an overall land use strategy for Minnesota. A first step in this regard would be to assess the spatial distribution of call and fulfillment centers in Minnesota. To the extent that these customer and distribution centers are potentially contributing to unwanted low-density development, the next step would be to convene a working group to consider how this important aspect of the Minnesota economy could be developed in a way the contributes to the state's smart growth goals.

In conclusion, as e-commerce becomes increasingly intertwined with the overall economic production function, it is harder to tease out those transportation actions and policies that need to be pursued as a unique response to e-business. Instead, the perspective needed is one that understands the new forms of travel (both personal and business) and is endemic to an electronic enriched business and social environment and to plan for these demands in the most robust and environmentally responsive manner. This scanning paper is a first step to highlight the types of actions that can be taken to create a transportation system that supports e-business while simultaneously pursuing other important social and environmental goals.

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CHAPTER 2

INVESTIGATION OF GPS AND WIRELESS TECHNOLOGY

Utilizing Transportation Technology to Support Strategic Management Initiatives

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ABSTRACT OF STUDY

Trends in strategic management heighten the need to service the customer in a fast, efficient manner. With budget constraints and shrinking staffs, operations can be difficult to manage. The introduction of technology systems to share and allocate resources greatly increases an organization's abilities to serve the transportation customer.

In Minnesota, two rural communities adopted wireless and global positioning systems (GPS) technology systems to respond to transportation emergencies. Wireless and GPS technology allows St. Louis County and Olmstead County a real time understanding of vehicle locations, which increases the accuracy and efficiency of deployment. The participating organizations

include the Minnesota Department of Transportation, the State Patrol, the Mayo Clinic, local fire departments, and local police departments. The management of the technology systems includes the acceptance of emergency calls, the response coordination, and the dispatch of participating vehicles.

To understand the opportunities of wireless and GPS technology in transportation, the State and Local Policy Program (SLPP) interviewed local experts, researched the media, and researched the demographics of the communities. SLPP held focus groups to identify the challenges in the implementation of transportation technology, how the challenges were overcome, and how residents responded to more widespread implementation.

INTRODUCTION

Strategic managers design plans to attain organizational goals. These plans generally minimize the constraints and maximize the opportunities of the organization. An organization limited by labor shortages and budget constraints needs to identify the local transportation needs, compare the needs to available resources, and secure the finances needed to successfully implement a new program. After an organization chooses a plan, the implementation stage begins. Implementing technology supplements the skills of current personnel in more efficient and accurate responses. An organization can adopt wireless and GPS technology to coordinate transportation programs in a selected geographic area. To gain a better understanding of these technological applications, the SLPP researched the experiences of St. Louis County and Olmstead County, which use wireless and GPS technology to increase transportation safety. The research included interviews, media research, demographic research, and focus groups. The research results allow organizations to compare local transportation needs and available resources to the experiences in St. Louis County and Olmstead County. In understanding common experiences, strategic managers can strengthen plans to increase transportation safety.

METHODOLOGY

In order to explore the opportunities of technology in transportation safety, the SLPP completed primary and secondary research on wireless and GPS technology. The methodology began with interviews with managers and technical experts. These experts gave a fresh perspective on the environment of technological implementation. Then, researchers studied secondary sources to find how the media's portrayal of technology influenced the receptivity by local citizens. The media research was accompanied by demographic research of rural counties in Minnesota. Lastly, researchers chose sites to conduct focus groups based on this research. Focus groups provided information on the experiences of technical users and the general public during the implementation process. These accounts included the challenges of technological implementation, how challenges were overcome, and how technical users and the general public might respond to more widespread implementation.

Interviews

To better understand the changing environment of technological implementation in Minnesota, the SLPP interviewed representatives from public and private organizations. These representatives ranged from implementers of technology to new users of technology. Interviews allowed interviewees to report, interpret, and provide his or her perspective on the situation. Interviews began with known experts in Minnesota who named other accessible users. Interviews were scheduled to be a short one-time meeting. The discussions followed a standard set of questions, yet were open-ended (Appendix G) to allow each interviewee a chance to provide a their perspective.(1)

The SLPP interviewed members of organizations that often use wireless and GPS technology. Researchers contacted David Gorg and John Scharffbillig of Minnesota Department of Transportation, since they assist in technological implementation for their divisions. Another interview with Max Donath, the Director of the ITS Institute at the University of Minnesota, provided researchers with technology studies in other areas of the university. In the end,

researchers interviewed eight representatives from Mn/DOT, the State Patrol, the Mayday Program, the University of Minnesota, a private business, and a property owners association. Representatives of differing backgrounds provided comparative perspectives of technological implementation throughout the state.(1)

Media Impact

Politicians implementing new programs will often supply information to journalists, in order to gain legitimacy for the program. There are two stages in legitimization: quantity and quality of media coverage. A favorable and heightened portrayal of a story can positively affect the response of the general public.(2) Based on this understanding, researchers studied local media outlets to better understand the responses of the technological implementation projects by local communities. The media research strengthened our understanding of the portrayal of technological applications in transportation today.

Demographic Research

Communities interested in technology applications must understand the benefits and the drawbacks of a new program. Benefits may include a more efficient allocation of resources and a quicker response rate to emergency situations, while drawbacks may include large initial costs of the program. In rural Minnesota, demographic research identified population rates, traffic accidents, and response rates. The demographic information allowed organizations to identify transportation needs and recognize the opportunity to implement wireless and GPS technology. St. Louis County and Olmstead County have balanced their needs and opportunities of technology implementation.

Focus Groups

Focus groups have many advantages during research studies. As compared to larger studies, focus groups can be brought together at shorter notice and less cost and in a flexible manner. Focus groups allow researchers to interact with the sample to clarify answers and note the verbal and nonverbal reactions. Meanwhile, the open-ended format allows the group to explore, react, and build upon each other's responses. Other benefits include personalized and understandable

responses. To increase group cohesiveness, one strategy is to construct homogenous groups to better understand the target populations. By creating two different groups—one technical users and one general public—a conversation can avoid negative interpersonal communications and/or domination by one group or another.(4) The technical users can also provide insights to challenges for late adopters of the technology. The end result allowed researchers to understand the concerns of technical users and the general public in the implementation of wireless and GPS technology. Understanding these concerns allows program designers to create more effective programs in widespread implementation.

Structure

SLPP chose the sites for the focus groups based on the interviews, media research, and demographic research. Once the sites were chosen, SLPP contacted former interviewees for local experts in the selected communities. Two local organizations with program coordinators were contacted to help host the focus groups. The coordinators offered their facilities and the names of expert users of wireless and GPS technology in their organizations.

Participants represented a sample of the population and categorized as either an expert user or as a member of the general public. Participants included 13 people from Virginia City and six from Rochester*, split between the two focus group categories: 10 technical users and nine general public participants. Depending on their geographic location, participants convened in Rochester or Virginia City to discuss the concerns of transportation safety and the opportunities of wireless and GPS technology for a period of two hours. The goals of the focus groups were to obtain information regarding previous challenges of transportation technology, how those challenges were overcome, and how residents might respond to more widespread implementation of transportation technology. *(The Rochester focus groups' attendance was much lower than expected. The focus group was held September 20, 2001: Nine days after the attacks on the World Trade Center and the day that President Bush responded to the attacks in a national press conference.)

Surveys

Focus Group: Background Survey (Appendix H) increases an understanding of the demographics of technical users and the general public in the focus groups. The participants completed surveys prior to the start of the oral discussion. The completed surveys provide researchers the ability to recognize the impact of group dynamics in altering the overall responses during the focus groups.(4)

Oral Questions

After completing the background surveys, the focus groups discussed the oral questions, moderated by SLPP researchers. The Focus Group: General Public (Appendix I) was designed using oral questions for the general public regarding wireless and GPS technology. The Focus Group: Technical Users (Appendix J) was designed using oral questions for expert users regarding wireless and GPS technology. Both focus group oral questions (Appendix I and J) use open-ended questions to allow the development of discussion within the groups.

FINDINGS

The methodology allowed SLPP to understand the safety concerns in rural transportation, as well as the opportunities to implement wireless and GPS technology. The goal of the interviews, media research, and demographic research was to choose sites for focus groups. The rural counties chosen were St. Louis and Olmstead Counties in Minnesota. Our discussions with interviewees referred to these two counties numerous times. The rural media outlets were supportive in their write-ups of new technological implementation in transportation. Lastly, the demographics of these two counties demonstrated the needs of wireless and GPS technology applications to increase transportation safety.

Interviews

SLPP asked a standard set of questions (Appendix G) to gain fresh perspectives on the receptivity of the wireless and GPS technological implementation process within organizations and towns that experienced the transitional process of technology adoption. The interviewees repetitively noted two projects in Minnesota that tested the applications of the technology. These two projects were the Advanced Rural Transportation Information & Coordination (ARTIC)

project in St. Louis County and the Mayday Program in Olmstead County. Interviewees discussed the implementation stage of the technology adoption in emergency vehicles and snowplows.(5, 6, 7, 8, 9, 10)

The first few interviews began with technical explanations of wireless and GPS technology. Included in the explanations were how devices worked with larger systems, how towers and satellites honed in on the devices, and how new regulations allowed for more accurate readings. Learning about the applications allowed researchers to develop a better understanding of opportunities and issues involved. Technical opportunities included increased resource efficiency and decreased response times in emergency services. Opportunities to apply these applications to other vehicles include “(G)arbage trucks, street sweepers, street painters, lawnmowers, and road repair vehicles.”(9) Respondents discussed age differences within the organization and younger users’ abilities to adopt technology at a faster rate. At times, the younger users showed trainers new techniques.(5, 6, 7, 9) Later interviews included daily users of the technology, and their comments reinforced earlier discussions with the technical interviewees.(8, 10, 11)

In Minnesota, a lesson learned early in the implementation stage was the need for education programs for users and communities. In one community, users that were not well trained reacted negatively by filing a grievance to their union over concerns of privacy. During the review stage, the organization institutionalized training programs for each and every user. The process began by welcoming the end user to participate in the organization’s decision-making process. Involving the end users dramatically increased the success rate of the program.(9) In another community, community outreach programs were needed during the implementation process. The case included a private company’s cellular telephone tower, which upset the town because the tower’s height loomed above the local lakes and pine trees. The citizens felt that the tower and its red blinking light spoiled the natural beauty of the area. A few months later when Mn/DOT proposed a tower to correct satellite signals for GPS technology, the town reacted negatively and the tower was not built. Had Mn/DOT approached the issue with public outreach during the implementation stage, the project may have received a better response from the general public.(12)

St. Louis County

St. Louis County, which includes the cities of Duluth and Virginia, has many opportunities to apply wireless and GPS technology in emergency and safety vehicles. The largest program in St. Louis County is called the Advanced Rural Transportation Information & Coordination (ARTIC) based in Virginia, Minnesota (Figure 2.1). The ARTIC program uses a satellite as a base point to scan the locations of various vehicles in the region. The station assists in the positioning of the vehicles and bounces information from the Virginia Communications Center to (VCC) the satellite, which is then distributed to the vehicles for deployment purposes. VCC receives data and defines the parameters of a response to allocate resources in an accurate and efficient manner. The various groups that respond to the calls from the VCC include the State Patrol, local firefighters, Arrowhead Transit, Dial-A-Ride, and Mn/DOT snowplowers.(13)

Olmstead County

Olmstead County, which includes the city of Rochester, is currently testing the previously mentioned Mayday Plus Program, a \$2.5 million public-private partnership. One project in the program covers 11 counties and distributes GPS devices for free to local emergency services and volunteer organizations to identify crash locations and increase response times after an accident. A second project incorporated in-vehicle crash transponders with cellular communications and GPS, as well as a special responder system installed by the Mayo Clinic and the Minnesota State Patrol. There were 120 vehicles in the Rochester area with sensors and technology to automatically give the location and severity of an accident to emergency crews. This system was designed to notify authorities and medical technicians by transmitting GPS data regarding the vehicle's location and the change in velocity lost during the crash. This information can be used to effectively respond to emergencies. During the testing period, none of the participants were involved in an accident, however one participant manually deployed the technology for roadside assistance.(14)

Media Impact

Across Minnesota, a variety of articles on wireless and GPS technology and transportation were written over the past two years. These articles spotlighted the testing of the ARTIC program and Mayday program. The articles helped to educate local communities on the opportunities to create

safer road conditions and better emergency response teams. The educational format introduced the technology to the public at a comfortable level, rather than a complex, technical level during the implementation stage. Good public relations increase the capabilities of an organization when managing a public good. The outreach increases the knowledge and trust between the general public and the organization. The ability to effectively communicate with the public will strengthen the long-term success of the plan.

Snowplows

Wireless and GPS technology on snowplows was described in a *St. Paul Pioneer Press* feature story. The article highlighted the benefits of the wireless and GPS technology and described a variety of ways snowplows are equipped in preparation for whiteout conditions and snow/ice removal. The overall portrayal of the technology was fascination with the snowplow's new abilities.(15) The article was very favorable and well placed in the newspaper. Other communities carried similar articles in their local papers to spotlight new wireless and GPS applications, as Hutchinson carried one article and Duluth carried two articles in 2000.

Emergency Crews

News in Olmstead County reported the benefits of the Mayo Clinic's Mayday Program. A Mayo Clinic trauma surgeon promoted the program, which increased the overall capabilities of emergency services in the area. A Colonel of the Minnesota State Patrol, Anne Beers, stated "Response time is critical in our rural areas,"(16) The article also discussed opportunities for larger, coordinated projects.

Demographic Research

With emergency response times 1.5 times slower in rural areas than urban areas, lives are at a greater risk in rural transportation accidents. Response rates over 30 minutes occur in five percent of rural accidents due to long travel distances, lack of communications, and varied geography.(17) In an accident, a victim has one hour to receive medical attention to greatly increase the chance of full recovery, known as the golden hour.(14) By increasing technological applications, local emergency crews can allocate resources faster and more efficiently in less

populous areas. The decrease in time and increase in efficiency can make a difference between life and death for a patient in a rural transportation accident.

Concerns in transportation safety were identified during the planning process. The concerns highlighted a growing population and an increasing number of miles driven. Over the past decade, the population of Minnesota increased more than nine percent. The total number of miles driven in Minnesota increased from 38.9 billion miles in 1990 to 48.5 billion miles in 1998.⁽¹⁸⁾ As rural counties are less populous in comparison with urban counties (Table 2.1), accidents per capita are comparable (Table 2.2). Unfortunately, rural and urban counties also have a comparable number of fatal accidents. (Table 2.3) ⁽¹⁸⁾ According to “Mayday Plus Facts,” rural roads account for 30 percent of miles driven in Minnesota and 70 percent of fatal crashes.⁽⁹⁾

Some rural communities may lack the resources to decrease response times. As budgets may not allow an increase in staffing to attend to accidents in the region, fatalities may increase. In the example of trooper staffing, southeast Minnesota has 20 regional troopers patrolling 1,417 miles of roads on an average weekend. At the same time in northeast Minnesota, seven troopers patrol 989 miles of road.⁽²⁰⁾ Troopers that patrol these rural regions regularly respond to accidents 30 to 60 miles away. Depending upon the distance traveled, the trooper may not arrive at the scene until an hour after the accident was reported. As time passes, the chance of death and disability greatly increases for accident victims.⁽¹⁴⁾ In these cases, technology, such as automatic vehicle notification systems using wireless and GPS technology, increases the known information about the accident. The operator at the response center could locate the troopers, emergency crews, and other vehicles on the road to send the closest vehicle to attend to the accident victims. The efficient allocation of resources, as a result of new technological applications, increases the survival rates of the accident victims.⁽¹⁶⁾

The implementation of new wireless and GPS technology is expensive for small communities. St. Louis County and Olmstead County have per capita income higher in comparison with other counties, which may allow local governments a greater opportunity to test new technology. On average, the income per capita for Minnesota in 1998 was \$29,263. However, 82 percent of Minnesota counties fell below \$25,000 as the income per capita. In the top 20 percent, St. Louis

County had a \$25,600 income per capita and Olmstead County had a \$30,880 income per capita in 1998.(19) The opportunity for these communities to test new technology may arise from their financial position. If these experiences prove cost effective for the early adopters, counties with fewer resources may be more confident in their long-term investments of transportation technology.

Focus Groups

Research determined which areas of the state implemented wireless and GPS technology to increase transportation safety. Focus groups were conducted to research the challenges of wireless and GPS technological implementation, how those challenges were overcome, and how residents might respond to more widespread implementation. These focus groups had representatives from the early and late adopter stages. The technical users groups represented the early adopter stage, while the general public represented the late adopter stage. (Figure 2.2) (3) The early adopters provided a better understanding of challenges in adoption of wireless and GPS technology, the obstacles to implementation, the benefits of the technology, and the opportunities for future application. The late adopters provided a better understanding of their current perceptions of transportation issues and technology. Lessons learned in technology implementation for early adopters can be applied in technology implementation for late adopters, therefore a comparison of the two groups allows strategic plans to prepare for issues and concerns in widespread adoption.

The focus groups included written surveys and oral discussions. The surveys were distributed at the beginning of the session. The surveys revealed that 100 percent of the general public participants and 75 percent of the technical user participants thought that technology could help solve transportation problems. More than 2/3 of the total participants used technology at work and at home. More than 2/3 of participants believed that technology had changed over the years in speed, usefulness, and design. In ranking negative concerns of new technology, both groups

perceived technology as being too expensive and too hard to use. The rankings were from 1 to 5 with 1 being the strongest.

Public participants felt:

1. technology is too expensive,
2. technology is too hard to use,
3. technology invades privacy,
4. technology complicates life, and
5. technology is harmful to the environment.

Technical user participants felt:

1. technology is too expensive,
2. technology is too hard to use,
3. technology complicates life,
4. technology invades privacy, and
5. technology is harmful to the environment.

Note that these five choices were the only choices on the survey. With GPS-specific technology, participants had varied experiences with the technology. The survey revealed that more than 75 percent of the general public and 90 percent of the technical users would want to use the technology at the personal or professional level, if they had the chance.

During the oral discussion, participants discussed the greatest transportation problems in their communities. Transportation safety was discussed in the form of roadway quality, weather related issues, and aggressive drivers. As a solution to these transportation concerns, the technical user groups discussed the usage of technology. Familiar with technology, technical users were able to creatively expand the applications. Not as familiar with new technology, the general public did not specify technological applications, however they suggested better enforcement of current laws, centralizing communications, alerting the public of transportation changes, and a change in social thinking to decrease aggressive driving.

Participants discussed various reasons to adopt new technology. Participants liked to use new technology more often when the devices were familiar and fun. Some participants felt competition from younger generations to learn the capabilities of technology. Participants discussed how incentives and/or requirements to adopt new technology at work increase adoption of technology. After using the technology, the technology was viewed as useful and beneficial to the participant.

There were many negative concerns regarding new technology identified by the focus groups. Both the general public and the technical user participants discussed concerns of improper technology use and dependency on technology to complete a task. Other negative concerns of both groups were the high costs of technology reflecting the needs for cost-effective investments and widespread implementation. A large concern of participants was the lack of adequate training on new technology. Lack of training created frustration on the job for both the general public and technical users. General public participants noted that more time was consumed in trying to remember and figure out how to use new technology, while trying to complete their normal workloads. The technical users discussed the training concern as an obstacle in making their work more efficient. Technical users noted that technology should automate processes, such as paperwork, centralize communications, and increase their ability to research information. These capabilities can allow participants to focus on serving the public in the field.

Most participants said that adequate training made them more comfortable and confident in working with newer technology. Having a personal trainer explain the uses, the processes, and the benefits increased the adoption rates of new technology. Participants noted having an expert to call upon when frustrated would also make them more comfortable. Some technical user participants discussed the need to know the reliability of the new technology. These participants said that technology upgrades were great with the larger available options, but they would be happier if they had the old, familiar technology with an upgrade in reliability when responding to emergency situations.

Many participants knew about GPS technology from professional and personal experiences. These experiences included applications in camping, canoeing, and hunting. In general, the

participants felt that the technology was a positive tool. The participants supported the application of GPS technology in response to safety concerns. The participants felt that the technology and services should be equitable, flexible, inexpensive, and cost-effective. The participants also endorsed combining GPS technology with cell phones for adoption in the general public.

There were various methods to increase the comfort levels of the technology among participants. These methods included greater availability, lower costs, more training, and incentives for technology usage. For example, participants use the technology, become comfortable with the technology, and demonstrate the technology to others, therefore continuing to spread technology throughout society.

RECOMMENDATIONS

The implementation of technology can greatly serve the transportation safety needs of a community. Recommendations for wireless and GPS technology implementation include:

- *Explain the benefits.* The transition to the technology needs to have an effective plan with programs to demonstrate the benefits of the technology to the end-users. The transition should be invisible to non-users, however if the transition is visible, then the organization should maintain outreach programs for non-users to explain the benefits of the technology change.
- *Adequate training is key.* The training must adequately explain the benefits of the new technology. Proper usage increases the user's confidence in the technology and increases the applications of the technology. The rise in familiarity and applications diffuses the technology to other users.
- *Availability to all interested parties.* When technology is diffused throughout the organization(s), the technology should be inexpensive, cost-effective, and flexible in changing systems. As a tool to alleviate traffic concerns, the technology needs to be available to provide equitable services to all involved agencies.
- *Demonstrate reliability.* Unreliable technology can slow operations and affect the organization in the short and long run. In the short run, the unreliable technology impedes normal operations, and in the long run, adoption is slowed or stopped because users no

longer trust the technology. The affected organization in turn cannot fully service the needs of the general public. The break down in the technology can greatly impact the larger community, especially in emergency situations.

- *Alternative operations.* Under standard operating conditions, the technology is very beneficial to the organization. However in serving the needs of the general public, an alternative plan must be available in times of failed technology. The alternative plan signals to users that management understands and plans for technical failure, which increases the confidence of users in responding to daily duties.

