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Publication of this paper sponsored by Committee on Social, Economic, and Environmental Factors of Transportation.

Resource Implications of Electronic Message Transfer in Letter-Post Industry

ALFRED M. LEE AND ARNIM H. MEYBURG

As Western societies move more and more rapidly to information economies, the need for face-to-face human interactions and for the exchange of physical goods is being replaced by the need to exchange information. New technologies have been and are being developed that facilitate this flow. The impacts of this change in orientation are many. Substitution of personal travel and hard-copy communications transport by electronic means is a significant social development with implications for energy consumption, vehicle fleet, paper, and labor requirements, among others. This paper attempts to illustrate some of the impacts of substituting communication for transportation. The use of electronic message transfer technology by the U.S. Postal Service is examined in the context of current first-class mail shipment patterns. Limited energy, vehicle, and paper resource conservation possibilities could be enhanced by implementing policies to stimulate the development and use of electronic message transfer technologies.

Western societies are moving at a rapid pace toward information societies. The information flow required per person in personal life-styles, in research, in administration, in all service industries, etc., is increasing dramatically. All aspects of daily life and of society in general are affected by this acceleration in the exchange of information. Few households are without telephones or televisions. Banks and travel agencies without computers are rare. Government recordkeeping would be virtually impossible at the present scale without the extensive use of electronic devices.

Transportation and communications are closely related infrastructural elements of society (1). These modes are used to enhance and facilitate exchange in the national and international economy and to increase the level of human interaction. As society moves toward an information economy, the need for exchange of goods, defined in a very broad sense, is being replaced by the need to exchange information. This evolution is changing the nature of demand for these services.

In some instances communications may substitute for particular transportation needs. In other cases, they may be complementary. Patterns of telephone use serve as an example of the substitution potential of communications for transportation. Telephone communications have reduced the need to transport various kinds of messages and also

the need to travel personally to communicate. Complementary relationships develop in situations where communication activities affect the operation, safety, efficiency, and effectiveness of transportation services.

This paper is concerned with the resource implications of transportation-communication trade-offs. In order to avoid confusion about the distinction between the substitutive and complementary relationships, which is at times difficult to maintain, substitution analyses will be confined to those situations in which a trip is entirely replaced by communications. Since extensive examples of the complementarity aspect were published previously, they will not be considered here (2,3). This paper concentrates on the substitution aspects of communications for transportation, specifically in the context of electronic message transfer.

Numerous studies have considered the substitution potential of communications for transportation (e.g., 4-8). Most research has dealt with technologies to reduce personal travel needs. Two technologies that seem to be particularly promising candidates to influence future travel demand patterns are the videophone and the teleconferencing unit.

The video telephone adds a visual dimension to the telephone, allowing transmission of pictures of the communicating parties or conveyance of visual information. Communication of graphic data, for example, could facilitate consumer decisions regarding purchases by telephone and also allow security monitoring. The motivation behind the development of this technology lies in a desire to enhance the performance of traditional voice communication systems to a degree that they are attractive alternatives for satisfying some traditional personal travel needs. The potential for augmented audio communications and the possibility of viewing textual and graphical material are considered to be the principal advantages of the technology. The potential benefits of this technology have not been fully realized due to the lack of development of a suitable market. While at the present time consumers have not perceived a sufficient increase in utility to justify purchasing and using this expensive equipment, demand is expected to grow in the future. In the United States, the videophone, developed by Bell Laboratories of the Bell System®, is known by the trade name Picturephone®.

Teleconferencing services are essentially an extension of the videophone capability. They are designed to reduce personal travel needs to attend meetings. Also, these services could have a substantial impact on the character of work trips. It is feasible to decentralize office locations by using teleconferencing services. Such workplace location decisions are significant since people working in the central business district (CBD) travel twice the distance and have approximately 2.25 times longer trip times than those persons with suburban employment. Obviously office or workplace locations in different cities can be connected by means of teleconferencing technology, thus reducing the need for intercity business travel.

New electronic message transfer technology now under development offers the potential to alter transportation demand in a significantly different fashion. Innovative electronic systems that transfer both messages and information can reduce needs to transport paper-based media. This discussion will sketch the rudimentary features of such systems and then consider the resource conservation implications of substitution possibilities, particularly with respect to the letter-mail market.

ELECTRONIC MESSAGE AND INFORMATION TRANSFER

Emerging electronic message and information transfer systems include a range of newly developed technologies that could have a dramatic effect on the volume of discretionary travel demand such as shopping, social-recreational, educational, human interaction, personal, and business travel needs. One such technology is known by the generic term as viewdata, and by the trade names Prestel (United Kingdom) and Bildschirm-text (Federal Republic of Germany), among others. Essentially it consists of modified telephone and television units that allow subscribers to gain access to complete libraries, newspapers, mail-order catalogues, entertainment information, electronic games, home computer services, news, sports, and weather information. The number of potential services is only limited by the willingness of information suppliers to make their products available to subscribers.

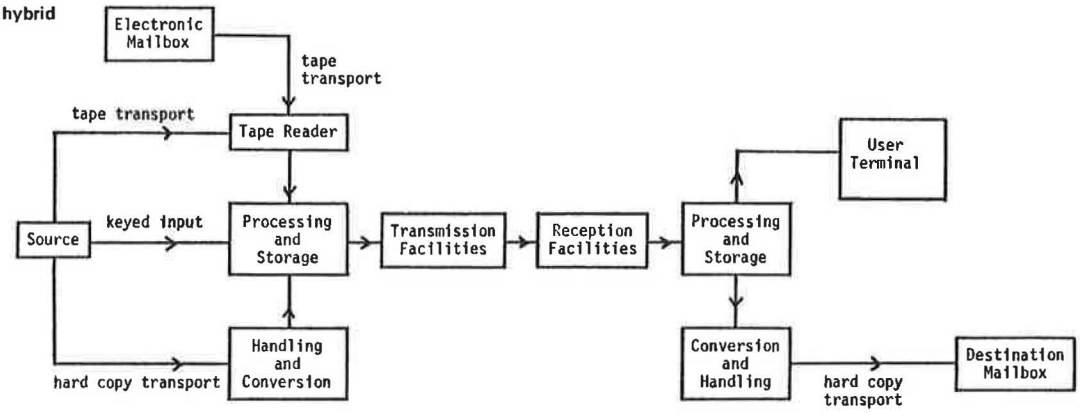
These systems offer primarily information retrieval, interactive gaming, or teleprocessing capabilities. Data are accessed by telephone lines from a central data storage bank and displayed on modified television receivers. At a somewhat more sophisticated level, this operational technology could allow subscribers with modified television-keyboard units to generate and exchange personal messages. Such systems could stimulate changes in methods of distributing books, publications, newspapers, etc. These practices could affect transportation, energy, and paper requirements.

A second objective of evolving electronic message transfer technology is to facilitate the exchange of person-to-person communications that are graphic or alphanumeric character-oriented and digitally encoded. Such services convey messages electronically but may at some stage produce and transfer paper copy by conventional means. The U.S. Postal Service (USPS) and private corporations are currently evaluating the operational and economic feasibility of electronic message transfer services. The private sector is concentrating primarily on terminal-to-terminal systems. The USPS has been developing a nationwide system that integrates conventional postal operations with electronic techniques.

The USPS has been developing this hybrid electronic message transfer system design for more than two decades. The current design will provide a nationwide service with next-day delivery for 95 percent of messages entering the system by 5 p.m. on the previous day. Plans are also being made to provide a priority service (i.e., 1-2 h transfer of messages) at a premium price. Both the overnight and priority service will use the conventional postal collection and distribution system along with new electronic equipment under development.

Various input alternatives will be available. Large-volume users, such as banks or credit card companies whose messages mostly consist of computer-generated material, will be able to drop off magnetic cards or tape containing encoded messages. The USPS will provide equipment to read and route these messages electronically. Other heavy users with messages already printed on paper will be able to submit paper packs (i.e., bundles of nonenveloped message pages boxed in cardboard containers), which will be facsimile encoded by USPS personnel. Individuals with single hard-copy messages will access the system by using coin-operated facsimile machines called "electronic mailboxes", which are to be located in post offices and public facilities (e.g., shopping malls). Those users with input terminals will be able to submit messages over local telecommunication links, although USPS is not encouraging wire-line input at this time.