CONCLUSION

The information provided by these two communities' experiences could serve as a model to other communities to learn how to implement systems of technology and continue to promote transportation safety. To adopt new technology and enhance transportation safety, a community must understand the local transportation needs. If the needs of the community match the opportunities of wireless and GPS technology, then the community can develop a plan for implementing technology to alleviate the problem. This plan should call for input from managers and end users alike. During the implementation stage, the organization needs to make the technology available to all interested parties. The plan must include extensive training for all users to ensure the full potential and the proper technology use. The trainers need to demonstrate the technology's benefits and reliability and how users can operate under technological failure. The greater the participation in the program, as made possible through availability and familiarity with the technology, establishes more accurate and effective deployment of emergency services.

ACKNOWLEDGEMENTS

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The authors appreciate Laura Olson's time and effort in the interview segment of the project.

Section Tables

Table 2.1 Minnesota Populations by County (21)

Minnesota Population by County (1998)

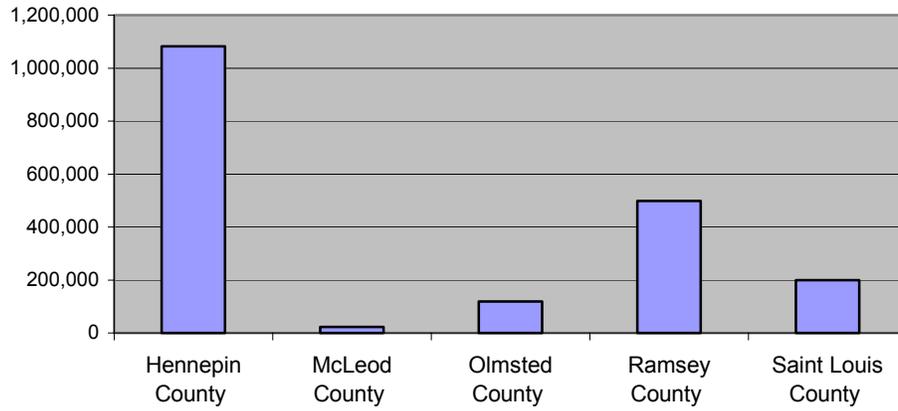


Table 2.2 Accidents per Capita by County (21)

Minnesota Transportation Statistics
of Accidents per Capita by County (1998)

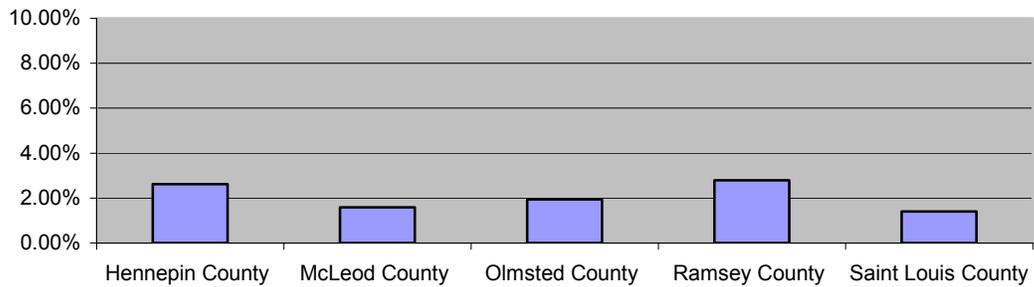
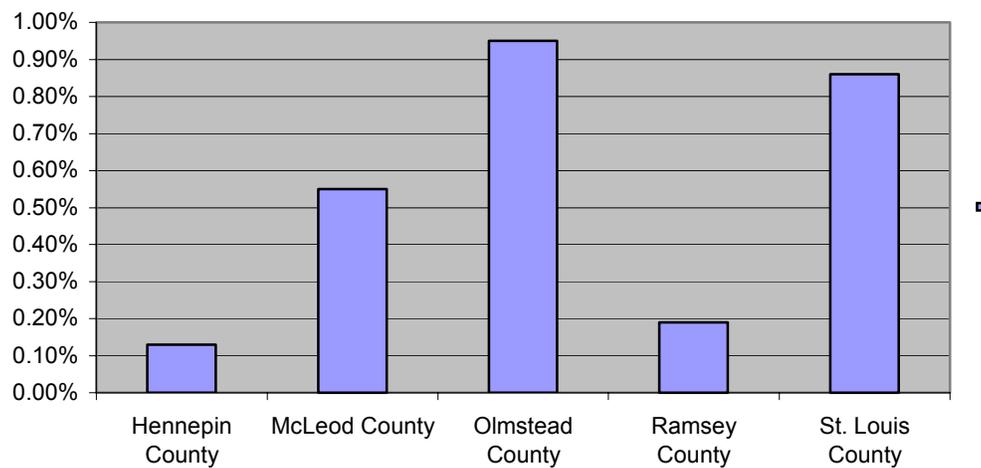


Table 2.3 Fatal County Accidents as a Percentage of All County Accidents (21)

Fatal Accidents as a Percentage of All Accidents (1999)



Section Figures

Figure 2.1 The ARTIC Program (3)

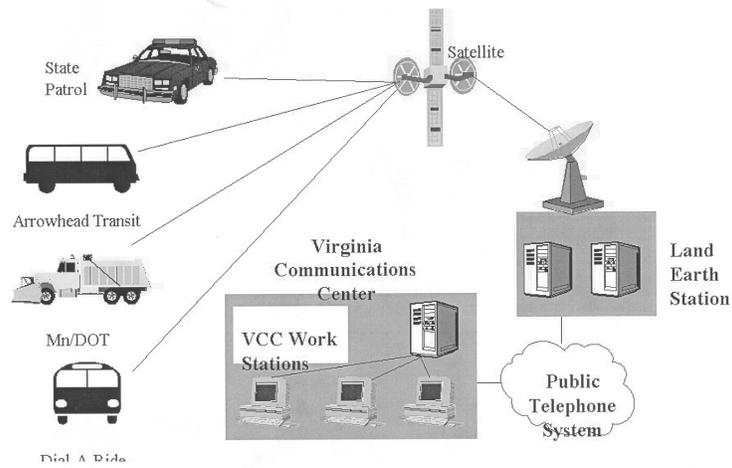
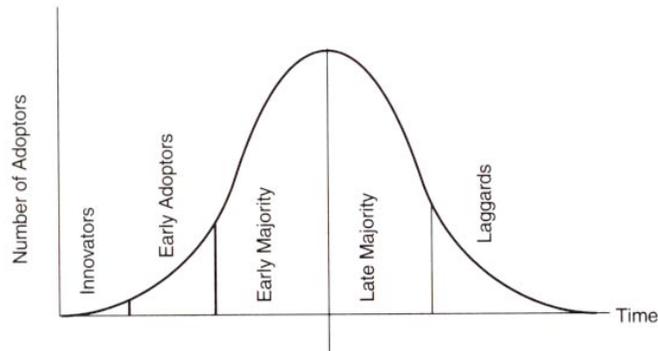


Figure 2.2 The Process of Technology Adoption (3)



Regulation of Safety and Privacy Issues in Wireless Communication Applications for Transportation

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INTRODUCTION

In recent years, federal, state, and local policymakers have weighed the benefits versus the risks of using wireless telecommunications technology in a vehicle. Cell phone users are able to place emergency calls directly from their motor vehicles and save lives. Travelers can get information about services or map instructions in any possible location by using wireless innovations in their cars. However, along with these benefits, many sources indicate that in-vehicle electronic devices, cellular telephones in particular, can present a significant safety concern.⁽²²⁾ Inattention and distraction created by cellular phone use while driving can increase the risk of a crash.⁽²³⁾

A survey conducted by National Highway Traffic Safety Administration (NHTSA) in January 2001 found that 54 percent of motor vehicle drivers in the United States usually have a cell phone in their vehicle or carry cell phones while driving.⁽²⁴⁾ Almost 80 percent of these drivers have their cell phone turned on, and 73 percent of respondents report talking on the phones while driving. These numbers are expected to grow continuously.⁽²⁵⁾ Federal and state governments have started legislative activities to ensure road safety is preserved in situations where cell phones may be used.

This article will discuss and conduct a comparative analysis of legal norms regulating use of a cellular telephone while driving a vehicle in four states that were active in addressing the safety

issues: California, Massachusetts, Florida, and New York. The article will then consider private and public regulatory efforts on the national and international levels and conclude that while the current efforts at private self-regulation may be the most useful at this time, government regulation may eventually have a proper role as well.

COMPARATIVE ANALYSIS OF CALIFORNIA, MASSACHUSETTS FLORIDA, AND NEW YORK LEGISLATIVE REGULATION OF CELLULAR PHONE USE IN A VEHICLE

The use of wireless technologies to promote traveler safety is more of a state interest than a personal one. While individuals certainly benefit from technology that will improve their safety, individuals may also decide to adopt technologies that decrease their safety or endanger the safety of others. For example, cellular telephones have accelerated access to help in emergency cases on roads but distraction due to use of it while driving puts safety of all drivers under risk. On the other hand, it is rarely in the interest of the state to promote innovations that decrease the safety of its citizens.

Currently, at least 27 states are considering taking actions for solution of the safety problem.(26) In Minnesota, concern regarding the safety of operating a motor vehicle while using a cellular telephone has been sufficient to initiate a legislative action. In 2001, a bill was introduced to the Minnesota State Legislature to ban the use of cellular phones within the state or on any boundary water of the state.(27) Similar bills have been introduced in Wisconsin, Arizona, New Jersey, Virginia, Hawaii, and other states. However, none of these bills were enacted. Nevertheless, Minnesota public offices have held special statewide campaigns to fight the driver distraction problem and educate the general population on the risks of using a cellular phone in a motor vehicle. For example, the most recent campaign “Safe and Sober,” will send messages to the public to help combat the high incidence of distracted driving throughout the state.(28)

The history of legislative restrictions of mobile telephone use in a vehicle started in California in 1987. It was the first successful attempt to bring safety issues in using the cellular phone under statewide legal control. The limited group of legal participants and limited sphere of its effect characterize this rule. Specifically, Section 28090 of the Vehicle Code of California states:

Every renter of a motor vehicle with cellular radio telephone equipment shall provide the person who rents the motor vehicle with written operating instructions concerning the safe use of the equipment.(29)

Being aimed only at motor vehicle rental services, the Section does not apply to individual car owners or other legal entities—public/private companies or agencies that provide their employers with motor vehicles for various purposes. For motor vehicle renters, the rule requires the safety instructions for the cellular phone use be included in the car but imposes no duty on a driver to follow these instructions. It is also important to note that the content of the safety restrictions is not stipulated in the Section.

In Massachusetts, the state government has gone a little further than in California. Since April 12, 2001, a law restricts cellular phone use in school buses. The fifth paragraph of §7B, Chapter 90, states, “No person shall operate a moving bus while using a mobile telephone except in the case of an emergency.”(30) In other words, this statewide law addresses the safety of school pupils and other passengers on the school bus and prohibits the school driver to communicate by the cellular phone in the moving vehicle, except in emergency cases. The regulation implicitly permits drivers of motor vehicles other than school buses to use the cell phone while driving. The Massachusetts law has a power over a limited group of individuals, i.e., the school bus drivers, and this characteristic relates this state to California.

Florida also considers cellular telephone use in moving vehicles as a risk to safety on public roads. The State Uniform Traffic Control has outlawed the wearing of headsets, headphones, or other listening devices, other than a hearing aid or instrument for the improvement of defective

human hearing.(31) The law does not state applicability of this restriction to the cellular phone use. However, the part (d) of §316.304 does allow the use of “a headset in conjunction with a cellular telephone that only provides sound through one ear and allows surrounding sounds to be heard with the other ear.”

This statement allows a headset to be a substitute for some operational functions of the hand-held cellular telephone if one ear is open to surrounding sounds. Currently, some of the large wireless service providers, such as AT&T Wireless, Verizon Wireless, Sprint PCS, and OnStar, are taking steps to oppose restrictive regulations and are producing inexpensive headsets, speakerphones, voice-activated navigational systems, and voice-dialing services that leave the driver’s hands free for driving.(32) These in-vehicle devices are already legalized under the Traffic Control laws of Florida.

On June 28, 2001, New York became the first state in the nation to enact a state-wide ban on the use of hand-held phones while driving on all public roads except in the case of an emergency.(33) In a comparative view, this could prove to be an effective tool to regulate the cellular phone use as it applies to a wide spectrum of individuals driving commercial and noncommercial vehicles.

The law defines the terms “hand-held mobile telephone” and “hands-free mobile phone” and specifically exempts from the law’s prohibitions the use of hands-free mobile telephones, as well as emergency calls made to medical assistance services, peace officers, and other specified cases. By permit or license, state or local agencies can be authorized to impose more stringent restrictions on local employers. For example, after enactment of the state law, the Taxi Limousine Commission (New York City) plans to prohibit the use of hand-held and hands-free mobile telephones by the drivers during performance of their duties.

Such decisions may be based on findings from a medical study conducted four years ago. In February 1997, *The New England Journal of Medicine* published findings of the study on

association between cellular phone use and traffic accidents. According to the results, there was no “safety advantage to hands-free as compared with hand-held telephones.”(34) The policy imposing restrictions on use of hand-held cellular telephones while driving could not be sufficient to eliminate the hazard to safety on roads.(35) The study found that “the use of cellular phones in motor vehicles was associated with a quadrupling of the risk of a collision during the brief period of a call.”(36)

ADDRESSING DATA SECURITY AND PRIVACY ISSUES AT THE INTELLIGENT TRANSPORTATION SOCIETY OF AMERICA (ITSA) AND THE CELLULAR TELECOMMUNICATION AND INTERNET ASSOCIATION (CTIA)

Along with the safety issues of driving a motor vehicle while using the cellular telephone, data security and privacy issues have arisen and become hot topics discussed by consumers, service providers, and advocates of privacy protection or technological innovations. The leading wireless carriers soon plan to offer roadside assistance, traffic updates, and a route planning as well as shopping and service guides through GPS technology built into new phone chip sets. The carriers will be able to gather data on location, habits, and daily life of their consumers.(37)

This year the Intelligent Transportation Society of America (ITS America), which unites efforts of federal, state, local, and foreign government agencies in increasing safety and efficiency of advanced technology in transportation, approved ITS America’s Fair Information and Privacy Principles.(38) The principles “recognize and respect the individual’s interests in privacy and information use” through enforcement of an opt-in standard for the collection of personally identifiable information and an opt-out standard for the collection of anonymous information.(39) The opt-in standard means that disclosure of identifying information is prohibited unless the individual chooses to allow the collection and use of personal information.

The opt-out standard for anonymous information still allows a market for ITS applications that do not require “identifiers,” while continuing to preserve the rights of ITS users to protect their identity.

The law enforcement principle has a significant importance for protection of data security and privacy of the ITS users. The principle states a mandatory requirement for service providers to deny access to client’s data for law enforcement office unless unambiguous authorization of law or law enforcement officer is presented. This provision helps to close loopholes that might otherwise force service providers to disclose identifying information. However, state or federal government may legislate conditions under which collected information can become easily accessible to law enforcement offices and other government entities for various purposes. For instance, the most recent federal law on terrorism (USA Patriot Act of 2001) includes a new provision that allows a service provider to disclose to a law enforcement agency customer communications or records if “the provider reasonably believes that an emergency involving immediate danger of death or serious physical injury to any person.”(40) This could raise concerns over the definition of “relevancy” of personal information collected by ITS applications. The sixth principle says that the information will be relevant for ITS purposes. It is not clear whether the service provider itself will determine the relevancy of the information or it will be prerogative of legislation (federal, state, or local). Nevertheless, the ITS America principles can play an important role in provision of guidance to wireless service providers and jurisdictions in development and deployment of Intelligent Transportation Systems.

The Cellular Telecommunications Industry Association (CTIA) proposed the Location Privacy Principles in its petition to the United States Congress Federal Communications Commission last year.(41) The CTIA’s proposed principles would ensure that users of any mobile service will be informed about information collection and use practices of the service provider before any information is disclosed or used. CTIA’s principles also build upon the opt-in standard that provides customers with a choice to define nature of information to be collected and methods of its use.

In addition, the CTIA proposes to implement technology-neutral privacy rules. It means that the rules should be technology-neutral so that the mobile consumer's privacy expectations are satisfied regardless of the technological device. In a situation with constant technological advancements and rapid introduction of its products into markets, the technological neutrality rules would gain significance in the privacy protection issue.

As both the ITS America and the CTIA principles are advisory and designed to be flexible, companies and jurisdictions can decide to incorporate them fully or partially. Of course, this leaves some opportunity to manipulate and result in decreasing value of the proposed principles in a matter of privacy protection. Legislation representing the main ideas and values of the principles might be a solution to the privacy protection issue.

Wireless Issues Outside of the United States

As wireless technology reached market readiness, governments saw the possibility of wireless networks and services not only as a new form of service but also as competitors to the established wireline telecommunications providers. In many countries, licenses for wireless service were awarded to new companies as well as to offshoots of the established providers. As a result, the global wireless industry has been dynamic and growth-oriented compared with the traditional telecommunications sector.

An important fact in global wireless development is that the United States is not the dominant player and has not necessarily shaped the issues. Europe and Asia lead the world in wireless usage (controlling for population size) whether measured in terms of voice use, text messaging, or live Internet access. Part of the reason for this dominance in Europe derived from the ability of the European Union to foster common technical standards among its member states at a relatively early stage of wireless development. In Asia, the leading role of Japan as a research and development engine was critical as well as the fact that throughout Asia, the penetration rate of traditional landline infrastructure was limited. Thus, wireless networks—albeit of varying scope and power—were appealing as a less costly more readily implementable alternative to

traditional landline service. As other countries developed these wireless networks in this fashion, the concerns which resonate as legal or policy issues in the United States in the transportation and telecommunications arena are not very well mirrored elsewhere.

The dominant issue in both Europe and Japan about cell phone usage has focused on the potential health hazards of cell phone usage to individual users. There is a long-standing concern that cell phone usage may be linked to increased cancer risk. Governments have required industry to support research to help answer those questions, but in the meantime, it is common to see cell phone users in both Europe and Japan attach a particular charm to their handsets in the belief that it will deflect possibly harmful signals from the handset.(42)

One of the most striking differences in issue concern is the relatively muted concern about privacy in the use of cell phones. The orientation about privacy concerns is rather different in Europe from the United States. For example, users of cell phones in Europe are less likely to be anxious about the government collecting data about them from their cell phone use than about whether other users or corporate entities would be able to learn the content of their communications. These concerns have risen to the level of discussion in both the European Union and Japan that each has adopted a broad set of guidelines in respect to privacy in the information society (although the orientation in those policies is toward the privacy needs of electronic commerce).

Another key difference is the relatively modest emphasis in both Europe and Japan on transportation safety issues in the use of cell phones. The nature of daily transit helps account for this difference. Both Europe and Japan show populations concentrated in urban centers with a much greater reliance on public transit rather than individual vehicles as in the United States. Thus, the question of highway safety is less emphasized outside of the United States. However, other issues have been raised including the enforcement of courtesy surrounding the use of wireless phones in public spaces such as train cars, etc. In Japan, there is a setting on the handset that is referred to as the “manners” setting. It allows the user to direct all incoming messages to a silent voice mail with screen display of content of the message.

CONCLUSION

The new transportation applications of wireless and GPS technology demonstrate that new ground needs to be covered in transportation and communication data regulation. The current open nature of transportation data regulation creates an opportunity for the collection and distribution of data on a large scale without discussion of the costs and benefits of such a development. Since these applications can improve traveler safety, convenience and access to information, and at the same time improve overall system safety and performance, asking questions about privacy and hidden factors that could actually make travel less safe may seem like simple obstructionism. However, this examination of the applications and the current regulatory environment shows just how important it is to ask these questions now and begin a discussion of how they should best be answered.

While government regulation can be an attractive solution for the simplicity of stating what providers can and cannot do, government faces many of the same lack-of-full-information problems that consumers do and attempts to regulate could actually nip an emerging market in the bud. Further, the experience of cellular telephones demonstrates the difficulty of agreeing on appropriate regulatory measures: Despite the increased evidence of decreased safety from cell phone use while driving, only one state has succeeded in developing a law specifically designed to curtail the practice. In light of the importance of privacy expectations and the uncertainty that current industry efforts at self-regulation alone will produce adequate protections, public policy makers should develop a clearer understanding of the appropriate role of possible state regulation.

However, at the current time, policy makers should be encouraged by the wireless service providers' deliberate acceptance of regulatory responsibility through the proposed measures and standards for safety and privacy protection. As such, industry self-regulation currently appears to be the best option. The concerns that dominate in the United States about cell phone usage have not occurred in Europe or Asia due to differences in economic development patterns, transportation infrastructure, technology, and lifestyle of people. In addition, private organizations that could have international membership, such as the CTIA and ITS America,

have already taken initiatives to respond to arising concerns by ensuring safety and privacy of consumers. Finally, state legislatures, which often are fertile grounds for federal initiatives, have largely been passive in addressing issues of the cell phone and other wireless technologies in transportation. As such, there may not be great benefit in the United States government taking actions toward a federal regulation of the cell phone usage until the effectiveness of the current private efforts has been determined.

GPS, Wireless, and Transportation: The Promise of GPS in “Services-on-Demand” Public Transportation Systems

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INTRODUCTION

The major goal of this report is to investigate the use of GPS technology in public transit systems with a particular focus on services-on-demand types of transit systems (dial-a-ride, jitney, door-to-door services, taxi, etc.).

In the face of mounting traffic congestion nationwide, a major policy goal is to find ways to get people out of their cars and into public transit. The single-occupant driver of an automobile clearly has many advantages. There is scheduling at the driver’s convenience, door-to-door service, and privacy. Also there is no waiting and no need to transfer to other vehicles. Out-of-pocket costs are perceived to be low (few people factor in the capital or insurance costs). There are disadvantages such as the aforementioned congestion, possible parking fees, or a possible shortage of parking spaces. But overall, the advantages apparently greatly overshadow the disadvantages.

A variety of small-scale, door-to-door public transit services have developed throughout the country, in both urban and rural areas, that actually come closer to providing nearly comparable advantages than traditional bus and rail systems. Generally referred to as services-on-demand, they include jitney, mini bus, van, and taxi services. They are also referred to as “dial-a-ride” services or “paratransit” services. While many have traditionally been privately provided, most

are publicly financed or partially subsidized. For many rural areas, this is often the only public transportation available. Also these services are often targeted to special populations—particularly the disabled or the elderly. Metro Mobility in the Twin Cities area is one such service that is publicly subsidized and targeted to the disabled. In general, these services have served to provide transportation for those who cannot drive or do not have a car. Seldom is there an effort to divert automobile drivers to these services. This is in contrast to proposals for light rail, commuter rail, and fixed-route bus systems, where the hope is that the facilities will actually get people out of their cars and off the highways.

One premise of the present study is that jitney services may actually have a better prospect for reducing single occupant vehicle (SOV) automobile usage than fixed route services. Such a prospect is based on the promise of material improvements in efficiency, reliability, safety, and convenience that might be offered by the use of GPS technology.

The cost of such services can be seen to be relatively high. Private taxi services are a good benchmark for envisioning such costs. Most jitney services have public subsidies for all or a major share of the costs. The federal government funds a few of these (particularly those serving persons eligible under the American Disability Act) but most are funded by local sources. Users unable to drive—such as the disabled or the elderly—are the primary justification for government involvement.

The question is, can GPS technology contribute to making these transportation services more available to the general public and more competitive with alternative forms of transportation? Fixed-route systems tend to be heavily subsidized; yet it can clearly be debated whether they effectively help reduce SOV automobile travel and diminish congestion.

GPS technology provides a means of tracking vehicle location more precisely than any previous automatic vehicle locator technology, as described on the following page. Since 1994, GPS increasingly has become adopted by major fixed-route bus systems throughout the United States. One of these is Metro Transit serving the Twin Cities area. Others include Chicago, New York, Detroit, Oakland, Denver, Milwaukee, Portland (OR), Baltimore, and Buffalo. These include a

few small systems, such as Napa, California (with 18 buses). In addition, a few cities in Canada have installed GPS systems, as have cities in Europe and Asia. A recent study estimated that more than 60 bus systems in the United States have adopted GPS technology (U.S. DOT, 2000).

GPS technology promises enhanced transportation services from both a supply perspective and a demand perspective. While no formal evaluation studies have been undertaken, there is reported anecdotal evidence of improved service from the supply perspective. These include:

- GPS enables more effective dispatching procedures and control of vehicle operations.
- Combined with geographic information software and real-time traffic data, GPS enables the plotting of optimal routing of vehicles given the conditions of congestion or weather.
- GPS enables significantly more response time in cases of emergency or accident.

There's been relatively little attention to the potential improvements on the demand-side, although GPS offers an expanded capacity to inform passengers of real-time conditions in terms of vehicle location and anticipated arrivals and departures. Keeping potential customers informed in a real-time fashion has yet to be fully developed. Up-to-date notice boards in the stations of fixed-route systems would be an improvement. This is hardly new, however, nor is it dependent on GPS technology. Metro Transit in the Twin Cities has experimented with such devices in key park-and-ride stations on the I-394 corridor. Others using such notice boards include King County Metro in Seattle and Metro Transit in Halifax, Nova Scotia. Such communications to passengers are fairly routine in European transit systems (such as the Paris subways and the Amsterdam tram system). These systems do not have GPS technology, but through ground-based sensor systems, such information services have been available for many years (GPS, of course, would not be applicable to a subway system). In a demand responsive jitney service, however, it would appear that communications with customers could be direct, personal, accurate, and up-to-the-minute. Should there be a delay for any reason, customers could be notified immediately in their homes by telephone or e-mail. In short, GPS technology can provide significant improvements in operations and also in public transit services marketing.

Thus, the issue to be explored is whether such improvements can both provide greatly enhanced service in terms of convenience and dependability and also be more cost-effective, not only for

large fixed-route bus systems but also for smaller demand-responsive systems.

BASIC FORMS OF PUBLIC TRANSIT SERVICES

A variety of public transit services are available as alternatives to automobile travel or as choices for individuals unable to drive or own a car. One of the disadvantages car drivers see in public transit is the relative rigidity of routes and schedules. One can feel the prisoner of the available stops and times. Another disadvantage is the necessity to transfer to a different vehicle to reach a destination. Still another is the need to wait outdoors in cold or inclement weather. However, flexible services are available and with GPS enhancements could overcome these disadvantages and provide the desired flexibility and convenience.

A full typology of public transit services would include the following:

Fixed Right-of-Way Services—This includes commuter rail, light rail, subway, trolley, and exclusive bus right-of-way. They tend to be the most expensive and the least flexible. They can handle very high volumes of traffic, but they also rely on high-density settlement patterns for both residential neighborhoods and employment centers. By design, they have fixed schedules and fixed headways. They experience efficiency difficulties in most American cities through the need to handle peak loads during the morning and evening rush hours, while much of the rolling stock sits idle in other periods. They offer speed of service since their exclusive rights-of-way mean that they face no competing traffic from other modes. The lack of flexibility makes it difficult for rail services to broadly serve the highly dispersed suburban and exurban settlement patterns that have emerged in American cities in the last 30 to 40 years. Fare structures for commuter rail and light rail tend to be higher than other forms of public transit.

Fixed-route bus services—Fixed-route bus services provide the basic public transit opportunity for most urban areas. Even cities with various forms of fixed-rail service also have extensive bus routes serving their central business districts as well as providing feeder service to fixed-rail station stops. Fixed-route bus services offer more flexibility than exclusive rights-of-way services. Using city streets shared with automobiles, trucks, and pedestrians means that the bus system can cover a wider geographical area and have many more passenger pickup stops. This

wider-area service tends to have a cost in slower service since many routes may stop at almost every block. In using public streets, buses are also subject to the delays of congestion, unless special high occupancy vehicle (HOV) lanes are provided.

In addition, bus systems have historically been designed to serve central business districts. Designing services for low-density suburban job centers and dispersed residential subdivisions has been as difficult for bus systems as for rail systems.

Demand responsive services—Demand responsive services tend to offer the greatest flexibility for public transit service. There are various forms with varying levels of flexibility, including:

- Fixed route-deviation—These services are basically similar to fixed-route bus services with some deviation allowed from the scheduled route. Deviations may involve added fares over and above the fixed route fare.
- Point deviation—These services offer a variety of fixed routes, but they lead to specified checkpoints such as a shopping mall or other employment center.
- Many-to-few—These services have completely dispersed trip origins but a few fixed destinations, such as a medical center or shopping mall.
- Many-to-many—Within a defined service area any origin and any destination may be served.

Demand-responsive services are also flexible in terms of scheduling. These include:

- Flexible-fixed schedule—With these services, customers can become regular subscribers and be picked up on a fixed schedule (daily, weekly) as determined by the customer.
- Advanced request—Trip requests originate from the customer through a telephone call within a fixed amount of time before the trip. A number of services, for example, follow a policy of requiring requests to be called in twenty-four hours prior to the trip.
- Immediate request—Customers may request a trip as soon as possible; in short such a service would be a true on-demand service with real-time scheduling. Such service, of course would be most convenient for passengers, and most costly and complex for providers.

- Flag-down service—This type of service is best exemplified by taxi services in dense urban areas. It is clearly the most flexible of all but also the most expensive to provide. Its feasibility is highly doubtful in low-density suburbs or sparsely populated rural areas.

As noted, many demand-responsive services are targeted towards certain specific client groups including the elderly, those with disabilities, and children (through school bus provisions or special fares on regular public transit).

AUTOMATIC VEHICLE LOCATION (AVL) AND GPS

Automatic vehicle location (AVL) systems date back to the 1960s as an aid to transit system planning and design, dispatching and performance monitoring, and response to emergencies. The systems were adopted more quickly in Europe than in the United States. The Chicago Transit Authority was the first to install an AVL system in 1968 with Federal financial assistance. The early systems used ground installations known as signposts where signposts were located at intersections or stops while buses were equipped with transponders sending a signal to the signpost. These devices were connected to a central dispatch office. Advances in technology included systems whereby buses communicated directly with the central dispatch office through microwave communications. The ground-based Loran-C radio positioning system developed by the United States Coast Guard provided further technological advance.

The Global Positioning System (GPS) is the latest technological advance and provides significantly greater accuracy and flexibility and much lower cost. The system was developed by the United States Department of Defense to provide more accurate and real-time locations of military operations. While system development began in the 1970s, it was not until 1995 that it was fully operational. The system consists of 24 satellites that are configured such that constant visibility from five to eight satellites is ensured from any point on Earth. These are complemented by five control tracking stations located on earth so that the orbital and clock parameters of each satellite are known. GPS receivers mounted in buses or automobiles can thus have their location pin pointed within five meters through triangulation with signals from at least four satellites. (Until recently, the Department of Defense “degraded” the signals as a precaution for national security. This led to so-called “differential” GPS where additional control stations in

a time zone were established to compensate for the error. Five such control stations were located in the upper Midwest. Recently, the DOD decided to stop “degrading” the signals, so that even inexpensive hand-held, or pocket, GPS receivers provide accuracy to within 5 meters or within 15 to 20 feet.) The costs of GPS receivers have lowered in the last few years so that they are quite affordable.

Small pocket receivers are used by hunters, hikers, and boaters and can be purchased retail for as little as \$99. GPS receivers can be purchased for installation in private automobiles together with base maps for as little as \$150. Receivers for buses can run as low as \$300 (as will be discussed in the following pages, this is only a small part of incorporating GPS within a fully integrated control and management system). The receivers can provide both location data and tracking data. Data includes x, y, and z (altitude) coordinates and can be set up in latitude and longitude, UTM, or other projection.

GPS has been used extensively in Minnesota, particularly by state agencies and has been used for everything from basic surveying to tracking hazardous environmental sites to monitoring snow-plowing operations. The use of the technology in transportation has been growing in recent years. GPS provides not only accurate location data but also precise time information. Thus this technology is highly useful for monitoring speed as well as location and, thereby, tracking individual vehicles as well as fleets of vehicles.

In public transportation systems, Metro Transit in the Twin Cities is a good case in point. Presently, about 25 percent of Metro Transit’s bus fleet is equipped with automatic vehicle locators using GPS receivers. This has proven to be beneficial in a number of respects. It provides a central control over keeping buses on schedule as well as determining accurate location in cases where a bus experiences an emergency. It generally provides a far superior system monitoring resulting in improved and on-time service. Data from such real-time monitoring is also useful in scheduling and route planning. Future plans for the use of this technology by Metro Transit include:

- Linking GPS with electronic malfunction diagnostic information for buses that have experienced a breakdown;

- More detailed data respecting fare box information and bus stop passenger counts for improved planning and scheduling;
- Linking real-time data to other transit providers, such as dial-a-ride and other providers; and
- Expanding the installation of GPS to a greater number of buses. (Interview with John Levin, and Gary Anderson, Metro Transit, April 2001.)

Also being considered are plans to improve communications with customers including providing real-time information on the Internet and signs announcing when a bus is scheduled to arrive at a stop.

Small-scale jitney services are frequently found in rural areas or in peripheral parts of metropolitan areas. The following are examples found in the Twin Cities metropolitan area:

- The DARTS system serving northern Dakota County (and currently planning for use of GPS)
- The Anoka County Traveler (a mini-bus system)
- The Hopkins Hop-a-Ride
- The Plymouth Dial-a-Ride
- The South Shore serving communities around Lake Minnetonka
- The Woodbury Dial-a-Ride mini-bus
- Carver Area Rural Transit (CART), Chaska
- Scott County Human Services, Shakopee
- City of Hastings

There are also jitney-type services in many rural communities throughout the state as well as in rural areas in surrounding states. (A full listing of these services in Greater Minnesota is provided in Appendix K.)

The key characteristics where these types of service have advantages are as follows:

- Relative low densities or sparsely settled areas;
- Origins and destinations are variable or do not necessarily fit any pre-established pattern (a key factor given today's trends in urban sprawl);
- Demand densities are not very low and trip distances are not very long;
- Ride-sharing can be used to reduce the cost per trip for each passenger;

THE BASIC TASKS OF SERVICES-ON-DEMAND PUBLIC TRANSIT SYSTEMS

For small paratransit services with fewer than 10 to 15 vehicles, the logistics of providing service on demand can be managed fairly readily with limited technology. This is especially true where the clientele is limited to specific populations (disabled, elderly) and the service area is relatively confined. However, if the flexibility of paratransit services is to be realized, larger scale operations are called for implying highly complex staffing and equipment. GPS technology plays a role, but other advanced technologies are also involved. These include:

- Telephone or Internet technology to handle service requests—For small-scale operations, this is typically handled by telephone calls from clients that are answered by transit service staff. The trip is logged in by hand on preprinted forms. Subscriber trips form the initial foundation for early scheduling. For larger scale operations and for meeting the needs of “immediate request” customers, this task can easily swamp a small staff. It suggests a need for more advanced technologies such as the automatic telephone answering facilities now available and used by airlines, pharmacies, and other service operations that handle a high-volume of service request calls. In addition, trip reservations might also be handled by Internet, as is the case with airline trip bookings.
- Scheduling and Dispatch Computer Software—Again, for small-scale operations, making up the schedule is handled by manual markups that are developed in stages and written up by hand as request calls come in. A number of computer software vendors have developed integrated software such that telephone requests are immediately entered into

the computer and schedules are automatically created and updated. From this, the software can create updated vehicle trip assignments for the entire fleet based on patterns of origins and destinations and time of day. This software is vital if there is to be effective handling of same day requests. The DARTS system in Dakota County installed such software in 1995.

- GIS mapping software for instant map displays of trip origins and destinations—For small operations, trip origins and destinations can be marked on a wall map and dispatch plans developed from that. As the volume of trip requests increase however, this can become a very labor-intensive task and subject to error. Accordingly, many paratransit services are adopting GIS software that permits instant geocoding of trip requests and rapid map displays of request patterns. This software also has the ability to quickly analyze the most efficient routes for each vehicle in the fleet within the service area.
- Communication Systems—In the actual delivery of transportation services, the ability for communication between the central dispatch office and the fleet under its control is a central task for every public transit system. For many years, these communications have been handled by voice radio. This provided only a limited amount of information and had reliability problems. Present day communications systems include the ability to transmit both voice and data. An automatic vehicle location (AVL) technology is vital for this task and, in today's terms, this usually means GPS. In larger, fixed-route bus systems, this technology can include not only a vehicle's location, but also data about adherence to schedule, the mechanical conditions of the vehicle, passenger exit and entry at stops, and fare collection information. This is frequently referred to as Automatic Vehicle Management (AVM).
- Ability to adjust for unforeseen contingencies—In the course of delivering transportation services, many contingencies arise that can create problems in maintaining a schedule. Last minute cancellations, unforeseen construction sites, delays due to accidents, and many other events may require dispatching adjustments during the course of a day. Thus, AVL and AVM technologies are important for dynamically adjusting for these contingencies. These technologies are also important in helping communicate to customers how they might be affected by the contingencies.

- Ability to respond to emergencies—One of the often-cited advantages of AVL technology is the ability to respond quickly in cases of emergency or accident. With the technology precisely pinpointing the location of the vehicle and the nature of its problems, correct and immediate responses can be made.

The DARTS service provided in Dakota County offers an example of the tasks involved in demand-responsive service delivery for even a small agency. This agency offers regular service from 8:00 a.m. to 4:00 p.m., Monday through Friday. For persons older than 60 and those with disability, DARTS provides door-to-door service seven days a week. Evening service to connections with Metro transit is provided for ADA clients. DARTS has a fleet of 25 vehicles. Its ridership includes standing order (or “subscription”) trips and demand trips. Standing order trips are those occurring at the same time and on the same day on a reoccurring basis. Demand trips are those that do not reoccur on a regular basis. Each vehicle is scheduled for approximately four driver runs per day. Each run includes approximately six client pickups. For the DARTS system, approximately half of each run is devoted to subscription trips.

Demand trip booking involves scheduling trips that are requested by telephone. Prior to the installation of computer-aided scheduling and dispatching, such trips were required to be requested at least twenty-four hours in advance (but no more than a week in advance). Thus the one-week pre-schedule was incrementally adjusted as calls were received. The full schedule for each vehicle on a given day was thus determined on the previous day. Same-day trip requests were accepted and filled only on the basis of cancellations.

By adopting computer-aided scheduling and dispatching, the agency developed an enhanced capacity to accommodate same-day trip requests. Much of the handwork involved in scheduling was eliminated, permitting more time for customer service activities. The software, using triangulation algorithms, produces better schedules than those produced manually and do so much more rapidly. This allows for more trips to be served within the same revenue vehicle miles/hours (or an equivalent number of trips can be served with fewer revenue vehicle miles/hours).

As of this writing, the agency is in the process of signing contracts to implement the introduction of GPS to the system.

THE ROLE OF GPS TECHNOLOGY IN SERVICE-ON-DEMAND PUBLIC TRANSIT

As can be seen from the previous section, GPS technology is a vital part of an overall integrated technology package designed to significantly enhance demand-responsive transit services. It should be emphasized that such integration is essential since GPS receivers offer substantial quantities of real-time location and tracking data that needs to be encoded and transmitted from the vehicle and then received, decoded stored, interpreted, and analyzed at a central control facility. This data has immediate, real-time utility as well as long-term management and planning value.

Although there appears to be no formal evaluation of systems that use GPS as their AVL technology, in terms of real-time utility, GPS is expected to have potential for:

- improving schedule adherence
- improving service efficiency
- improving information accuracy and availability
- providing customers with real-time service information
- improving safety on buses
- improving response time to incidents and emergencies

In terms of long-term management and planning, GPS technology is expected to enhance opportunities for:

- improving analysis of peak and off-peak loads
- providing more accurate trip data as to patterns of origins and destinations
- offering better cost analysis and financial accounting data
- improving overall system planning for trends in customer demand
- improving vehicle maintenance efficiency
- reducing the number of field supervisors
- facilitating system integration

GPS is not a magic bullet, however. The technology has limitations. Receivers need constant exposure to at least four satellites. Thus, signals get degraded and sometimes eliminated in with tall buildings in high-density business districts. The same is true in heavily wooded areas with high, full tree canopy. GPS receivers obviously work not at all in tunnels. Dense cloud cover or fog may also degrade signals. Thus, GPS makes optimal contribution in developed low-density suburban areas and open (not heavily forested) rural areas.

COST EFFECTIVENESS OF GPS TECHNOLOGY IN SERVICE-ON-DEMAND PUBLIC TRANSIT

The critical issue is clearly whether these technological improvements cannot merely be financially feasible but also must be instrumental as a major force in significantly reducing costs. There's some limited data on the cost of demand-responsive jitney services—and as expected, the cost per revenue passenger mile tends to be rather high. From the limited data, we have gathered thus far, such services are more expensive than those of fixed-route bus systems, but this conclusion needs to recognize that there's great variability in the quality of the data. While there are numerous parameters influencing costs that depend upon local conditions, a real demanding test of GPS technology will be whether flexible, demand-responsive public transportation services can not only compete with existing fixed route systems, but also have some influence in competing for the patronage of present SOV auto drivers.

Data on costs for GPS technology is difficult to obtain. The most recent study of the Transit Cooperative Research Program (TCRP) of the Traffic Research Bureau (1997) provides the results of a survey undertaken of 29 fixed-route bus systems throughout the United States. For those systems that reported cost data, the average per vehicle cost for some form of AVL system (ground sensors, radio systems, or GPS), as reported in the survey was close to \$14,000 per vehicle. These costs need to be viewed with caution, however, as it was not clear that all transit agencies were reporting costs in a uniform manner. Thus, the standard deviation was almost \$8,000. (Full costs could have included the costs of software, GIS data base support, telecommunications, training (supervisors, dispatchers and operators), customer services and equipment maintenance and upgrading. Survey respondents did not always report full costs. One software vendor gave an informal estimate in 2001 of \$50,000 per vehicle, including all of the

costs cited here.) Part of the wide variation can not only be attributable to reporting inconsistency, but also given the fact that the agencies reported a wide variety of AVL systems, with many still using ground sensors or radio systems.

The study noted that the actual cost of a GPS receiver and antenna is in the vicinity of \$300, as of 1997. What increases the costs of GPS deployment is the extensive infrastructure needed to effectively manage and use the considerable volume of data generated by the GPS receiver. Thus, there is need for integration with the communications technology as well as a variety of interface components. Most systems use software that entails interfaces with dispatch scheduling and control functions including radio and telephone systems, databases, mapping software, as well as linkages to other departments within the transit agency and to other connecting transit providers. The report estimates that central control hardware, software, and interfaces run to about a third of total procurement costs in deploying GPS. Communication system costs can run equally as high.

In the survey, 13 of the 29 systems reporting were involved with GPS. Five systems were operational with GPS, five were in the implementation stage and four were in the design or planning stage. Their cost figures (shown in Table 2.4) appear to be more consistent with each other, particularly for those systems that were either operational or in implementation. For these agencies, the mean cost per vehicle was reported as \$12,800 for agencies that were operational and \$12,500 for those in implementation. For those transit systems planning to introduce GPS, the mean cost reported was \$22,700—substantially higher than those already using or implementing GPS.

Table 2.4 Costs for Transit Systems Having Adopted or Are Adopting GPS

Transit Systems Having Adopted or Are Adopting GPS				
<i>System Name</i>	<i>No. Vehicles</i>	<i>Total Cost</i>	<i>Cost/Vehicle</i>	<i>Stg of GPS adoption</i>
The Vine, City of Napa (CA)	18	130,000	7,222.22	Operational
Lackawanna Co. (Scranton, PA)	32	357,935	11,185.47	Operational
Metro Transit, MetCouncil (Mpls)	80*	1,500,000	18,750.00	Operational
Milwaukee County (WI)	541	7,800,000	14,417.74	Operational
Denver Regional (CO)	900	11,000,000	12,222.22	Operational
AVERAGE FOR OPERATIONAL CITIES			\$12,759.53	
<hr/>				
SMART (Detroit, MI)	400	2,700,000	6,750.00	Implementation
Metro Dade Transit (Miami, FL)	614	14,000,000	22,801.30	Implementation
Tri-Met (Portland Oregon)	630	6,600,000	10,476.19	Implementation
Mass Transit, Baltimore (MD)	844	8,100,000	9,597.16	Implementation
AVERAGE FOR CITIES IN IMPLEMENTATION STAGE			\$14,291.55	
<hr/>				
City of Raleigh (NC)	52	600,000	11,538.46	Planning
New York City Transit (NY)	170	5,230,000	30,764.71	Planning
Sun Tran (Tucson, AZ)	200	3,500,000	17,500.00	Design
NFTA (Buffalo, NY)	322	10,000,000	31,055.90	Design
AVERAGE FOR CITIES IN PLANNING OR DESIGN			\$26,440.20	
<hr/>				

Source: Transit Cooperative Research Program (1997).