Figure 1. The USPS electronic hybrid system.



Messages contained in paper packs or on magnetic media can be deposited at post offices or regional postal facilities (called sectional centers). From there they will be transferred by truck to specialized message centers to be electronically routed toward receiving centers. In the case of remote electronic mailboxes, encoded messages will be moved electronically to message centers over local lines or stored on magnetic media and trucked to centers, depending on the cost-volume characteristics of each mailbox. The 87 electronic centers, which are expected to cost $320 000 each, will be located geographically according to generated message loads.

Messages arriving at destination centers can be conveyed to intended recipients by several means. Messages that are directed to user terminals will be routed to a communication processor and interface and are held until contact is made between message centers and remote terminals. Messages to be conventionally delivered are reproduced on paper, enveloped, and then sorted according to carrier delivery sequence. After hard-copy production, messages will be trucked to the local postal distribution stations to be fed into the conventional mailstream. Hard-copy message production requires the use of sophisticated paper-handling equipment to facilitate the movement of paper through the output subsystem. The USPS hybrid design is illustrated in Figure 1.

The integration of conventional and electronic message delivery activities suggests some resource conservation possibilities, which will be discussed later in this paper. Some competitors fear that eventually USPS may operate local telecommunications links for input and output directly between stations and message origin-destination points. Others feel that provision of all-electronic services to hard-to-reach rural areas would be a cost-effective move for USPS. Such an expansion of service might reduce both carrier personnel and vehicle requirements. However, suggestions that USPS operate either electronic collection or distribution services have been met with quite vocal oppostion.

RESOURCE SAVINGS POTENTIAL

During the last decade the general public has become increasingly aware of the unpredictable nature of energy supplies and the impending scarcity of nonrenewable energy sources (especially fossil fuels). As a result, there is greater public sensitivity to energy issues, more debate over which energy policies are most desirable (e.g., developing nuclear versus new nonnuclear sources, and conservation efforts), and also greater efforts devoted toward conserving resources, especially energy supplies. Therefore, the resource conservation potential of electronic message transfer cannot be ignored. The application of such technology in USPS letter-post operations could result in limited resource savings, especially in fuel and vehicle requirements, as will be illustrated in the following sections. Of course, additional resource savings are clearly possible as applications of new communications technology permit the elimination of various discretionary and business travel needs, as noted previously.

Energy Implications

The energy requirements of conventional postal technology can be compared with those of electronic message transfer. Any complete analysis of these alternatives would require an examination of the total energy use of each system (i.e., energy requirements to produce necessary machinery along with energy used in equipment operation). However, within the resource constraints of the research project that underlies this paper, only the energy used in electronic transfer operations is compared with that required for conventional transportation of messages. This concise analysis is only intended to initiate a larger discussion of the energy conservation potential of electronic message transfer. It is hoped that these order-of-magnitude calculations will be expanded and refined through additional research efforts.

The data in Table 1, provided by the Ford-Philco Corporation, list the labor, equipment, and power requirements of a model electronic hybrid transfer system. Notice the power requirements of the four transmission station types. A complete transfer system, consisting of a varied mix of these stations, would use 25 141 200 kW·h or 85.78 billion Btu's to move 30 billion messages. On a per-message basis, each transmission would require an average of 2.9 Btu's.

Table 1. Resource requirements of an electronic message transfer hybrid system (30 billion messages/year).

Item	Terminal	No. of Shifts	Requirement
Staffing	A and B	3	1 engineer[a], 2 technicians[b]
		2	2 technicians
	C and D	3	1 engineer and 1 technician
		2	2 technicians
Control		3	2 engineers
		2	1 engineer
Power	A		50kW = 438 000 kW·h/year
	B		30kW = 262 800 kW·h/year
	C and D		20kW = 175 200 kW·h/year

[a]Engineer salary = $40 000. [b]Technician salary = $25 000.