AVL Systems for Bus Transit: A Synthesis of Transit Practice. TCRP Synthesis 24.

Washington, DC: Transportation Research Board, National Research Council.

* At the time of the TCRP report, Metro Transit in Minneapolis had 80 buses with GPS.

Today Metro Transit has 250 buses with GPS equipment.

A more recent publication of the ITS Program of the United States Department of Transportation found similar variability. Six transit agencies in large cities were studied of which five had installed some form of GPS. Unit costs ranged from \$6,800 to \$30,500. The average per-bus cost for all six systems was about \$15,500. Again, it is not clear if all respondents were including exactly the same cost elements, but they did include basic features such as software for computer-assisted dispatching, mobile data terminals, remote diagnostics, and limited automated passenger information. The per-vehicle cost was based only on the actual number of vehicles equipped with GPS.

A recent interview with representatives of the Spokane, Washington, Transit Authority indicates areas where costs may be reported differently. That agency operates 100 vehicles, all equipped with GPS receivers as their AVL system. They cover all of Spokane County (370 square miles) and provide approximately 1,700 rides per weekday (or 170 per vehicle per day). Annually, their ridership is 4,300 per vehicle. They provide same-day service on a space-available basis. Their costs for their AVL system came in quite low in comparison with the systems described in the previous paragraphs—approximately \$2,500 per vehicle (the GPS receiver was \$295). However, the Authority used a considerable amount of existing equipment through modifications. Their radio system, for example, was modified for about \$100 per unit. Their software license was one of the lowest costs among the vendors selling such software. They needed to purchase only a small number of new workstations.

An earlier TRCP report (1995) provides an analysis of rural systems with federal assistance under the United States Department of Transportation's Section 18 Program. These systems are in keeping with the focus of this study. They are primarily demand-response systems with some scheduled services and a few fixed-route services often in conjunction with demand-response services. The 1995 study, however, does not directly address the question of AVL equipment and the financial figures are from 1993—a time when GPS technology was in its infant stages.

Despite their limitations, the data does provide some framework for overall fiscal parameters for the types of services of concern. Focusing only on the Section 18 transit services in the Midwest region (about 25 percent of the national total of Section 18 agencies), median ridership is approximately 7,000 riders annually per vehicle with an annual budget of approximately \$32,000 per vehicle (in 1993 dollars; about \$35,000 in 2001 dollars). (Eight Minnesota transit services participated in the 1993 survey. Lincoln Heartland Express, Ivanhoe; City of Hastings; Hubbard County Heartland Express, Park Rapids; Douglas County Senior Citizen Program, Alexandria; Carver County Transportation, Chaska; Arrowhead Transit, Virginia; Red Wing Transit Service, Red Wing; City of Hutchinson.) One again, the data is highly variable, but calculating over all of the Midwest demand-responsive services it would appear that a single rider costs approximately \$2 in current dollars. Again, this is a median value derived from highly variable data. (Douglas County was one agency singled out as a "Top Performer" in 1994. Their cost per mile the

previous year was \$0.81 as compared to the national median of \$1.51 and their cost per hour was \$4.12—even more significantly below the national median of \$19.88 [all figures in 1993 dollars]).

The crucial point is that these largely rural, demand-responsive services run on very tight budgets. In many instances, federal, state, or local subsidies are involved. GPS can very likely help significantly in lowering costs while raising the quality of service. However, at this point in time, upfront investment costs of something in the order of \$12,000 to \$16,000 per vehicle appear to be quite formidable without some form of external funding assistance. Lacking such assistance, these costs could imply an increased cost per rider of 40 to 50 cents (depending on financing arrangements).

THE POTENTIAL FOR BROADENING THE MARKET FOR SERVICE-ON-DEMAND PUBLIC TRANSIT

In overall perspective, the costs cited above are minimal in comparison with the investment in highway facilities and the costs of automobile congestion. There are also distinct cost advantages for potential customers. From the perspective of an individual household, operating a standard automobile in the \$15,000 to \$20,000 range can run between \$4,000 to \$6,000 per year including amortization of the car loan (or lease), insurance, vehicle registration, maintenance, and gas and oil. A fare of \$2.00 using a dial-a-ride service for door-to-door commutation to work would cost just over \$1,000 per year. (Technically, for what an automobile costs per year, a commuter could pay a fare of \$10 per ride to spend the equivalent amount.)

From the discussion, there are still difficulties in adopting GPS and related technologies based on the experience of systems that have adopted them. In almost every instance, procurement and implementation of the equipment and software took longer than expected. This is less a problem with GPS equipment than it is with the integrating software. Only a few vendors have developed the necessary software packages, and in many instances, software design was customized on site at the time of implementation. As more experience is gained, however, these problems should likely diminish. As noted above, fixed-route bus systems now in the planning and design stage quoted higher unit costs than those systems already operational. Despite the general lowering of

hardware costs, this may actually be a result of more experience, especially on the part of software vendors.

Another limitation in terms of the time involved in implementation is the extensive training needed for all personnel, including drivers, dispatchers, supervisors, administrators, and managers. While the operation of a single GPS receiver is fairly straightforward, training personnel in terms of using the scheduling, dispatch, GIS, and financial software—in short, the overall AVM system—can be time consuming. Reported implementation periods of six to nine months were reported in the 1997 TCRP Report.

From this experience, it would appear that most of the implementation tasks that have been reported for fixed-route bus systems are also within the range of feasibility for demand-responsive services. Two key issues remain, however: (1) can demand-responsive services develop the communications with customers that will make such services truly competitive, and (2) since such services at present operate with relatively small fleets and limited service areas, can economies of scale be realized with significantly larger fleets and service areas?

(1) The challenge of communicating with customers is the critical one if services-on-demand systems are to be successful in marketing themselves as a dependable, convenient, and pleasant alternative to a private automobile for local trip-making to work*, shopping, medical appointments, church, etc. *(It would seem likely that very long commutes to work—involving 15 minutes or more—would not prove viable for services-on-demand systems. Transportation data for the Twin Cities reveal that most work trips, however, fall within the 10 to 20 minute range. Work trips from suburban home to suburban job would appear to be prime candidates for services-on-demand systems.) Technology is developing for fixed-route systems in terms of notice boards within station stops and special dial-up telephone services in key locations such as shopping malls, medical centers, or industrial parks. Fixed-route systems also offer Internet Web sites; although, real-time information on such sites has yet to be developed. The challenge for services-on-demand systems, however, is to develop more direct communication with individual customers through automatic telephone services, or e-mail, or both. (A recent product being marketed may provide additional opportunities for customer communication. Magnavox has come out with a cell phone with a built-in GPS receiver so that a call-in request for service could

immediately pin-point and map the caller's location.

See: <http://offer.technoscout.com/cgi-bin10/flo?y=mL760CDNSa0FzC0OvW0B8>)

(2) As noted in the previous paragraph, integrated services-on-demand can likely best function in developed suburban areas and open (non-forested) rural areas from the perspective of optimal development of AVL data using GPS technology. These types of areas are the very ones that fixed-route systems have the most difficulty in serving. Highly dispersed points of origin and destination are key problems, even when the fixed-route system offers special “park-and-ride” lots in suburban locations. The key question is whether services-on-demand systems can expand fleet sizes and service areas in a manner that can realize economies of scale while still providing enhanced dispatch and control management. The data from the 1997 TCRP report does not provide clear answers to this issue. There is no statistical association between unit costs of implementation and fleet size—if anything, smaller systems tended to have lower unit costs. There is insufficient experience to forecast the impact of size on efficiency in annual operating, maintenance, and upgrade costs. Thus, the optimum scale of operation, in terms of either fleet size or geographical service area, cannot really be determined without further experience.

There would appear to be promise for further experimentation with services-on-demand transit services through additional pilot programs such as one now going on with the Smart DARTS program in Dakota County. The program involves the participation of the Federal Highway Administration, the Minnesota Department of Transportation's Office of Transit and Guidestar Program, the Metropolitan Council, and other sponsors. In this program, DARTS is about to implement GPS technology. An evaluation of the program, similar to that undertaken for the 1995 installation of scheduling and dispatch software, should include particular attention to the system's ability to handle same-day trip requests. The program might also be broadened to design a system with advanced communications technology as well as an expanded marketing effort.

In conclusion, the promise of GPS as an aid to services-on-demand public transportation is yet to be tested. GPS as an aid to regular fixed-route bus systems is still in its infancy, but there is growing evidence that the technology is materially enhancing the quality, dependability, safety,

and efficiency of such systems. Its promise for services-on-demand systems would appear to be even greater with the possible provision of public transit services in areas and communities that fixed-route systems cannot easily serve.

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Monetized Benefits of a Zero-Death Scenario

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INTRODUCTION

From one viewpoint, monetizing the benefits to society of reducing automobile fatalities is an extremely simple exercise. One simply looks up the dollar value ascribed to each fatality published by the National Safety Council (NSC) and multiplies it by the number of fatalities saved. So the benefits of a program that reduce the number of fatalities by x is $3,200,000x$ dollars.⁽⁴³⁾ Other values may be added if the program will reduce other types of injuries. If y is the number of incapacitating injuries that are saved by a program, and z is the number of noncapacitating injuries saved, the total program benefits given NSC figures is:

$$3,200,000x + 159,000y + 41,000z$$

However, when one begins to look behind the numbers, difficulties with the methodologies used in coming up with the value of a human life make it difficult at best to ascribe a set value therefore to evaluate programs designed to reduce fatalities. The discussion will be broken down into three sections. First, we will discuss the most common methodologies used to assess values of intangibles like the value of life. Second, we will talk about criticisms that have been leveled against these methodologies. Last, we will discuss the implications of these criticisms for the practice of valuing benefits of life-saving programs.

In order to understand the problems faced by analysts in trying to value programs, one needs to realize that there are really two broad categories of benefits generated by any program. Tangible (sometimes called use) benefits derive from someone actually using the good or service provided in the program. Intangible (or non-use) benefits derive from the mere presence of the good or

service. An individual realizes intangible benefits from the program without intending to use the good or service that the program provides.

Intangible benefits can be broken down into five categories:

1. Existence value is the value obtained by an individual from the knowledge that a good or service exists (or is protected in the case of an important resource);
2. Vicarious value is the value that an individual obtains from the knowledge that others consume a resource;
3. Option value is the value obtained from having an option to enjoy the good or service later;
4. Quasi-option value is the opportunity value that an individual obtains by delaying a decision that would result in irreversible losses without the presence of the good or service; and
5. Bequest value is the value that an individual in the current generation gets from preserving a resource for the use of future generations.(44)

The important value that analysts try to measure when defining a public program is the “willingness to pay” for a program. This value defines the marginal social benefit of a program and thus produces the value to which costs must be held if an efficient level of public good is to be produced.(45) For private goods, both tangible and intangible values are incorporated into the purchase price of the good or service. Individuals purchase the quantity of goods or services at which the market price equals the benefits received from consumption. But for public goods, there is a fundamental problem. Public goods are goods (or services) where consumption is nonrivalrous (one person’s consumption of the good or service does not reduce another person’s consumption), and exclusion of people that do not pay for the good or service is infeasible. These characteristics lead to the free-rider problem—individuals can consume the good or service without paying. In this case, the price that individuals are willing to pay must be deduced from other evidence, because individuals have an incentive to understate what they are willing to pay for the public good or service.

There are two broad methods that researchers have used to try to deduce citizen's willingness to pay for public goods or services: revealed preference methods and stated preference methods. Revealed preference methods attempt to make inferences about citizen's willingness to pay for public goods by examining decisions made about similar goods or services available in the private sector. Within this broad method, there are two similar techniques of analysis. Cost analysis uses the prices of market goods to estimate the value of public goods. For example, one cannot measure the value of police services directly. However, one can use what is paid for private security services as a proxy. (Of course, one must adjust this for the presence of economies of scale and scope along with other variables likely to affect the choice to get private security services.) Hedonic pricing resembles cost analysis in that the price of market goods is used to estimate the value of public goods. However, hedonic pricing breaks down the private market good into a collection of characteristics. Returning to the police service example, one could break the private security services down by frequency of patrols, capabilities of the patrols (for example, whether the patrols also do emergency medical services), and qualifications of the personnel used in patrols. One can then estimate through regression analysis what each of those characteristics adds in value. Often times, by concentrating only on the features of a private good that are relevant to public goods, a more accurate measure of the value of public goods can be found.

The second broad method of determining willingness to pay is the stated preference method. This is an extremely direct method of determining value. In essence, individuals are "asked" what they would pay for a nonmarket good or service. The questions asked in a stated preference study generally are based on scenarios or options constructed by the researcher.⁽⁴⁶⁾ Within the area of stated preference techniques, there are two techniques that are most commonly used to assess value: contingent valuation methods (CVM) and conjoint analysis. CVM is the most commonly used method of determining willingness to pay for nonmarket goods. The technique consists of surveying individuals concerning their willingness to pay (WTP) for certain goods or services or surveying individuals willingness to accept (WTA) the loss of a certain nonmarket good or service. Conjoint analysis also surveys individuals. However, a conjoint analysis survey asks individuals to make choices or rankings of the attributes of a good or service. By analyzing the rankings and values assigned to the attributes, researchers can build a picture of the total

value of a good or service through determining the total value of a given package of attributes. In this way, conjoint analysis resembles the revealed preference technique of hedonic analysis.

The two most common ways to assign values of human life for purposes of valuing public programs are cost analysis and CVM. The National Safety Council values cited in the first paragraph of this paper were created using cost analysis of “what people actually pay to reduce their safety and health risks.” This methodology has many potential problems. First, one must draw an extremely large sample as markets for risk reduction products and services may not be complete in some areas. Second, the mere analysis of costs of risk reduction products and services ignores the many different attributes of those products. It is possible that what is actually being purchased is some relative assurance that risks are reduced to an acceptable level.

A more fatal flaw in cost analysis is that one is measuring not only willingness to pay, but also ability to pay when using a simple cost analysis. A critical assumption of this model is that individuals can pay more for increased quantities of risk reduction. However, if individuals are constrained by income or by perceptions of price, the level of risk reduction obtained may be below what individuals consider optimal. They are willing to pay more, but cannot. This problem is exacerbated because of economic problems in markets for insurance type products. Adverse selection in these markets causes the price paid for insurance products to be higher for those that are *ex ante* higher risks.(47)

There are plenty of questions surrounding the valuation of human life, especially as it is measured through cost analysis. However, all methods of valuing nonmarket goods have uncertainties associated with the values produced. For example, a recent summary of studies of the value of life indicates that the studies produce results with a range of values from just over £100,000 to nearly £100,000,000 (U.S. \$146,330 to \$146,330,000 given current exchange rates).(48) The best advice that could be given to practitioners may well be to acknowledge the uncertainty associated with value of life calculations and insert a range of values. The study cited above suggests using ranges of \$1,400,000 to \$14,000,000 (converted from £ and rounded). This would suggest that the values offered earlier must be within a range with a width of 10 times the

low estimate, with a low estimate of around 40 percent of the NSC figures. Therefore, the low estimate of benefits would be:

$$1,400,000x + 64,000y + 16,000z$$

and the high estimate of benefits would be:

$$14,000,000x + 640,000y + 160,000z$$

There are obviously other ranges of benefits that could be generated. The important thing is to acknowledge and not minimize the uncertainty associated with calculating program benefits. Not acknowledging or minimizing this uncertainty could lead citizens to support or oppose a program based on a false sense of accuracy over the benefits of the program.

In order to project the total benefits of reducing accident related deaths and injuries, one must get accident data and project forward the expected deaths of a no policy change decision. Using year 2000 statistics collected by the state of Minnesota(49), accident related deaths and injuries were projected forward using a combination of methods. The following estimate of total benefits from the reduction of traffic fatalities to zero were produced:

- Low estimate: \$ 23,573,620,711
- High estimate: \$235,736,207,113(50)

Description of the Mobile GPS Devices

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In today's highly advanced technical world, a number of applications of the GPS technology have been developed to provide significant convenience and benefits for travel, work, and recreational purposes. Specialists from marine, aviation, and cartographic spheres have already discovered great potentials of GPS technology. In addition, inland transportation has started to use the GPS for traveling in the United States and other places of the world. Demand for location-based services such as GPS-assisted emergency service and route direction guidance for motor vehicle users has increased recently.(51)

Despite rapid integration of the GPS technology, its application remains undiscovered for some modes of transportation. This short study has a goal of exploring features of the GPS products designed specifically for travel use by pedestrian and bicyclists, in particular.

One of the greatest opportunities in the GPS technology and biking is a provision of travel information in interstate bike routes. Route direction options provided by GPS technology such as bike map, "turn by turn" voice/map instructions, help to make trips more convenient and enjoyable.(52) Pre-travel planning of trips to various geographic places has become feasible due to the possibility of downloading additional maps, if base maps in the GPS device are insufficient. Technical advancements have eliminated a necessity to look up hard copies of yellow pages for information about bicycle shops, grocery stores, and errand and recreation destinations as the GPS products provide this type of travel information.(53) Moreover, the GPS can become important in addressing the safety issue for bicyclists en route and pedestrians as well. In case of injury or any other emergency, location information obtained by the GPS technology can greatly accelerate access to help.

The use of GPS technology for bicyclists and pedestrians needs more research as a number of benefits exist. For instance, the cost of commuting by car can be compared with the cost of commuting by bicycle.(54) Use of the GPS device can help to estimate the costs of commuting and the result of the comparison would support the sustainable transportation argument.

Development of new products integrating the GPS technology offers large area for the study of GPS applications. One of examples of the integration is a placement of the GPS technology in helmets for alerting local emergency crews of an owner's accident and compile statistics.

The following descriptions of four types of the GPS products, which are currently available on the market, provide the most important information. More detailed information on performance is given in a form of matrix (see Appendix L).

Casio Pathfinder GPS Wristwatch—It is one of the world's first wristwatches designed to receive and process data from the GPS satellites. The wristwatch comes with built-in receiver that picks up signals from the GPS satellites. Functions of Pathfinder include timekeeping mode; a positioning feature that displays current latitude and longitude; and a GPS navigation feature that graphically shows the direction and distance to a desired destination. Casio's chip design creates a very low voltage drive circuit that provides more than 720 one-shot GPS measurements on a single CR2 lithium battery.

GARMIN GPSIII+—The GPSIII+ features a base map covering most major highways and interstates in the United States, and it accepts detail map downloads from map source CD-ROMs. The drawback of this design is that the 2-MB internal download memory is not expandable. The GPSIII+ can be mounted horizontally or vertically on motorcycles (bicycles) by a special mount set, which significantly contributes to convenience of using this device while moving.

eTREX—eTREX is also called "a small wonder" as it is featured with capability to receive 12 parallel channels and put information into a six ounce package fitting in the human palm. The design allows one-handed operation without obstruction of view of the display. Bright yellow

case makes easier to find in the backpack or boat. One of the best characteristics of the eTREX is maintenance of tight satellite connection in forest-like conditions.

GARMIN'S NavTalk[®]—GARMIN NavTalk represents a new generation of the portable GPS devices, which combines an analog cellular phone and a full-featured GPS receiver. As the cellular phone, NavTalk has exceptional features as touch-tone location reporting, including the ability to send an exact position and have it displayed on another unit. NavTalk's GPS position reporting shows exactly the location from where a call is coming. The GPS receiver technology is the same 12-parallel channel receiver as in the GPSIII+. NavTalk has an extensive internal database that includes road network of the United States, Canada, and South America.

Telecommunications & Information Society Policy Forum

Sponsored in part by the State and Local Policy Program (SLPP) at the Humphrey Institute of Public Affairs, the April session of the Telecommunications & Information Society Policy Forum (TISP) was held Friday, April 27, 2001 at the Humphrey Institute. Transportation and other professionals with a background in telecommunications, wireless, and GPS were invited to present at the meeting entitled “Roundtable on Applications and Issues in Wireless Telecommunications.” Many of the presentations reflected the presenters’ work with the SLPP’s study on “Transportation Technologies for Sustainable Communities,” which is supported by the Center for Transportation Studies (CTS).

Steve Bahler, from the Minnesota Department of Transportation (Mn/DOT), started the roundtable by reviewing the different levels of GPS, its accuracy, and its respective uses. For example, standard GPS technology has a 3- to 15-meter accuracy, which is used in emergency vehicle management, in-vehicle driver assistance, and commercial vehicle taxation. More highly accurate GPS has a 1- to 3-centimeter accuracy and is used for surveying purposes, vehicle guidance, and railroad crossing indicators.

Next, Dick Bolan, Professor Emeritus at the Humphrey Institute, presented his research on the potential for GPS technologies to enhance jitney services as a viable, demand-responsive transit mode. He defines these jitney services as a mode of transit that does not follow a fixed route—such as taxis, van circulators, and dial-a-rides. He believes that if jitney services use GPS/wireless technology to improve their reliability and safety, they may be able to serve SOV drivers better than standard fixed-route services. This could be accomplished by using the technology to provide riders with real-time information, such as the service’s arrival time and the approximate length of route. Bolan stated that this type of technology would be most effective for varied routes in low-density areas

Mn/DOT’s Bicycle and Pedestrian Design Engineer, Mark Lober, presented the next topic, “GPS and Wireless Use for Bicyclists and Pedestrians.” He highlighted how bicyclists could use GPS

to help plan route choices and destinations, such as areas with secure bike racks and shower/locker rooms. He said GPS could also be used en route to provide both bicyclists and pedestrians with maps, destination, and weather information, and that motorist and bicyclists with transponders could be used to inform drivers of a bicyclist's location, thus enhancing safety.

Frank Douma, Research Fellow at the Humphrey Institute's State and Local Policy Program, reviewed legal and safety issues surrounding wireless applications. Specifically, he highlighted certain legal loopholes. For example, although the state is not allowed to disclose personal information about motor vehicles, there is a considerable ambiguity regarding what is considered "personal information." In addition, he mentioned safety issues associated with distraction due to wireless phones and in-vehicle telematics. Finally, Douma suggested industry self-regulation, user education and responsibility, as well as government regulation and sanction, as possible solution models.

Dee Ryberg, of AT&T Wireless Services, discussed how the efforts of the Minnesota Wireless Foundation are working to reduce driver distractions by promoting the safe and responsible wireless phone use. This foundation comprises companies that manufacture and provide wireless services, as well as law enforcement agencies, consumer safety organizations, and transportation organizations. This group is currently confronting inattentive driving by providing pamphlets entitled "Safety—Your Most Important Call" with the purchase of new cell phones. They are also a member of the Distracted Driver Billboard Partnership, which sponsors billboards that promote awareness of driver distractions, such as eating, children, and wireless communications.

Mark Erickson discussed how his Five Community (5Comm) advanced telecommunication project works as a proto-type in helping small, rural communities integrate new telecommunication models into their everyday activities. He feels that this new technology can help rural areas become better connected with their neighbors as well as distant cities and nations. 5Comm also provides its five rural communities with comprehensive computer education, as well as advanced training, in order to ensure that the residents are able to take full advantage of the telecommunication options now available to them.

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38. ITS America’s Fair Information and Privacy Principles are the following:
1. *Individual centered*. Intelligent Transportation Systems (ITS) must recognize and respect the individual’s interests in privacy and information use.
 2. *Visible*. ITS will be built in a manner “visible” to individuals.
 3. *Comply*. ITS will comply with applicable state and federal laws governing privacy and information use.
 4. *Secure*. ITS will be secure.
 5. *Law enforcement*. ITS have an appropriate role in enhancing travelers safety and security interests, but absent consent, statutory authority, appropriate legal process, or emergency circumstances as defined by law, information identifying individuals will not be disclosed to law enforcement.
 6. *Relevant*. ITS will only collect personal information that is relevant for ITS purposes.
 7. *Anonymity*. Where practicable, individuals should have the ability to use ITS on an anonymous basis. Commercial or other secondary use. ITS information stripped of personal identifiers may be used for non-ITS applications.

8. *FOIA*. Federal and State Freedom of Information Act (FOIA) obligations require disclosure of information from government maintained databases. Databases arrangements should balance the individual's interest in privacy and the public's right to know.
9. *Oversight*. Jurisdictions and companies deploying and operating Intelligent Transportation Systems should have an oversight mechanism to ensure that such deployment and operation complies with their Fair Information and Privacy Principles.
<http://www.itsa.org/8525659B0064A9EE/0/BEFDF519D916C0818525629300551633?Open> (last visited August 22, 2001).
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CHAPTER 3

SUSTAINABLE BEST PRACTICES

Transportation Demand Management for Inter-Regional Corridors

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TRANSIT ORIENTED DEVELOPMENT AND INFRASTRUCTURE ISSUES

On July 25, 2001, the State and Local Policy Program (SLPP) staff made a presentation to the Mn/DOT Office of Environmental Services about major concepts and best practices for the Transportation Demand Management (TDM) programs. As the TDM programs cover a variety of solutions, the Mn/DOT staff expressed its interest in furthering a study of Transit Oriented Development (TOD) projects. Infrastructure issues in the TOD strategy were of particular interest.

In a process of studying the TOD strategies, we found that there was a set of common principles upon which TOD (or traditional) neighborhoods could be built or developed in existing cities. Investigation of the best practices revealed a number of common design features in the traditional neighborhoods. In addition, we noted several positive effects of TOD strategies that would benefit both the community and the environment.

KEY ELEMENTS OF TRANSIT ORIENTED DEVELOPMENT

In the 1920s, zoning for separate uses of land became a basic pattern in modern city planning.(1) Planners and policymakers concerned with public health guided to locate polluting and noxious industries away from residential places. However, application of the rule of separate uses was taken to an extreme in many development projects, including education, retail, and office amenities. A development pattern that might be defined as low-density sprawl has resulted and has been blamed for a number of societal problems: congestion, air pollution, wasteful land use, and unsafe urban life.

An answer to this low-density development is TOD. By definition, TOD is a way to design residential and commercial areas to maximize access by transit and non-motorized transportation. The TOD strategy provides a number of potential benefits: convenience to consumers (people who live, work, or shop in a particular area), area revitalization, accessibility, and sustainable development, among others. The success of TOD implementation is usually evaluated by time, comfort, and financial cost of travel for local residents and employees.(2) Since people desire to reach things at minimum cost and with maximum choice, areas developed according to TOD design principles may become very attractive places to live and work.

TOD Principles

TOD principles are also called the Ahwahnee Principles, (3) and include the following:

1. All planning should be in the form of complete and integrated communities containing housing, shops, work places, schools, parks, and civic facilities essential to the daily life of the residents.
2. Community size should be designed so that housing, jobs, daily needs, and other activities are within easy walking distance of each other.
3. A community should contain a diversity of housing types to enable citizens from a wide range of economic levels and age groups to live within its boundaries.

4. Businesses within the community should provide a range of job types for the community's residents.
5. The location and character of the community should be consistent with a larger transit network.
6. The community should have a center focus that combines commercial, civic, cultural, and recreational uses.
7. The community should contain an ample supply of specialized open space in the form of squares, greens, and parks whose frequent use is encouraged through placement and design.
8. Public spaces should be designed to encourage the attention and the presence of people at all hours of the day and night.
9. Each community or cluster of communities should have a well-defined edge.
10. Streets, pedestrian paths, and bike paths should contribute to a system of fully-connected and interesting routes to all destinations. Their design should encourage pedestrian and bicycle use by being small and spatially defined by buildings, trees, and lighting, and by discouraging high-speed traffic.
11. Wherever possible, the natural terrain, drainage, and vegetation of the community should be preserved with superior examples contained within parks or greenbelts.
12. The community design should help conserve resources and minimize waste.

Pedestrian and Bicycle Amenities

A plan that incorporates these principles can greatly assist in building complete, coherent neighborhood units with pedestrian scale, all amenities, and services at hand. Planners can assign more open spaces to public needs and make wider sidewalks the focus of city/neighborhood life. In addition, a TOD plan promotes social mix and works for solving many ecological issues. Of course, every development and construction plan should be specific to the area, reflecting a continuity of its history and culture.

An examination of TOD neighborhood design details shows that many trips remain within the area and do not impact arterial or regional roadways.(4) As different service utilities are in a close proximity, most of the trips are short enough to be made by walking or riding a bicycle. The design considers a sidewalk as a focus place of public life,(5) elements of TOD, such as frequent and safe crossings, narrow streets, and placement of trees and houses closer to the roadway, all help reduce traffic speed and create a comfortable environment for pedestrians. To encourage non-motorized travel, planners can also integrate separate bike lanes into the streetscape of the TOD neighborhood. Compared to the TOD streets, conventional streets are long and carry more traffic with higher speed. Sidewalks are often attached to the curb and trees and houses are set back from the street, so there is no buffer for pedestrians. As a result, people do not feel safe and comfortable walking on these streets.

Transit Specifications

One of the principal components of the TOD design is public (street) transit. Carefully planned into the infrastructure of a city or community, public transit will make centers of the traditional neighborhoods more accessible. It is important to note that the high-capacity transit service (rapid and semi-rapid buses, light rail transit, metro systems, etc.) is more appropriate on main streets at the edge of neighborhood centers than their centers.(6) Traffic calming devices and narrow streets can bar even standard buses from these centers. This situation can be improved by the provision of priority treatment (e.g. exclusive lanes, signal preemption, etc.) for the transit at important points. On heavily used bus routes, limited-stop service can supplement regular local service and offer more attractive travel times.(7)

Transit stops are an important part of the pedestrian environment and streetscape, as well as a functional element of the public transportation system.(8) Pedestrians are given a primary consideration in design and location of the transit stops. Route maps and schedules also should be provided, where possible, as well as information about community and its activities. Transit service and stops must be accessible to people with disabilities.

Bus stops can be located at the far side or near side of an intersection, at midblock locations, or off-street in shopping centers, parking sites, or office amenities. In general, transit stop location is affected by potential traffic delays, impact on signalization, proximity to other bus stops, pedestrian linkages, space for bus maneuvering, automobile movement, neighborhood impacts, etc.

In addition to appropriate location and visual attraction, transit stops should provide passenger amenities that make waiting comfortable and pleasant. Such amenities can include: automated teller machines, retail kiosks, telephone, post office vending, concierge services, and day care centers.(9)

In the TOD neighborhood, all parking, except short-term curbside (on-street) parking, is underground. The TOD principles recommend introducing more effective parking management strategies. The strategies are divided into two categories: supply and pricing. The supply strategies employ measures that control availability and timing of parking spaces and promote car- and van-pooling and peripheral parking. The pricing strategies set parking fees and taxes at rates that discourage long-term parking and reduce or eliminate employer parking subsidies. Nationwide experience shows that the most effective programs use a combination of the supply strategies and pricing strategies.(10) Individual garage doors from the frontage are banned for pedestrian safety and traffic delay prevention. Parking can be relegated to the rear of the buildings and usually accessed by alleys or lanes.(11)

Community Benefits

The study of experiences from the past and the present has allowed discovering alternatives to sprawl development and suburban lifestyle. Through a carefully planned program, transit-oriented development puts a great emphasis on keeping the environment in which people work, live, shop, and recreate within walkable distance. A survey of available resources has also revealed a variety of benefits that a community itself derives from the implementation of TOD.

In particular, the Online Encyclopedia for Transportation Demand Management (TDM).(12) has described the following positive features in the TOD measure:

- *Congestion reduction*—Transit travel can significantly decrease a number of automobile trips and requires less space on roads per vehicle driver.
- *Increased road safety*—Transit service is regarded as a safer mode of transportation than a personal vehicle. Travel safety in public transit contributes to lowering expenses related to necessary infrastructure (fire fighting, road reconstruction, traffic control devices, etc.) maintenance.
- *Economic development*—It refers to increases in economic productivity, employment, business activity, and investment. As the TDM Encyclopedia states, economic development also considers social and ecological activities and non-market values.
- *More efficient land use*—Successful TOD has a big potential to decrease per-capita motor vehicle travels, free spaces from parking amenities, and relieve from necessity to build additional road network and infrastructure.
- *Environmental and livability benefits*—Well-elaborated public transit service networks and biking/pedestrian improvements help to reduce natural resource consumption and pollution from human activities. The result: We will create more attractive and livable communities in a given area.

RECOMMENDATIONS

As a result of this study, we recommend to consider and implement the following:

1. If a TOD strategy is adopted for the inter-regional corridors, these principles can play a guiding role in implementing TDM measures and coordinating efforts of regional/local authorities, developers, and planners.
2. Pedestrian and bicycle amenities are key elements in the traditional neighborhood. We highly recommend the incorporation of wide pedestrian-friendly sidewalks and separate bike lanes. This measure would encourage people to decrease significantly car use that has become the predominant mode of travel in many cities and suburbs.

3. The transit-oriented roadways should be a focus of planners. Mn/DOT should ensure that the IRC network includes a well-elaborated network of transit ways that support a popular exploitation of a number of modes, rather than a car.
4. Bus stops should be designed to respond to passenger needs, thus ensuring access and convenience to as many people as possible. Convenient amenities at bus stops (community maps, schedules, public phones, etc.) would demonstrate a commitment transit, and facilitate repeated use of transit.

TRANSPORTATION TECHNOLOGIES FOR SUSTAINABLE COMMUNITIES

The Minnesota Department of Transportation (Mn/DOT) asked the State and Local Policy Program (SLPP) to investigate best practices for Transportation Demand Management (TDM) programs as they might apply to Mn/DOT's Inter-Regional Corridor (IRC) program.

The IRC program presents a unique setting for TDM measures, as the IRC corridors can include rural and urban areas over their length, while most TDM measures have been developed and designed for use in urban areas. Consequently, many measures, such as those that encourage heavy transit use, may not be appropriate for application in the IRC program.

To begin its investigation, SLPP reviewed the Victoria Transport Policy Institute's on-line TDM Encyclopedia (<http://www.vtpi.org/tdm/>) to review existing TDM measures and identify opportunities for the IRC corridors. The following pages summarize these findings, and include Web page references for where more information is available.

As a result of this investigation, the following elements of TMS programs are recommended:

1. Commuter Choice/Employer Financing Measures—These programs focus on providing financial incentives to employers and employees to reduce commuting trips. These programs would target some of the greatest users of inter-regional corridors (commuters) while helping create demand for vanpool and TDM alternatives mentioned on the following page.
2. Ridesharing—This program is a logical response to the financial incentives discussed in previous paragraphs. By creating financial incentives to find alternatives to single

occupant vehicle travel, a demand is created to coordinate trips among those traveling the same routes, even if the route is not densely populated.

3. Tele-Access and Alternative Scheduling—Rather than focusing on the travel method, these measures call for employer policy changes. However, the effects on inter-regional corridors could be significant, as they can be targeted to the commuter population along corridors, require little additional infrastructure, and can reduce trips even in low density areas.
4. Transit Oriented Development (Long Term)—As development may focus along the priority corridors, the principles of transit oriented development (TOD) should be used as guidelines so that destinations can be accomplished by a number of modes, rather than only by car.
5. Marketing and Cooperation—To ensure that these measures succeed, an organization should be created, or existing organizations engaged, to create awareness and support for the programs. In addition, stakeholders should identify and exploit opportunities for cooperation between jurisdictions, particularly as new technologies are deployed.

While a number of the examples listed here are from the Pacific Northwest, the elements discussed in previous paragraphs could be applied to the IRC corridors in Minnesota. In addition, a number have been applied in the Twin Cities Metropolitan Area. Those involved with implementing these measures in the IRC corridors should take advantage of the expertise available in Minneapolis and St. Paul.

Definition of a TDM Program

A Transportation Demand Management (TDM) program is an institutional framework for implementing a set of TDM strategies. Such a program has stated goals, objectives, a budget, staff, and a clear relationship with stakeholders. It may be a division within a transportation or transit agency, an independent government agency, or a public/private partnership. The TDM program can play a coordinating role for other programs aimed at changing commuting behavior.

<http://www.vtpi.org/tm/tm12.htm>

Summary of Best Practices

The Commuter Choice program offers financial benefits to employers for promoting employee use of alternatives to the single occupant vehicle (SOV). A Commuter Choice program can be developed by an individual company or as a part of regional strategic program. Federal tax laws related to transport, vanpool, and parking provide tax savings to both employers and employees. The employers get a deduction from Federal business tax in amount of benefits paid to employers under the Commuter Choice programs. Employees can receive transit, vanpool, and parking benefits completely free of all United States payroll and Federal income taxes. Such programs also provide opportunity to solve commuting difficulties of employees and recruitment/retention of employees, improve customer service through enlarging parking and other amenities.

Under Commuter Choice programs, communities usually derive economic benefits. Urban transit agencies whose services compete with free parking in a city can experience an increased demand for alternative transportation modes. This can aid urban revitalization and efforts to prevent pollution.

Government offices, public organizations, and businesses have practiced Commuter Choice programs. For example, the Intel Corporation in Oregon has effectively introduced a Commuter Choice program. The company has provided free transit passes to its more than 10,000 employees. As a result, the company receives a significant discount over the standard pass price, and it receives both state and federal tax credits.

<http://www.epa.gov/oms/transp/comchoic/ccweb.htm>

<http://www.epa.gov/oms/transp/comchoic/benoff.htm>

Other programs focus on *commute trip reduction*, which provide commuters with resources and incentives to reduce employee vehicle trips in peak periods. These program draw from the following TDM strategies:

- **Commuter Financial Incentives**—These are programs that include a financial payment for using alternative travel modes. For example, in a “Parking Cash Out” program, commuters who are offered subsidized parking are also offered the cash equivalent if they use alternative travel modes. Travel allowances are another type of financial payment to employees to cover commuting costs; however, employers do not provide free parking with this program. Commuters can use this money to pay for a parking space or for another travel mode. Company travel policies can allow cycling and public transit expenses to be reimbursed for business travel. In some situations, these modes are as fast or faster than driving. Commuter financial incentive programs usually involve employers, employees and labor organizations, local governments, developers, and transit agencies. <http://www.vtpi.org/tdm/tdm8.htm>
- **Fuel Tax Increases**—Fuel tax increases are another potentially effective tool to promote commuting by alternative modes of transportation. The TDM Encyclopedia points out “the energy tax increases are justified as a way to reduce dependence on imported energy, a climate change emission reduction strategy, and as a way to preserve non-renewable resources for future generations.” To gain some support for such an increase, some economists recommend increasing fuel taxes as part of a revenue-neutral tax shift that “means increased taxes on resources such as fuel are offset by reductions in other, more economically-harmful taxes, such as those on income and investments.” Higher vehicle operating costs may reduce a number of vehicles in travel and shift toward more fuel-efficient vehicles. <http://www.vtpi.org/tdm/tdm17.htm>
- **Rideshare Matching**—These programs apply to carpooling and vanpooling. Carpooling uses participants’ own automobiles. Vanpooling uses a van or a bus that is usually owned by an organization (such as a business, non-profit, or government agency) and made available specifically for commuting. Ridesharing is one of the most common alternative modes, particularly in areas that are not well served by public transit. Rideshare programs are particularly helpful to commuters who cannot drive or who lack a reliable automobile.

These programs require support by transportation and sometimes transit agencies, or by individual employers, in that a central agency needs to act as a clearinghouse to match potential car- or van-poolers. <http://www.vtpi.org/tdm/tdm34.htm>

- Cycling and Pedestrian Improvements—Non-motorized improvements can substitute directly for automobile trips. Walking and cycling improvements can also help increase use of public transit and ridesharing. A relatively short non-motorized trip often substitutes for a longer car trip. Non-motorized transportation improvements are usually implemented by local or regional governments, sometimes with state or provincial transportation agency support. Businesses and developers implement some measures, such as sidewalks, paths, and bicycle parking facilities.

<http://www.vtpi.org/tdm/tdm25.htm>

- Flextime and Alternative Scheduling—In these measures, employees are given some flexibility in their work schedules. Such measures can help to reduce the number of employees arriving and leaving a worksite at one time and consequently reduce traffic congestion on roads. Employers mainly implement alternative work schedules through changes in institutional and management practices. Governments can promote alternative work schedules as part of a Commute Trip Reduction or regional TDM program and allow it for their own employees. <http://www.vtpi.org/tdm/tdm15.htm>

- Tele-Access—This provides substitution for physical travel by various uses of telecommunication technologies (telephone, fax, e-mail, Web sites, video connections, etc.). This program includes telework, distance-learning methods, Internet shopping, Internet banking, Internet business transactions, and electronic government. The success of the program implementation depends on employers' policy and practices in tele-access activities. <http://www.vtpi.org/tdm/tdm43.htm>

Vehicle Use Restrictions

The TDM Encyclopedia has described a number of regulatory strategies that can be used to control vehicle use:

- Discourage or prohibit automobile traffic on certain roads at certain times to create pedestrian-oriented commercial area.
- Establish auto-restricted zones that limit automobile access, for example, to residents and commercial vehicles. These often have features of car-free planning, location efficient development, traffic calming, and transit oriented development.
- Divide a city into traffic cells that have direct walking, cycling, and transit connections, but require a longer trip to travel between by private automobile.
- Driving can be restricted based on vehicle license plate numbers. For example, vehicles with license numbers ending in 0 or 1 are prohibited from driving on Mondays, and other numbers limit driving during other weekdays. This is typically implemented as a temporary measure during air pollution emergencies or to reduce traffic congestion during major sport or cultural events.

<http://www.vtppi.org/tdm/tdm33.htm>

Transit Oriented Development

Transit Oriented Development (TOD) refers to residential and commercial areas designed to maximize access by transit and non-motorized transportation. A TOD neighborhood has a center with a rail or bus station that surrounded by relatively high-density development, with progressively lower-density spreading outwards. TOD neighborhoods typically have a diameter from $\frac{1}{4}$ to $\frac{1}{2}$ mile (stations spaced $\frac{1}{2}$ to 1 mile apart), which represents pedestrian scale distances. It includes these design features (Morris, 1996):

- A neighborhood is designed for cycling and walking, with adequate facilities and attractive street conditions.
- Streets have traffic calming features to control vehicle traffic speeds.

- Mixed-use development that includes shops, schools and other public services, and a variety of housing types and prices, within each neighborhood.
- Parking management to reduce the amount of land devoted to parking compared with conventional development and to take advantage of the parking cost savings associated with reduced automobile use.

The TOD section of the King County Department of Transportation has been working on bus-related TOD joint-development projects since 1998. King County projects are under way in the cities of Redmond, Renton, Seattle, and Shoreline. The county is also investigating the TOD feasibility in Kent and Auburn. <http://www.metrokc.gov/kcdot/alts/tod/todindex.htm>

Multiple Jurisdiction Cooperation

The “Regional Multi-Jurisdictional Transit Scheduling and Dispatch” project is one of the best practices in coordination of regional transit routes. Two transit agencies, Tri-Met in Portland, Oregon, and C-TRAN in Vancouver, Washington, have taken advantage of advances in ITS technologies to create an interoperable operations-based system. This project focuses on the agencies sharing regional fixed-route schedule data and integrating real time operations management information. This has resulted in system efficiency cost savings for Tri-Met and C-TRAN. Enhanced data sharing will allow more efficient inter-jurisdictional transit traveler information on bus and light rail services.

<http://www.tri-met.org/trimet5year.pdf>

TDM Marketing and Promotion

In addition, most TDM strategies depend on public awareness and support, because public attitudes can have a major effect on the use of alternative commuting modes. TDM programs are more effective if users receive positive recognition and stimulus. As the Encyclopedia states, TDM marketing includes:

- Educating public officials and businesses about TDM strategies they can implement

- Informing potential participants about TDM options they can use
- Promoting benefits
- Overcoming barriers to the use of alternative modes
- Encourage participation
- Parking management and parking pricing
- Others

Federal, state, regional and local agencies, business associations, individual businesses, and non-governmental organizations can significantly contribute to marketing measures.