To derive an estimate of energy used by the equivalent conventional transportation activity, several assumptions must be made. First, the transportation of messages between conventional processing stations and transportation terminals, which is provided largely by the USPS fleet, is assumed to be similar to the transportation requirements of moving hard-copy messages between the electronic processing centers and conventional distribution centers. This simplifying assumption suggests that the transportation requirements of the intercity contract fleet will be equivalent to those of the electronic transfer activity. A second necessary assumption involves the distribution of messages carried by each mode. Virtually all nonlocal, first-class messages travel on airline passenger flights while the remaining messages move by truck. Since 40 percent of first-class mail is nonlocal, in this sample calculation 40 percent of the message load is assumed to move by air while the remaining 60 percent is moved by truck.

In FY 1977, USPS estimated that 400 million ton-miles of transportation moved 53.7 billion first-class mail pieces between processing centers (9). Assuming a 40/60 split in traffic by mode and that modal energy intensities are 3300 Btu/ton-mile for belly freight carried on passenger flights and 2700 Btu/ton-mile for intercity truck, it can be estimated that 1176 billion Btu's were required to move 53.7 billion pieces (10). Directly scaling this estimate to match the system output of the electronic system suggests that 30 billion messages required 657 billion Btu's. On a per-message basis, intercity transport of each message required an average of 21.9 Btu's.

Comparing energy use in the transfer of 30 billion messages by electronic message transfer to that required by current conventional transportation practices, only about 571 billion Btu's could be saved by sending messages via electronic message transfer or 19 Btu's/message. Such energy savings are equivalent to about 98 450 bbl of crude oil. In the event that energy intensities of both conventional and electronic transfer technologies could be improved by 10 percent over the next decade, the conservation potential would amount to only 88 638 bbl. Actual savings of crude petroleum could be greater than the above figures indicate since electronic message transfer uses electricity that can be generated from nonpetroleum sources. By shifting to electronic message transfer, message movement could be accomplished without relying so heavily on petroleum sources of energy.

In terms of the aggregate domestic energy consumption, the potential savings due to electronic message transfer are quite small (11). In 1977 energy use was estimated to total almost 76×10^{15} Btu's. Of this aggregate amount, petroleum use accounted for approximately 37×10^{15} Btu's or about 6.7 billion bbl. When electronic message transfer energy savings are compared with these statistics, such possibilities amount to only 0.5 percent of petroleum consumed in one day and an even smaller proportion of the total energy used in 1977. Yet, an annual savings of 98 450 bbl will not be completely insignificant as petroleum supplies become more scarce.

One might expect much greater savings if conventionally conveyed messages shifted to an end-to-end electronic message transfer system. However, USPS uses only 350 million gal of gasoline and diesel fuel to move all classes of mail (i.e., more than message traffic). This annual figure, which includes fuel used in all owned, leased, and contracted vehicles, amounts to only 0.1 percent of national petroleum consumption in 1977. While the implementation of electronic message transfer technology has the potential to save previous petroleum resource, it cannot offer the resource-saving potential that, for example, other transportation or space-heating conservation programs could provide. However, it can contribute to general energy conservation efforts. Much greater energy savings are possible as consumers learn to substitute electronic alternatives for a wide range of travel needs. As petroleum supplies become more scarce, the government may well encourage the use and development of electronic message transfer services.

Vehicle Fleet Requirements

In FY 1978, USPS delivered more than 96 billion items of which almost 56 billion were first-class message items. To accomplish this task, an average of more than 40 million stops were required each day, amounting to an equivalent mileage of four round trips to the moon for rural routes and 1 million miles for city routes (12,13). As one might expect, USPS operations represent a unique assembly of resources and management practices.

USPS has one of the largest vehicle fleets in the world, currently owning approximately 120 000 vehicles in active service with another 70 000 under contract. This sizable transportation pool is larger than the combined fleets of the top five commercial carriers. The physical plant, vehicle fleet, and labor force managed by USPS amount to much more than that available to the very largest corporations such as American Telephone and Telegraph.

It is difficult to judge the effect that electronic message transfer will have on postal-owned vehicles and on leased and contract vehicles. Over the short term, this fleet of 190 000 vehicles will remain relatively stable. In the more distant future, vehicle requirements may change more radically. For instance, the delivery fleet, which totaled about 150 000 vehicles in FY 1978, may shrink if patrons overwhelmingly adopt electronic collection and delivery options and also if they are willing to accept reduced conventional services (e.g., three-day-per-week deliveries). Intercity contract vehicle needs may also change. If messages migrate from conventional to electronic alternatives, both the size and the number of trucks required may be reduced. Any shift in vehicle fleet requirements will depend on public response to both conventional and electronic alternatives.