<http://www.vtpi.org/tdm/tdm23.htm>

National Listening Session for Transportation and the Environment

On August 7, 2001, the University of Minnesota State and Local Policy Program at the Humphrey Institute of Public Affairs, and the Center for Transportation Studies, as well as the Federal Highway Administration (FHWA), Federal Transit Administration (FTA), and Minnesota Department of Transportation (Mn/DOT) hosted a listening session on the environmental aspects of TEA-21 for purposes of reauthorization. The session employed electronic voting technology allowing citizens, business and community leaders, and transportation professionals to provide direct feedback to federal and state officials. Participants included Congressmen Oberstar and Sabo; Sean O'Hollaren, United States Department of Transportation Assistant Secretary for Governmental Affairs; Cindy Burbank, FHWA Program Manager for Planning and Environment; and a number of State and local elected officials, organizations, and businesses.

Robert Johns, Director, Center for Transportation Studies, and Lee W. Munnich, Jr., Senior Fellow and Director, State and Local Policy Program, provided welcoming remarks. Mr. Johns indicated that the relationship between transportation and environment would become an even stronger theme in reauthorization. He also indicated that Congressmen Oberstar and Sabo were strong supporters of the University's transportation research programs. Mr. Munnich provided a background on the Humphrey Institute of Public Affairs, and indicated that ISTEA and TEA-21 made transportation programs more responsive to States and regional communities.

Steve Moss, Principal of Moss Cairns, explained the voting technology. Participants in the audience had a remote sending unit that enabled them to vote on various questions that were displayed on a large screen. After a vote, the results were immediately displayed on the screen (Results illustrated in graph-form throughout this section).

Figure 3.1 Participants' Demographics: Gender, Age, Miles Commuted to Work

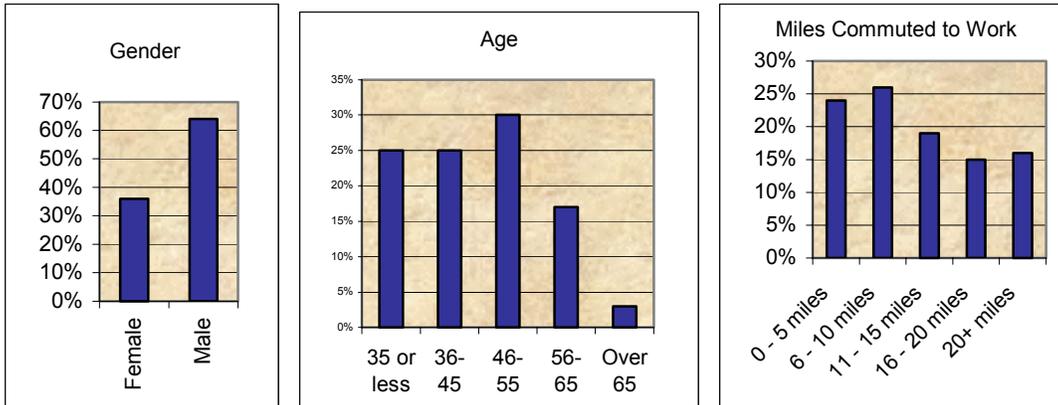


Figure 3.2 Participant's Demographics: Where They Live

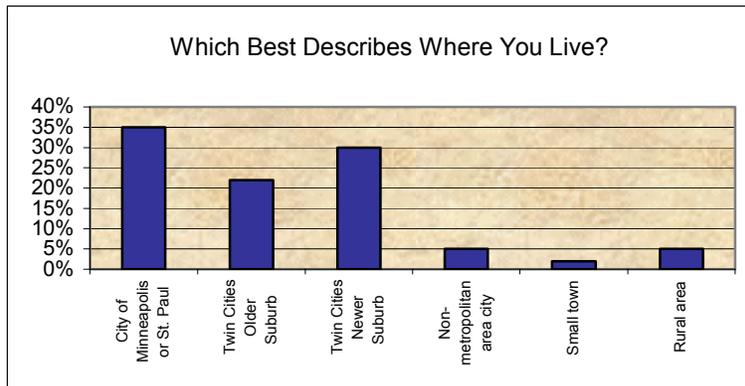


Figure 3.3 Important Re-authorization Bill Issues

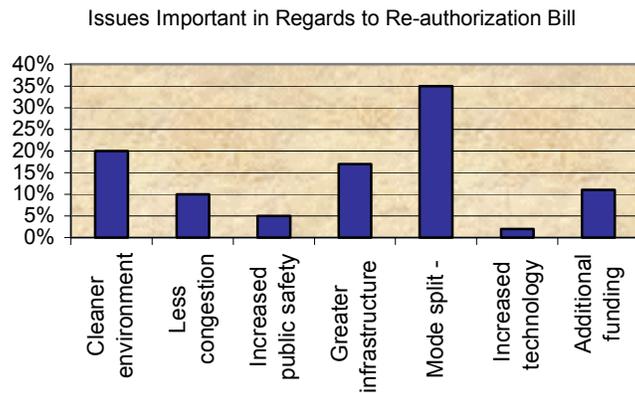
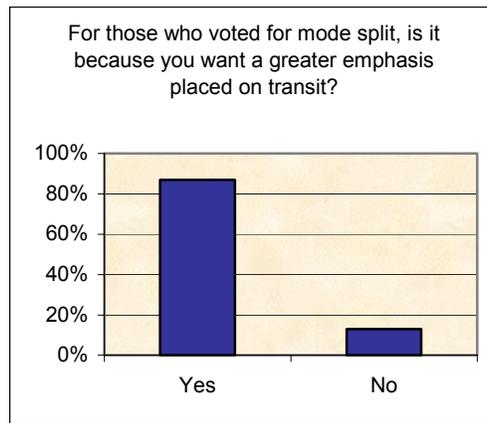
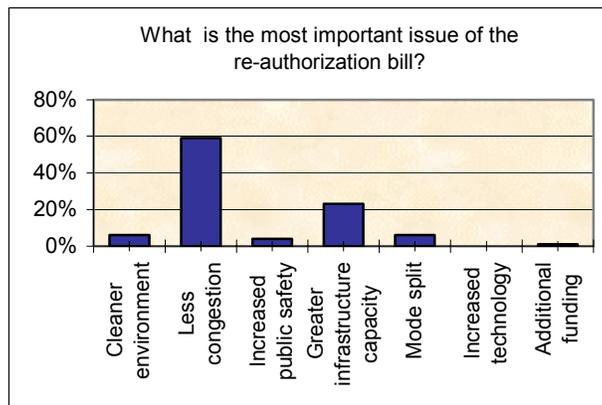


Figure 3.4 Follow Up to Mode Split



When the audience was asked what they thought the most important issue for reauthorization is, the number one response was for “mode split—greater balance between cars, buses, others.” When asked if this meant more funding for transit, 87 percent said yes. The number two response was for a cleaner environment. Participants were then asked what they thought the citizens would think is the most important issue. The top two responses were less congestion and greater infrastructure capacity. Mode split dropped to the fourth position.

Figure 3.5 Ranking of Issues Important to the Re-authorization Bill



In response to other questions, the majority of the participants agreed that funding levels for environmental programs should be increased and made more flexible. The best way to improve transportation and the environment is to increase funding for transit and non-motorized vehicles

and to use technological improvements. Finally, funding for environmental research should be increased by 50 percent or more.

Figure 3.6 Current Funding Levels for Federal Environmental Transportation Programs Around the Country

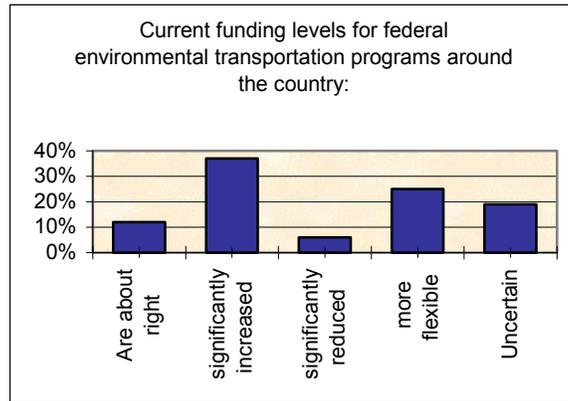


Figure 3.7 Best Hope for Improving the Environment and Transportation Nationwide

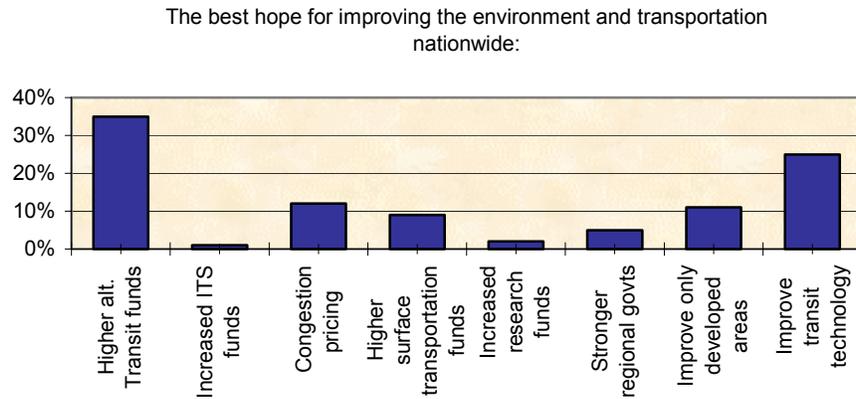
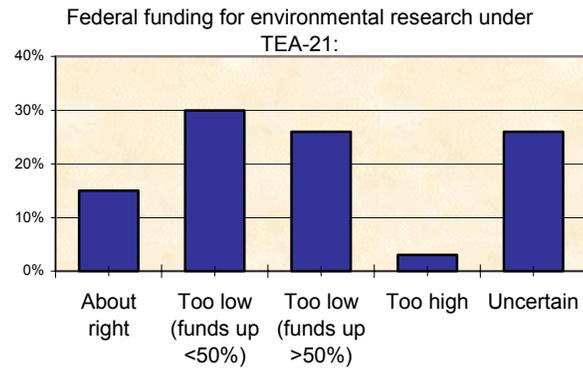


Figure 3.8 Federal Funding for Environmental Research Under TEA-21

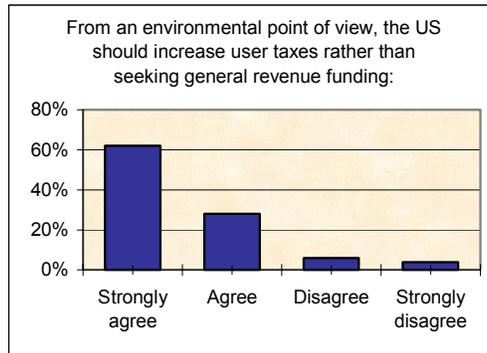


Cindy Burbank provided an overview of various issues to set the stage for a morning panel discussion. Ms. Burbank reviewed the history of surface transportation reauthorization, the time line for TEA-21 reauthorization efforts, provided a breakdown of current funding levels among the various programs, illustrated the growth in the time it takes to complete the NEPA (Environmental Impact Statements) process, and illustrated that it is the growth in vehicle miles traveled (VMT) rather than additional lane miles that contributes to congestion.

Elwyn Tinklenberg, Commissioner of Mn/DOT, indicated that transportation and the environment can go together, and that we need to make sure we are achieving the goals that we want, such as improved quality of life. He provided Minnesota’s ABCs for transportation. “A” is for advantages for transit; “B” is for Mn/DOT’s bottleneck program to reduce congestion; and “C” is for their corridor program, which involves working with a broader group of communities all along a corridor. Mr. Tinklenberg stressed that congestion is not a viable environmental strategy. He also indicated that 20 to 25 percent improvement in our transportation system can be provided through technologies such as ITS, ramp metering, etc. He also stressed the need for environmental streamlining, while protecting the environment, and indicated that delays result in lost resources to transportation.

Mr. Tinklenberg introduced and moderated the first panel. The panel included: Congressman James Oberstar; Congressman Martin Olav Sabo; Tom L. Chaffin, Division Vice President, Traffic Control Materials Division, 3M Corp; and Minnesota Senator Julie Sabo.

Figure 3.9 Participants' Opinions: From an Environmental Standpoint, the U.S. Should Increase User Taxes Versus Seeking General Revenue Funding



The major points emerging from the panel discussion and the audience participation are:

- There is a relationship between safety, congestion, and environment. Dealing with congestion needs to be part of the environmental discussion.
- Congressman Sabo indicated all programs need more money, but that there is no extra pot of money for major increases. He believes that the public would support a gas tax increase, but the States rely on general taxes; in addition, a large amount of local taxes subsidize highway programs.
- 90 percent of the participants indicated that from an environmental point of view, the United States should increase user taxes, rather than seek general revenue funding.
- Congressman Sabo also noted the importance of State matching funds for transit improvements.
- There was support for a balanced approach between modes.
- There is much greater sensitivity in transportation to environmental issues than there once was.
- In order to “sell” a tax increase we need to do a better job of demonstrating the need for an increase.

- Congressman Oberstar indicated that changing behavior is very difficult. If it is perceived as a penalty it will be rejected. If it is perceived as an incentive it will be accepted. If a gas tax will be used to fund more transportation projects including transit, it will be perceived as an incentive and have a better chance of being accepted. Other incentives that he mentioned included transit passes, carpooling promotions, and telecommuting.

Figure 3.10 Preferred Minnesota Transportation Strategies

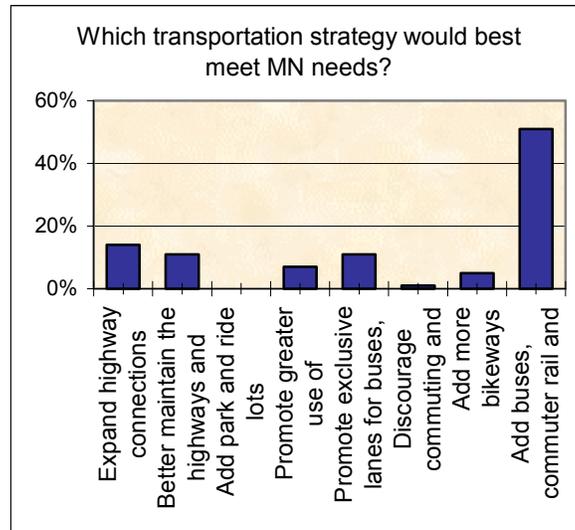
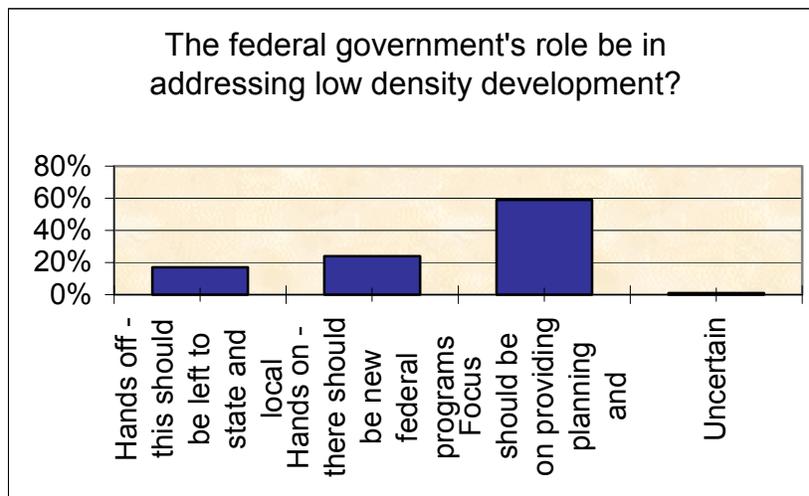


Figure 3.11 Preferred Federal Government Role in Addressing Low Density Development



- When asked, which strategy would best meet the needs of Minnesota, the number one answer was, “add buses, commuter rail, and light rail.” A distant second strategy was to better maintain the highway system.
- Congressman Oberstar mentioned the increased role of MPOs, citizens, and regional organizations in transportation planning as an important development facilitated by ISTEA.
- Congressman Oberstar also indicated that bikes make 30 percent of all trips in the Netherlands. He indicated that the United States needs to develop the bicycle as a mode of transportation, and that bike transportation should be included as an integral part of system planning.
- When asked what the role of the federal government should be in addressing low-density development, 59 percent of the audience answered that the focus should be on planning and research tools for State and local governments.
- TEA-21 expanded the transportation program into quality of life issues.

Congressman Oberstar provided a keynote address and made the following points:

- Concern for congestion, urban sprawl, and air quality led to ISTEA
- ISTEA and TEA-21 addressed environmental issues in two ways. First, they established new programs such as CMAQ, TCSP, the Clean Fuel Transit program, etc. And secondly, they enhanced alternatives to SOVs, such as providing a \$36 billion guaranteed account for transit and providing flexibility in other programs.
- There has been a significant increase in the dollars spent on bike projects.
- States have been slow to use the flexibility provided. CMAQ and TE programs have an obligation rate of 75 percent and 68 percent, respectively.
- States have to be more aggressive in using TEA-21 flexibilities or congestion will grow.
- Streamlining efforts should establish deadlines, provide concurrent reviews, provide adequate consideration of all views, and fund agency positions. He does not support streamlining efforts that circumvent environmental concerns. FAA has an inclusive process that has been very successful.
- We are in a new era of transportation involvement. Citizens need to be involved.
- The formula for TEA-21 should be the formula for reauthorization.

To begin the afternoon session, Cindy Burbank provided an overview of various environmental issues such as air quality, wetlands, scenic byways, streamlining initiatives, Indian reservations, context sensitive designs, environmental research, and the FHWA's Environmental Excellence Award Program. Ms. Burbank emphasized that Minnesota was a national leader in many of these categories. When the participants were asked whether the federal government should play a strong role in encouraging people to stop driving and use alternative modes, 71 percent either agreed or strongly agreed. Some suggestions for accomplishing this included, making rail and other modes more viable for trucks and increasing funds for TCSP.

Figure 3.12 Environmental Excellence Awards

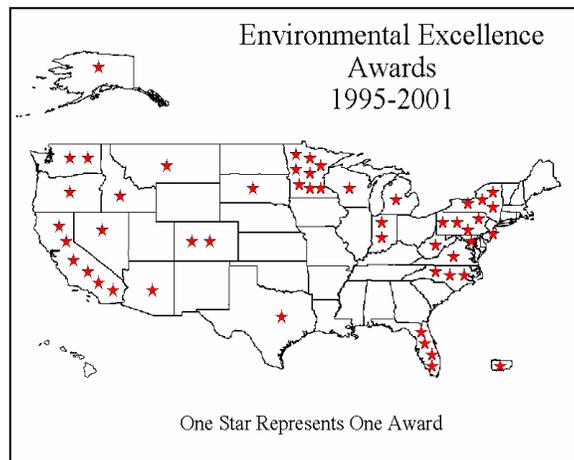
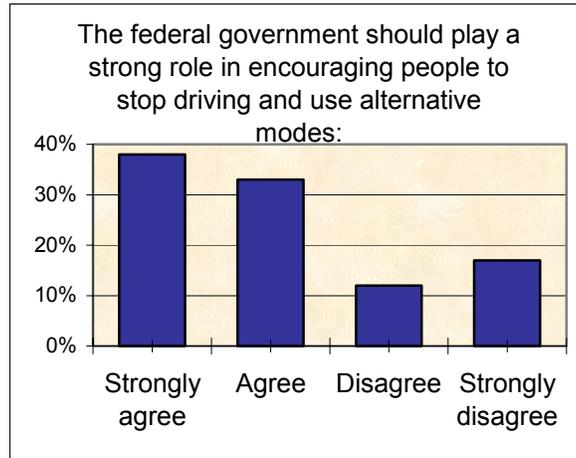
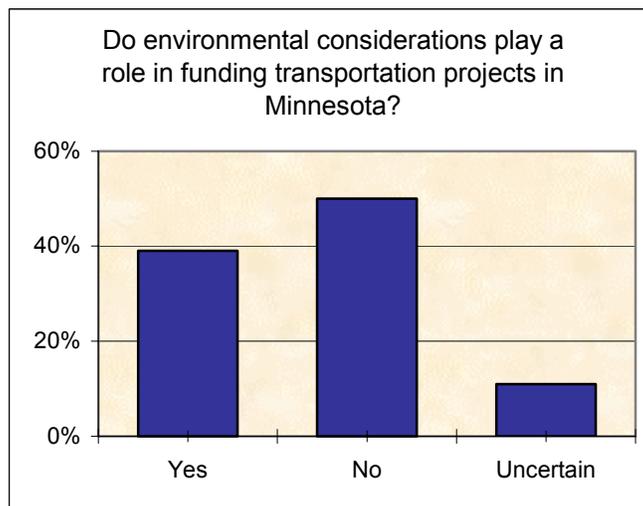


Figure 3.13 The Federal Government's Role in Promoting Alternative Modes



Tom Horan, Associate Professor, Claremont Graduate University, and Visiting Scholar, Hubert H. Humphrey Institute of Public Affairs, introduced and moderated the second panel. Dr. Horan defined ISTEA as “revolutionary,” TEA-21 as “stay the course,” and the next reauthorization as “stay the course plus.” The panel included: Susan Hoyt, Director of Physical Development, Dakota County; Minnesota Senator Roy Terwilliger; Marcia Marcoux, Council Member, City of Rochester; Lester Heitke, Mayor, City of Willmar; Scott Doig, Natural Resources, Mille Lacs Band of Ojibwe.

Figure 3.14 Impressions as to Whether or Not Environmental Considerations Play a Role in Funding Transportation Projects in Minnesota



The major points emerging from the panel discussion and the audience participation are:

- In response to some opening questions, a majority of the audience indicated that, first, environmental considerations do not play a significant enough role in the decision making process for funding transportation projects.
- Second, the greatest control in managing land use in Minnesota should lie within cities and counties, that the Minnesota State legislature should increase funding for transportation.

Figure 3.15 Impressions on Where the Greatest Control in Managing Land Use in Minnesota Should Lie

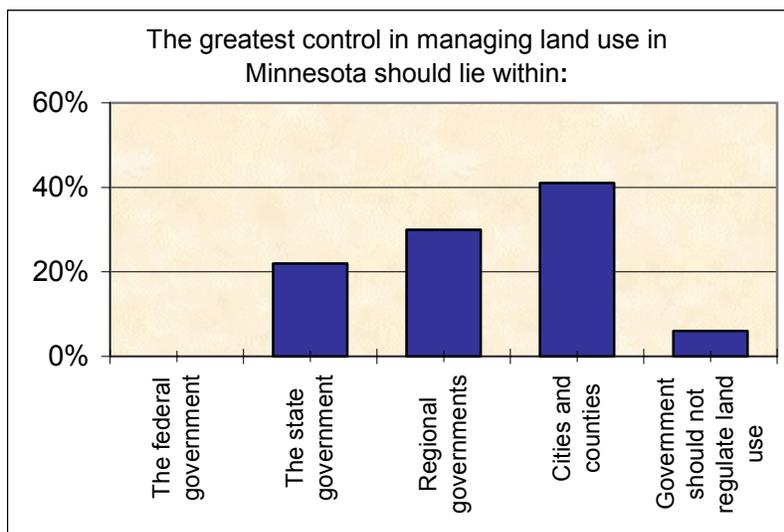
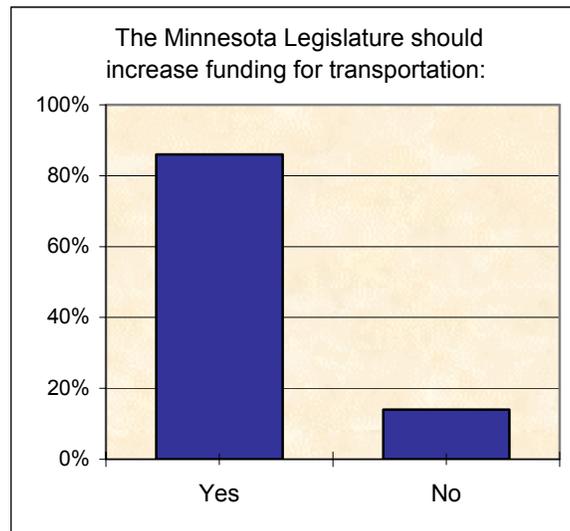


Figure 3.16 Impressions on Whether or Not the Minnesota Legislature Should Increase Transportation Funding



- The State legislature has not done enough to fund the transportation needs in the State. Start with highways and expand to transit. Get citizens involved and have them educate the State legislature.
- It's hard to control sprawl and promote heavy densities at the local level.
- Need to articulate a public vision for transportation. Develop a long term strategy, vision, and funding to support adequate transportation infrastructure and "stick to it," even with a change in State and local elected officials.
- The audience favored a State gas tax increase over an increase in the sales tax. If a sales tax were proposed, they would favor a region-wide sales tax increase over an individual county sales tax increase.

Figure 3.17 Impressions on Voter Support for a Statewide Sales Tax Increase

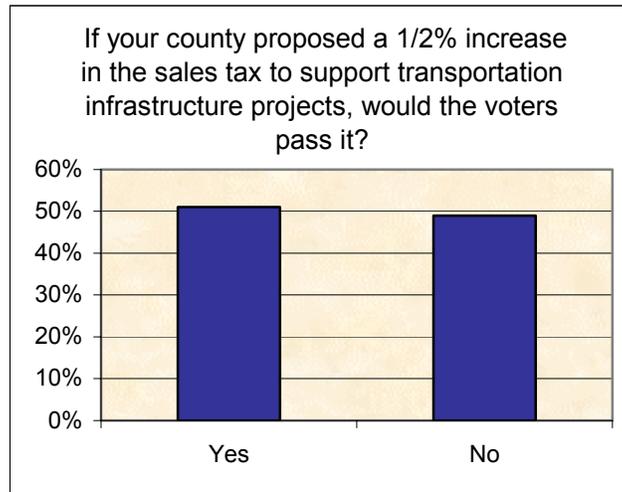


Figure 3.18 Impressions on Voter Support for a Gas Tax Increase

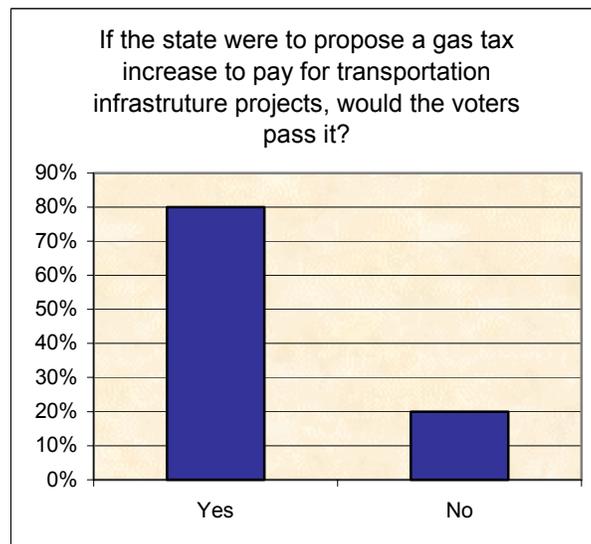
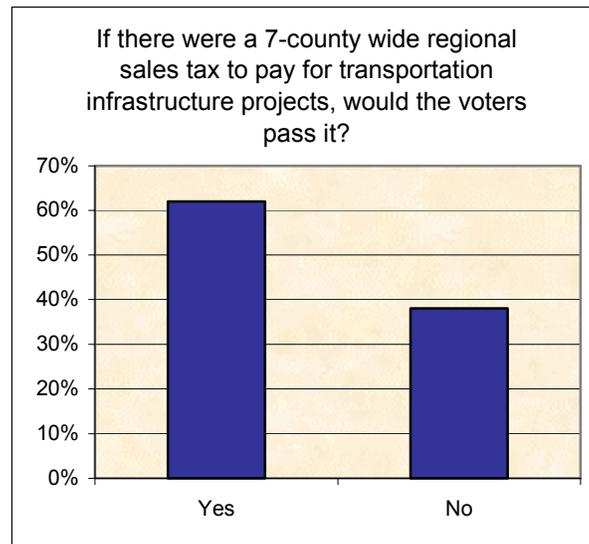


Figure 3.19 Impressions on Voter Support for a Regional Sales Tax Increase



- Land use considerations need to be integrated with transportation systems.
- TEA-21 priorities should include more funds for highways and transit; more funds for environmental programs and research; and a continuation of the Federal/State partnership. The audience generally did not support the turn back of environmental programs to the States.

Sean O'Hollaren made the following remarks:

- Federal, State, and local agencies need to partner together to solve issues.
- Transportation related environmental programs (i.e. CMAQ, TE, TCSP, Scenic Byways, etc.), together with transit programs, amount to 25 percent of surface transportation program funds. In addition, other programs can be flexed to help support these programs.
- The challenge with streamlining is to balance the need to make the process more efficient with environmental protection. Delays occur at all levels of government.
- Research got short-changed in TEA-21 and subsequent appropriations bill. Need strong research programs to help develop new technologies.
- Transportation and land use considerations need to be considered together. The federal role is to help provide the tools and training to assist State and local agencies.

Lee Munnich summarized the day's proceedings by providing the following closing remarks:

- Noted that pricing was not mentioned, but will likely need an increased role in the future.
- Stressed the need for a clearer vision of the future transportation system and needs.
- Stated that environment needs to be part of TEA-21 reauthorization. The Federal government cannot simply turn these programs back to the States; rather, they need to partner with the States in implementing these programs.
- The Federal government has a legitimate role in influencing travel behavior by providing incentives for bikes, transit, etc.
- Streamlining needs to be on the agenda. Set deadlines and provide for concurrent reviews.
- There is a need for planning and for providing better tools for addressing land use and sprawl.

Transportation and the Environment: National Listening Session
Tuesday, August 7, 2001

Hubert H. Humphrey Institute of Public Affairs

Sponsored by:

University of Minnesota, State and Local Policy Program, Center for Transportation Studies,
United States Department of Transportation, Minnesota Department of Transportation

PROGRAM AGENDA

- 8:00 **Coffee and Rolls**
- 8:30 **Welcome and Convening**
Robert Johns, Director, Center for Transportation Studies
Lee W. Munnich, Jr., Senior Fellow and Director, State and Local Policy Program
- 8:45 **Introduction to Voting Technology and Initial Votes**
Steve Moss, Principal, Moss Cairns
- 9:00 **Outline of Issues and Charge to Attendees**
Cindy Burbank, Manager, Environment and Planning, Federal Highway Administration
- 9:20 **Introduction of Keynote Speaker**
Elwyn Tinklenberg, Commissioner, Minnesota Department of Transportation
- 9:30 **Keynote Address**
Congressman James Oberstar
- 9:50 **Audience Discussion**
- 10:00 **Panel Discussion (questions to and from audience)**
Congressman James Oberstar
Congressman Martin Olav Sabo
Tom L. Chaffin, Division Vice-President, Traffic Control Materials Division,
3M Corporations
Minnesota Senator Julie Sabo
Commissioner Elwyn Tinklenberg, Moderator
- 11:00 **Response**
Sean O'Hollaren, Assistant Secretary for Governmental Affairs, United States
Department of Transportation
- 11:30 **Lunch** (available by reservation or on own)

- 12:30 **Outline for Local Discussion**
Cindy Burbank, Manager, Environment and Planning, Federal Highway Administration
- 1:00 **Panel Discussion (questions to and from audience)**
Ted Mondale, Chair, Metropolitan Council
Susan Hoyt, Director of Physical Development, Dakota County
Minnesota Senator Roy Terwilliger
Marcia Marcoux, Council Member, City of Rochester
Lester Heitke, Mayor, City of Willmar
Scott Doig, Environmental Programs Coordinator, Mille Lacs Band of Ojibwe
Tom Horan, Associate Professor, Claremont Graduate University and Visiting Scholar,
Hubert H. Humphrey Institute of Public Affairs, Moderator
- 3:00 **Response—Next Steps**
Cindy Burbank, Manager, Environment and Planning, Federal Highway Administration
Lee Munnich, Senior Fellow and Director, State and Local Policy Program
Tom Horan, Associate Professor, Claremont Graduate University and Visiting Scholar,
Hubert H. Humphrey Institute of Public Affairs
- 3:30 **Adjourn**

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CHAPTER 4

EDUCATION AND OUTREACH

The State and Local Policy Program (SLPP) conducted and participated in several events over the course of this study that allowed investigators to both disseminate findings and receive feedback. Both practitioners and interested members of the public were present at these sessions.

TISP Forum, April 2001

This Telecommunications and Information Society Policy (TISP) Forum was co-sponsored by SLPP as an opportunity to provide a project “update” to an informed audience. Several presentations were given, including an overview of GPS transportation technologies being tested in Minnesota, a discussion of potential applications to bicycle transportation, an overview of regulatory issues, and a description of industry efforts to respond to those issues. The forum concluded with a discussion of local efforts to bring the benefits of telecommunications advances to greater Minnesota. A more detailed description of the proceedings is printed at the end of [Chapter 2](#) of this document.

New Ulm Sustainability Conference, June 2001

Frank Douma, along with Emily Kuhn and Nodira Dadabayeva of the SLPP presented at a sustainability conference in New Ulm, Minnesota, that was sponsored by the local Isaac Walton League and several local interested citizens. Following large group activities and speakers discussing examples of environmentally sustainable behaviors, the SLPP staff presented information on best practices for sustainable transportation and worked with attendees to develop possible indicators of sustainable transportation for the area. The SLPP presentations drew from current and past research as well as information developed as part of the Transportation and Regional Growth studies.

Mn/DOT STI Group, July 2001

Frank Douma and Nodira Dadabayeva presented the findings from this study on implementing sustainable transportation best practices on Mn/DOT's Inter-Regional Corridor (IRC) system to the Sustainable Transportation Initiatives (STI) group of the Minnesota Department of Transportation in July of 2001. While the presentation covered several strategies for reducing dependence on single occupant vehicles, Mn/DOT staff members were particularly interested in measures that Mn/DOT could take to encourage transit-oriented development. This resulted in a follow up memo describing specific TOD guidelines as they might apply in the IRC network. This memo was subsequently distributed to Mn/DOT IRC staff. The supporting documentation for this presentation is included at the beginning of [Chapter 3](#).

Transportation and the Environment, August 2001

On August 7, 2002, the SLPP co-hosted a National Listening Session for Transportation and the Environment with the University of Minnesota's Center for Transportation Studies, the Minnesota Department of Transportation, the Federal Transit Administration, and the Federal Highway Administration. Participants included Congressmen Martin Sabo and Jim Oberstar, Sean O'Hollaren, USDOT Assistant Secretary for Governmental Affairs and City Burbank, FHWA Program Manager for Planning and Environment. The session also included a panel of local government officials from around Minnesota. A key element of this event was the use of electronic voting by the participants, which provided a significant amount of information that should prove to be useful to USDOT as the administration develops its recommendation for the next transportation authorization bill. The full proceedings are included at the end of [Chapter 3](#) of this report.

Peer Review Panel, November 2001

In November 2001, the SLPP hosted the annual meeting of its Peer Review Panel. Members of the panel attending this year were Arnold Howitt from Harvard University, Susan Handy from the University of Texas, and Randy Halvorson from the Minnesota Department of Transportation. Genevieve Giuliano, from the University of Southern California, joined the proceedings by telephone at the end of the first day, and Adeel Lari, Director of Mn/DOT's

Office of Research Services attended the second day. Progress reports from several SLPP studies were presented, including this study, and critiqued by the panel members. Full proceedings follow this document.

Transportation Research Board, January 2002

Frank Douma, Emily Kuhn, and Praveena Pidaparathi from the SLPP attended the Eighty-first Transportation Research Board Annual Meeting in Washington, D.C., in January 2002. In addition to attending several relevant concurrent sessions, the SLPP representatives presented “[How Was Your Trip? Exploring the Relationship Between Telecommunications and Travel Through the Time Use Diary](#),” printed at the beginning of Chapter 1, and “[Utilizing Transportation Technology to Support Strategic Management Initiatives](#),” which can be found at the beginning of Chapter 2.

ITSA America, April 2002

Frank Douma and Nodira Dadabayeva will attend the ITS America (Intelligent Transportation Society of America) Twelfth Annual Meeting and Exposition in Long Beach, California, at the end of April 2002. They will present “[Regulation of Safety and Privacy Issues in Wireless Communication Applications for Transportation](#),” which is printed in Chapter 2 of this report.

Peer Review Meeting Notes

November 27-28, 2001

State and Local Policy Program
Humphrey Institute of Public Affairs
University of Minnesota

Members present: Gen Giuliano (via telephone), Bob Johns, Randy Halvorson, Susan Handy, Arnold Howitt

SLPP Staff and RAs: Gary Barnes, Frank Douma, Marit Enerson Lee Munnich, Barbara Rohde, (RAs: Todd Anderson, Wenling Chen, Nodira Dadabayeva, Nathan Franzen, Emily Kuhn, Peter Langworthy, Praveena Pidaparathi, Michael Rentz, Greg Schrock)

Faculty, Partners, and Guests: Daryl Anderson, Dick Bolan, John Brandl, Ken Buckeye, Karen Chapple (via telephone), Max Donath, Tom Horan, Ken Kriz, Kevin Krizek, Adeel Lari, David Levinson, Kim Wells

Tuesday, November 27, 2001

12:00 Lunch

Lee Munich opened the peer review meeting by greeting and welcoming all the attendees. After introduction of the attendees, John Brandl, Dean of the Humphrey Institute of Public Affairs, said that research work, whether published in journals or not, greatly encourages people to think. He added that this research is important because it creates value and impacts the bulk of activities.

Bob Johns then spoke about the role of activities held by the University of Minnesota, Center for Transportation Studies, and Humphrey Institute of Public Affairs. Specifically, CTS fosters interaction among researchers and specialists. Its studies emphasize faculty encouragement in exploring new aspects of transportation use. The Humphrey Institute provides an arena for discussion of final solutions as research questions become more political.

Following the introductory notes of the attendees, Mr. Munnich reaffirmed the purposes of the peer review meeting. These are to review and comment on research work done by SLPP, to discuss whether methods of the research help to achieve its goals, and to focus on issues evolving from results of the research and others. Mr. Munnich also expressed SLPP's recognition of contributions from Dean Brandl, Tom Horan, research assistants, and CTS.

1:15 STAR/TEA-21

STAR/TEA-21 (Task 1): Dick Bolan

Dr. Bolan began by speaking about the overall concept of the project. Namely, it is focused on the spatial impacts of innovations in technology, specifically telecommunications and impacts on urban form. The study attempts to redefine information activity. It also looks at network externalities and their impact on special form, an analysis of the product life cycle and its impact on urban spatial form, and exploration of complexity theory.

Study Framework

Network Externalities

Both positive and negative externalities of telecommunications technology and infrastructure exist; however, the study focuses on the positive externalities. This deals with the assumption that an individual is connected to the network and is influenced by a person's own activities as well as by the activities of others communicating with that person. This can be seen on different levels.

Highlights from the Question and Answer Session

Question	Answer
Technologically, how does being connected to the network effect the production function of a firm such as lowering the production costs of its product?	Dr. Bolan: Adoption. The more people on the network, the more benefits can be realized.
What are internalities? What are the basic functions of the network—or direct versus indirect?	Dr. Bolan: This question has not been addressed. Negative externalities would reflect things we are experiencing now such as congestion in the network. The flood of messages is overwhelming the network and the user. Dr. Horan: There are internal costs to connect to the network. This could affect the value of the externality, or the return the firm gets from having access to the network.
We would like to see the basic economic relationship. What are base costs and benefits of hooking up to the network?	Dr. Bolan: We seem them as a part of a package. The investment is made on the understanding that there will be a return. There is a limit to the positive externalities to a network. There is a critical mass point where the network can survive without subsidy. Below the critical mass point, the users are not contributing the full costs of the network—just as universal phone service is provided to everyone in America. At some point in the development of the network there is a cost to not developing. That is, if you are in business and all of your competitors are realizing the benefits and you are not connected, you are experiencing the costs of not being connected.

Product Life Cycle

The is a standard life cycle idea, which reflects profit stages:

- Product birth and design = zero profit
- Super profit = temporary monopoly
- Global profit = lack of substantial market power by any one producer
- Normal = oligarchy
- Normal = excessive Competition

Dr. Bolan gave the example of Boston/Cambridge spin-offs from MIT and Harvard:

- Birth Stage—Initially these firms were located in vacated warehouses and lofts;
- Super Profit Stage—Larger facilities were developed with access to marketing and specialized workers;
- Global Profit Stage—Firms move to where labor is cheap, manufacturing became standardized.

Highlights from the Question and Answer Session

Question	Answer
You just described the spatial implications for a particular firm or industry. Would these concepts help you look at a particular set of places?	Dr. Bolan: Dick: Yes. Part of the reason we are looking at non-durable manufacturing is because we are assuming that they moved to places like Honduras for cheap labor. The next question is where in Honduras are they locating? So we are very much concerned with location tendencies of these firms.

Complexity Theory

Dr. Bolan began talking about the pitfalls of reductionism, an attempt to define the behavior of the most elementary matter, which sometimes obscures what it is you are trying to study.

Example: If you wanted to study the nature of a rhythm, you could not by looking at a single beat. Another important assumption is that most of our thinking in the social sciences has an assumption of equilibrium. Complexity theory argues that equilibrium is death, and that if the system reached equilibrium, it would quit exchanging energy.

Wrap-Up

Dr. Bolan said he was currently in the second year of a six-year study. Presently the focus is on case studies of new telecom in the old economy. These are non-durable goods such as food, apparel, and publishing. Are they adopting these new technologies? The study looks at firms with multiple operations with six or eight branch plants such as Nike, General Mills, and Coca Cola. In addition, the study looks at locations of URL addresses; they are primarily located in urban areas, but where in urban areas? One of the confusing factors is that telecommunications

has high rates of obsolete products. Cambridge and Silicon Valley continue to have innovations in products because of the existing structure, which allows for easy marketing and development.

Highlights from the Question and Answer Session

Question	Answer
A question you could ask is what the effect of a potential stream of innovations on a diluted geographical space is. Particularly, are there strategic places where investments could subsidize and spur that innovative process?	Dr. Bolan: We have a discussion on this topic already. One of them is to wire rural Minnesota. Is this a worthwhile investment? There are two faculty members currently working on the project; however, this may be up to three depending upon who is hired this summer.

STAR/TEA-21(Task 1): Karen Chapple

Underemployment and Commuting Patterns

This research focused on examining patterns of underemployment and commuting patterns in the North Metro I-35W Corridor. Initially a mail survey was done. Then there were focus groups culled from the respondents to the mail survey. There was good response from both of these survey methods. The researchers also interviewed 50 employers from along the corridor.

Dr. Chapple presented findings by underemployment type and gender. For the overall corridor, 31 to 49 percent of respondents were underemployed. She also presented findings by underemployment type and worker characteristics. A significant finding was that 31 percent of respondents wish to work fewer hours.

People who wish to work a greater percentage of work hours at home are in the following classes: clerical, personal service, art design, computer related, legal, architectural, financial services. Generally, it is people at the “higher end” of the employment spectrum who are inclined to work more at home.

Who rides the bus? The study found a disproportionately high number of females. Within the females group it is clerical, engineering, legal (downtown jobs). Fifty-two percent of respondents have bus service near their homes. Sixty percent of respondents have bus service near work.

Many respondents thought that providing transit service in suburbs was simply not practical and would not likely succeed.

Why don't people use the bus? A very important thing is people want flexibility to go to/from work when they wish and to be able to respond quickly if they have sick child, etc. Also, many people need vehicles at work for meetings, etc.

Would ITS technology help get people on buses? Dr. Chapple focused on the responses of people who currently do not use the bus. ITS would be used to get information to riders primarily regarding when the next bus is coming. Dr. Chapple highlighted the response of “Kathy,” a focus group participant, as being quite representative. “Kathy” said that ITS would be good for those who already ride the bus but would likely not get non-users to become users. There were a couple responses on the other end (ITS would help get people into buses), but these were very much in minority. For most people, it was an issue of service—not information—that was the limiting factor for people using transit in the corridor.

The committee noted the work done by Mn/DOT on this subject, but commented that there probably is a need to take a more focused look at why people don't use transit more.

Home-Based Work Study

Dr. Chapple reported one “staggering” finding, namely that one in five recently established businesses are in residential structures.

The primary types of services provided out of homes are:

- “high-end consulting” (of this, computer consulting is the biggest category);
- construction; and
- child care.

Dr. Chapple said she did not find any significant patterns regarding where home businesses are spatially distributed. They were pretty evenly distributed throughout the study corridor.

Businesses are just as likely to be in strictly residential areas as areas with some employment/commercial development.

Highlights of responses of people who are home-employed:

- It has very much helped their efficiency/productivity;
- Negative stigmas are breaking down (people don't equate working at home to Mary Kay Cosmetics any more).

At this point, Tom Horan suggested that the work he has done with SLPP on Guidestar projects points to three general categories of home workers: a) yuppie, single people doing groovy business start-ups, b) "trip-efficient soccer moms," and c) "couch potato tele-workers." Dr. Chapple said that these categories did ring true to her. She said that those in the first category, in particular, were quite prevalent.

Arnold Howitt then made the point that this discussion is consistent with the perception that trying to tie travel behavior to the work-at-home phenomenon is much more complex and difficult than originally was believed. This is because one cannot view work-at-home people as a clearly defined and homogeneous category. As discussed earlier, there are decidedly different categories of stay-at-home workers, each with quite different travel characteristics. Susan Handy commented that even within categories of stay-at-home workers, travel behavior and issues are complicated.

Dr. Howitt pointed out that, unfortunately, these findings and discussions are not "transit friendly." He said that transit needs "large patterns and large groups." The more "particularized" travel behavior is, the more difficult it is for transit to work.

Regarding next steps using the presented work as a basis, Dr. Chapple said that travel diaries would be a good next step (second part of the study). Also, she said that a good research effort would be a more focused look at why people do not ride buses more.

Dr. Handy asked Dr. Chapple what her favorite finding was. Dr. Chapple responded it was that a surprisingly high percentage of people would be willing to take a pay cut to be closer to work (reduce commuting time). Another surprising finding was that many people who express a desire

to be closer to work are recent arrivals to the corridor. This suggests that community amenities are more important than work accessibility in peoples' locational decision-making.

STAR/TEA-21(Task 2): Tom Horan

Managing Interorganizational Systems: The Case of Emergency Response

Dr. Horan began by presenting a layout of organizational systems architecture, which connects institutional and policy level issues. He noted that emergency services are not interchangeable; they are distinct and separate. Given this observation, the question of their relation becomes pertinent, especially given their time-critical nature.

Dr. Horan noted the increased importance of cellular telephones and emergency cell phone services. This has become the principle medium by which emergencies are communicated; more than 70 percent of emergency calls made are from cell phones. This is a self-organized system; no one mandates that cell phone users call, which creates the implication for transferability to other aspects of the transportation system. Namely, how could this be incorporated into other plans?

Current areas of analysis:

- How the technical, institutional and policy networks interact to create seamless service;
- Implications for distributed and emergent networks;
- Better understanding of wireless demand and use and impact of service planning and access in rural areas;
- National implications for management of critical infrastructures.

Dr. Howitt noted that this issue is something the justice department has looked at, especially in the wake of the emerging importance of emergency planning. He gave the example of Columbine High School, where officers using different radio systems couldn't communicate.

Dr. Horan responded that he plans to analyze the different plans that have been laid out and mentioned the example of the Mayo Clinic teaming with OnStar. In addition, Dr. Horan mentioned Mn/DOT and the e-911 services. He noted that he and his research staff have had to immerse themselves in these systems to find out about them and analyze policy implications.

Dr. Horan gave a review of the interviews of individuals that have been completed to date and noted that he is also conducting a review of literature of inter-organizational systems.

Some observations from interviews:

- Rochester and Mayo clinic: Immediate information about vehicle condition is critical in deploying the right set of services. Local officials realize that this is an inter-organizational issue.
- In Duluth, Dr. Horan spent time talking with police departments and understanding their role in dispatch of services. He noted the contribution of their bottom-up insight.
- In St. Paul, Dr. Horan and his staff have been talking at the policy level with people who are setting the standards.

The study plans to look at the goals of transportation system and safety to identify the management system needed. One particular issue is that the consequence of organization and planning happens in real time. The study aims to look at technical gaps and policy conditions as well as how to achieve integrated service that has to operate through some sort of maze.

Highlights from the Question and Answer Session

Question	Answer
<p>Dr. Handy: What about generalizability of study?</p>	<p>Dr. Horan: The consequences are so real time, because of situation, being able to look across systems and build interfaces is critical. If this can provide in-depth case study of managing systems, then it moves to theory of network management. The inter-agency, public-private issues would be generalizable.</p>
<p>Mr. Halvorson: Regarding the number of calls coming in by cell phone, what if the legislature outlaws cell phone calls from the car? Can the study findings be used in the debate? Would it be worthwhile to bring that forward in that debate? Hands-free cell phones are okay, that's a very important finding.</p>	<p>Dr. Horan: This is clearly one of these unintended impacts of technology. [A brief discussion of what the proposed laws actually are.] As a policy question, what are the impacts? One is an increase in the number of emergency calls; the second is the perils of driving while on the phone.</p>
<p>Dr. Howitt: If enforcement of said laws is difficult, we want to create a normative disposition to not using the phone for chatting. This effect would be very small.</p>	<p>Dr. Horan: The point is that the cell phone and wireless communication have become integral part of the transportation system. That's a reality. The question is what to do about it now. The notion of outlawing cell phones has not acknowledged that fact. Traffic management systems have been generally reluctant to recognize it.</p>
<p>Max Donath: The Harvard Center for Health Risks has done a lot of studies and has discussed the use of cell phones for notification. Hands-free calling on cell phones is not going to eliminate the very high potential for crashes because this has to do with content of conversation and stresses. Of course, there haven't been enough studies, so the jury's still out. Many countries ban the use of cell phones, holding cell phones while driving. Enforcement is so intense that almost all cars have some sort of voice communication with cell phones. It is very pervasive among car drivers who insist on using cell phones. So the change in law will have an impact, and people will pull over to talk on the phone. People really need to pull over. Given the introduction of traveler information systems, which are complicated with lots of menus, this will cause so many crashes. We're going to be appalled. Design is a very important part of how these technologies are employed.</p>	<p>Dr. Horan: The communications network that we're talking about for transportation has become one where the providers have control only over a piece of the network, not over the entire network. In the case of a ramp-metering system, control for access is in the hands of department operators. In this case, the major aspects of the network are not in the hands of the operators. What does that suggest for policy and partners?</p>

Dr. Howitt suggested characterizing the systems differently, namely as a network that is more complex. He noted that it has to do with the fusion of two networks, which have to operate in a more integrated way. One model is highly centralized; the other is heavily decentralized. The users are decentralized, with many providers. Intersection of the two networks is required to make them work. Consider the case of emergency services. In regular services, we're thinking of routinized provision of services, either demand-responsive or scheduled (bus service, for example). The aspiration is to provide high average quality. But within the quality constraint, there is also the goal to offer them in a cost-efficient fashion. Emergency services are quite different in that they are very unpredictable in terms of demand and when they are demanded. They are time sensitive and tend not to be cost-effective. Given the quality constraint, one aspect is the time sensitivity. Military services are analogous in that it is necessary to have a rich set of scenarios that you are ready for, even though trigger is unpredictable. The most unpredictable factor is the location. You have to plan, but you can't plan for the exact contingency you're going to face. So this service is inherently inter-organizational. So there's a very rich problem here, which is how you put capacity in place in anticipation of a wide range of events of which you can't predict the nature.

Dr. Horan noted that critical events have a galvanizing force (such as the Columbine incident previously cited), and said that he plans to have case studies and findings prepared by June, 2002.

Dr. Handy emphasized the importance of taking on a more general look at all that is telematics. She said the subject seemed a little muddled. She noted that there were so many things that get put into this, that she would like to see more talk about the categories and thought about some of the dimensions. She commented that the ITS seemed like a different creature: Telecommunications are activities, both high-tech and low-tech. ITS is a whole lot of different things, and a lot is focused on the technical side as well as the service. She suggested clearer categorization of these items.

Dr. Horan responded that he plans to focus on fine-tuning the categorization in year two of the study. He noted that the first phase of the study was aimed at defining the research question

conceptually. The research project will revisit many of the complicated categorization and interconnectedness issues down the line.

Dr. Howitt brought up the issue of the links between individual and system. He noted that the research program so far has been about individuals linked to institutions through a system. He questioned the direction of individuals providing work through the system. For example, for ITS it's much more muddled in the sense that ITS could be conceptualized in that way, or as smart travel kinds of things, but ITS also includes focus on the delivery itself. He said the issue concerned the system and its applications. He suggested the study look at institution-consumer linkages, but not necessarily as a system.

Dr. Horan said he was looking at subset of ITS as part of a community. The larger question for the research project is, "how do these things work themselves out?" He reiterated the need to look at naturally occurring patterns, or come up with conceptually clean framework. He said further work was needed to develop a conceptual framework for why things are categorized the way they are. He noted that the program is scheduled to last more than five years, and that so far, he is only one year into the project. Dr. Howitt agreed and emphasized the importance of looking at other case studies.

3:15 STAR/TEA-21

STAR/TEA-21(Task 3): Lee Munnich

Mr. Munnich talked about the relationship of ITS to industry clusters. He discussed the study background, the potential for application of ITS to the particular cluster, and how the cluster works.

Mr. Munnich discussed the research steps in the methodology used:

- Identify rural industry clusters;
- Convene national rural cluster experts;
- Examine importance of transportation;
- Assess potential for ITS application.

The committee then proceeded to a discussion of rural industry clusters in Minnesota. The group agreed that it would be necessary to look through the data to see which industries might be successful for a particular cluster. Also, clusters should be focused on particular areas, such as transportation, housing, etc.

Greg Schrock added two points concerning the research:

- The need to look at ITS with a narrower meaning; and
- The importance of examining how industries can interact with each other. (E.g., in different levels of firms, regions, and particular groups, different strategies may be taken.)

Dr. Horan brought up the example of Duluth, which could well illustrate the point with supply chain input production and technical cluster.

Gen Giuliano gave an overall review of the project. She noted that a lot of progress had been made, and that it was clearly a nice program. She also raised some questions concerning political feasibility.

Dr. Howitt joined the discussion and inquired about the political factors that shape investment in the last 20 years. Mr. Munnich noted that questions for the next steps include whether to continue considering the perceptions of clusters, and if so, which alternatives exist to be considered.

STAR/TEA-21(Task 4): David Levinson

David Levinson began discussing problems with the quality of traffic data. Because of these problems, the current analysis uses loop counter data rather than information from an old database. The study is interested in the cost of increasing the number of lanes and looks for budget data accuracy and models. There are two main focuses of the research:

- An empirical investigation of transportation network characteristics and the role of ITS in affecting those networks; and
- Related conceptual analysis on implications of network impacts for ITS investment and management.

Highlights from the Question and Answer Session

Question	Answer
Dr. Howitt: How will you figure in costs to ITS?	Dr. Levinson: Look at previous investments and analyze the costs of laying down new road versus ITS costs. The example here is ramp metering as compared to widening the road.
Dr. Howitt: A decision-making system or the political system is missing in your model. You may want to change the proposal to quantify the politics and give better recommendations to policymakers.	Dr. Levinson: This is intentional because I want to find out how much of the decision is not political, where the unknown in the model will be assumed to be political. Trying to isolate the problem right now, while putting the politics off for a while.
Dr. Howitt: I understand what you are saying; however, maybe other researchers could simultaneously study this issue to provide a strong report.	Dr. Levinson: There is an issue with the definition of politics.
Dr. Handy: At first I was skeptical of this paper; however, over time the paper grew on me—as if there is an inevitability in the choices. What are “decision-rules?” I think you may want to use another word. Also, there are differences between the extension of the network and the existing network. Finally, your model includes forecasts of forecasts, which becomes confusing to the reader.	Dr. Levinson: Decisions in the past often force “decisions” in the future.
Dr. Howitt: I understand your excitement on this topic, however I think the study can really be greatly improved by having various backgrounds look at the problem in different lights. Grants, Met Council decisions, Mn/DOT decisions, etc. I suggest you say the institutional processes in generating multiple projects. There could also be an opportunity to interview those who were involved to see if they respond to your results. The value-added information would benefit Mn/DOT by having a well-rounded study.	

4:45 Future Directions for Peer Review Process

Dr. Giuliano began the discussion on the function of the peer review group. She said the advisory function is useful because it helps to develop and define good research programs and to firm up

areas of emphasis. She complimented the clusters study and Dr. Levinson's work. She also said SLPP's commitment to value pricing should be rewarded, and that the State of Minnesota should be pleased.

Dr. Howitt reiterated his interest in Dr. Levinson's work, but noted that the study should be paralleled by a similar look at the political and institutional factors and constraints on network development.

Mr. Munnich said the peer review process had been very valuable to SLPP research projects, but noted that meeting over two days is time- and labor-intensive. He asked the group whether they felt the process was worth continuing; if so, how they thought it could be improved; if not, what other alternatives might exist.

Dr. Handy said the decision of where to go depended on what SLPP gets out of the process. She said meeting in person had definite advantages over going through a solely written process, but that she would prefer meeting in August versus November.

Dr. Giuliano noted that the peer review group served as the sole advisory group to SLPP, and this function is valuable. She said the originality of the ideas coming from a group of experts was key, and that meeting helps the center organize its thinking. She said the peer review process provides an opportunity for real strategic thinking about how to move work forward

Dr. Horan noted that the process was especially useful for research projects with durations longer than one year.

Dr. Howitt mentioned that one alternative might be a paper review and written review process, but that he preferred the live presentations during a set meeting time. He also suggested adding a part at the end of the meeting agenda for general, overall comments on research work being done.

Mr. Munnich brought up the topic of how to bring more faculty members into various projects. He noted that SLPP hasn't had full success at meeting the interested fields of faculty, and that the center should find out how to engage faculty members to join it.

Mr. Halvorson said the group discussion produces positive results, and that the group membership represents a good balance between academic and practical perspectives. He also recommended that sponsors of research, e.g., Mn/DOT, be given the opportunity to follow up and report on their progress in implementing the recommendations coming out of the research projects. He also noted the importance of putting forward these recommendations at the right moment.

Dr. Horan commented that he felt the dialogue around the concepts and methods of research was most valuable to him.

Kevin Krizek noted that the peer review process was examining several projects in various stages of progress. He suggested that the reports be divided up along the lines of the type of work, methodology, and findings.

Dr. Giuliano noted that the group had connected on methodology and research design in the past. Dr. Horan suggested that each individual researcher simply state which sort of recommendations or comments would be most valuable to her or him. Dr. Handy suggested noting these preferences in the briefing book.

Dr. Howitt said he would like to see more discussion of balancing the interests of faculty with those of the sponsors looking for a coherent message or recommendation at the final stages of research. He said the partners and peers of the group likely had faced similar situations and should discuss how to handle them.

Dr. Horan commented that the peer review process helps identify links among the different research projects, which could improve final message coherence. Dr. Howitt noted that

consideration of the big picture during the final part of the meeting would be useful. Dr. Horan added that it would also be beneficial to talk about current trends and recent “big ideas.”

Mr. Munnich noted that having a national group was especially useful, because perspectives from outside Minnesota are considered.

Ms. Rohde said she was hearing real appreciation for the process itself, but asked how to make it better. She queried the group about the length of the workshop, whether there should be field trips, and about scheduling next year’s peer review.

After some discussion, the group set the next workshop date for August 1-2, 2002. Mr. Munnich asked about the size of the committee and membership. Several names were suggested for additions to the group; SLPP staff will contact and follow up.

The meeting adjourned at 5:30 p.m., to be followed by formal dinner at Nicollet Island Inn.

Wednesday, 28 November, 2001

8:30 Value Pricing

Gary Barnes gave a brief update of the work of the Minnesota Value Pricing Task Force, which was organized by SLPP. The Task Force has gone through a criteria selection process to choose a value pricing demonstration project in the Twin Cities and has identified three major proposals.

The Task Force process has created a model for community input and consideration of major stakeholder and citizen concerns. The group is made up of local business and community leaders, political leaders, and civic group leaders.

Dr. Howitt recommended and the group agreed that SLPP staff draft a case study report of the Task Force experience with several phases and various decision making steps, so that it can be disseminated nationally and used as an example for how to manage the political aspects of project selection and implementation. Dr. Howitt further suggested that the case study would

show the different layers of the whole task—the progression levels, the operational levels, and the conceptual framework.

Mr. Munnich noted that congestion has been increasing in the Twin Cities and has been the major concern for the people here. He said that that it is a good thing that there has been some political interest regarding this.

10:00 Guidestar

Frank Douma began the introduction of the Guidestar 2000 study involving the time-use diaries. This project started out as a request from Mn/DOT to study GPS and technology use in rural Minnesota. The project included two steps:

- 1) Research on GPS and wireless; and
- 2) Focus groups in Virginia and Rochester.

There was further discussion on the focus groups including some misunderstandings with Mayo Clinic, the size of the focus groups, and the financial incentives. Mr. Douma then moved on to talk about the time-use diaries. He said that this was a direct follow-up of the previous study conducted on telecommuting. A paper on this project will be presented at the TRB conference in January 2002.

Mr. Douma and Dr. Horan discussed the details of the pilot test conducted in the months of August and September and some of the results from the pilot test. Dr. Handy said it was a very interesting research project and emphasized the importance of the methodology used. She said that the main point to consider is the aspect of substitution and the accuracy of the data. Furthermore, all members agreed that concrete conclusions couldn't be drawn from the pilot study seeing the sample group was small. Nevertheless, this should be considered as a learning tool for the actual study. Dr. Handy added that there would be value to developing technology exploratory research.

Kim Wells asked the presenters about the mix of qualitative and quantitative data. She noted that the methodology used separated them in order to collect richer data. She said qualitative

methodology collects richer data, but more details may be missed. On the other hand, quantitative can be more constrained, less details are missed.

Dr. Handy suggested having a structured part and an open part to the research methodology. She asked about the necessity of the daily experience diaries, which tended to be lengthy. She suggested thinking through what sorts of data are necessary and developing a shorter methodology.

In response to Ms. Wells' question about study length, Mr. Douma responded that two weeks seems to be ample time to judge work habits. Mr. Douma noted that more detail might be nice, but giving the survey respondents a 24-hour schedule plan worked well.

The group agreed that the time required to fill out the daily surveys places a heavy burden on the respondents, and this can affect the likelihood of respondents to complete the survey.

Dr. Howitt suggested the researchers actually meet with the respondents as a follow up to completing the diaries, perhaps in focus groups. Dr. Handy agreed and suggested designing the method to meet in the middle. She said it might make sense to do quantitative methodology first, and then use focus groups to get qualitative data.

Ms. Wells noted that perhaps the researchers should have practiced filling the form out as a group. Dr. Howitt noted that the quality of data would be good if the respondents carried it out and did it every day. Those who waited until every few days may have had memory failures and provided bad data. Mr. Douma noted that the respondents who did not fill out the survey every day ultimately dropped out of the study.

Hennepin County Corridors

Mr. Douma introduced the corridors research topic. He noted that research was to go from big picture to little. The plan consists of hosting a number of round tables and one large discussion forum.

Ken Kriz noted he brings the experience of a financier to the research project. He also said he believes the research project to date presents a good example of what needs to be in place to make transportation improvements.

The research project has sought to put together a framework with five spheres: The framework has four spheres in the outer corners, and one in the middle. The upper left quadrant is “finance,” the lower left is “design,” the lower right is “governance,” the upper right is “economic impact.” In the middle is “citizen preference.” Quadrants connect to their two neighbors and the center.

Dr. Kriz emphasized that citizen preferences must be taken into account, but can also be influenced. In response to Dr. Handy’s question of timing, Dr. Kriz responded that citizen preferences should be considered early. In addition, Dr. Kriz noted that the economic impact of road improvement and construction has to also be taken into account, seeing there is a stream of benefits and costs for different parties. He emphasized that the interplay between the spheres is always two-way.

Dr. Handy inquired about environmental and equity impacts, and Dr. Kriz responded that they appear everywhere in the model. Equity issues are included in the economic impact, and this ties into citizen preferences; economic impact is not just an aggregate number. He noted that perhaps this could be made more explicit in the model.

Dr. Howitt suggested breaking the economic impacts into “impacts” and have several sub-groups, like economics, etc., to which Ken agreed.

Dr. Kriz commented that the current method of road financing is not adequate. Innovative financing measures have nothing to do with new money, but rather reformulating cash flows. He cited the example of Denver, which has faced many financing prohibitions. In this case, local officials came up with GARVEE, a program to use state and local money to leverage federal money, not the other way around. As a total package, the cost was in excess of one billion dollars. A series of referenda was required to get the authority to do bonds, taxes, etc.

Regarding an analysis of design framework, Mr. Lari noted that putting transit in medians is cheaper, but it does not allow for economic development around it—this is not as good for the community it is in. The group tentatively agreed that research shows this is true.

Dr. Handy cautioned Dr. Kriz on the citizen preference circle. She said there was a lot of diversity among preferences. She also noted the problems of stated versus reveal preferences approaches. Mr. Lari and the group agreed that there could be bias introduced into the data when a respondent says one thing but really believes another.

Mr. Douma presented the question, “How can we get out there early enough to do citizen preference right?”

Dr. Horan described research he has done where people were asked to label the assets and liabilities of a community. This seemed to correspond to a corridor idea in some places and not in others.

Dr. Handy questioned the idea of forcing the use of the term “corridor” on discussion participants. Dr. Horan suggested going from town to town, rather than try to sell the corridor idea to them, and just end up with a corridor.

Dr. Howitt brought up the topic of government versus citizen preferences. People working in government change often during projects, yet time frames are lengthy. Also, often citizen participation reverts to simply paid special interest advocates. In addition, he noted that citizen preferences could change over time.

12:00 Lunch

Legislative Input on Research Priorities

Meeting adjourned at 1:00