Paper Requirements

One can anticipate that electronic message transfer will have implications for paper, a medium that has historically recorded and stored messages. End-to-end electronic message transfer and office automation systems have been commonly depicted as catalysts for promoting the paperless society. Ideally, recipients could review their correspondence in video form and decide whether to produce a paper copy or simply store it electronically. Considering the amount of paper-based correspondence and transactions flowing among business and government, one could imagine that such potential for saving resources is great. The hybrid electronic message transfer technology could actually increase the use of paper resources since each time a message is sent from a public terminal two paper copies of the message will be created. While the technology offers real options for paper conservation, the actual amount will depend on user habits.

SUMMARY

We have suggested that resources, notably paper,

vehicles, and energy, can be conserved if consumers react favorably to the introduction of hybrid electronic message transfer technology into the letter-post industry. Potential resource savings could be even greater if end-to-end systems become popular. Government may wish to implement policies to stimulate the development and use of electronic message transfer in order to realize these and other potential resource conservation possibilities.

This paper focuses on the resource implications of substituting communication services for transportation services. While the use of electronic message and information transfer services in the letter-post industry will not have the resource conservation possibilities of other programs, particularly in the transportation area, it could contribute to efforts to reduce the total resource consumption in the United States, in addition to offering potential speed and cost advantages. At a later stage, when the hybrid system equipment has been fully specified, it will be possible to make a much fuller energy analysis, comparing total energy use (i.e., construction and operation requirement) of the alternative systems. Of course, other applications of electronic message transfer technology (e.g., teleshopping, utility telemetry, and decentralized workplaces) could be even more significant.

In the context of this paper we were only able to cite one example of the likely impacts of this technology. The overall research effort that underlies this paper addresses a number of other dimensions, namely issues of privacy, liability, and capital or labor substitution possibilities in postal operations. The development of technically, economically, and socially efficient communication alternatives to transportation services requires that both the costs and the benefits be considered when designing and implementing such systems.

ACKNOWLEDGMENT

This research was supported in part by the National Science Foundation.

Discussion

C. John Langley, Jr., and Rammohan Pisharodi

The first order of business is to compliment Lee and Meyburg for a very interesting and relevant paper. This contribution appears to comply with the intent as well as the spirit of the charge to the Subcommittee on Social and Economic Effects of Energy Constraints of TRB Committee A1B03. While the topic of substituting communications for transportation has received a variety of attention in the past 10 years or so, there is no question that the concept integrates the nature of general concern for these two areas of national priority.

This paper provides some very interesting insights into the resource implications of substituting communications for transportation, specifically in the context of electronic message transfer. This is in contrast with the fact that most of the past studies in this area have dealt with technologies to reduce personal travel rather than messages.

The hybrid electronic message transfer system being developed by the U.S. Postal Service (USPS) provides an excellent case study for investigation. Although the research project admittedly did not consider every imaginable aspect of the resource savings potential of electronic message transfer, it does represent a concise exploratory research study on an aspect of the transportation-communication trade-off in which several claims had been made previously with little empirical support. The paper also raises several issues regarding the energy conservation potential, vehicle fleet reduction, and paper conservation opportunities associated with electronic message transfer. The analysis indicates that the potential of the system for conserving energy supplies, while not completely insignificant, cannot offer the dramatic results of alternative programs such as public transportation or space-heating conservation.

It appears that the electronic message transfer system has the potential to substitute fully for letter mail, at least in the context of the needs of business and industry. The system can transmit product specifications, technical details, market information, purchase orders, copies of contracts, etc., in a very short time. This could lead directly to shorter market response times and purchase lead times, which in turn would permit companies to reduce their inventory levels, while simultaneously providing an equal or improved level of customer service. This in turn will reduce the waste of resources such as materials, manpower, and facilities that could result from a sudden change in market conditions. While it would be very difficult to measure the resource conservation potential of consequential impacts such as these, we can speculate that it would be considerable.

In an overall evaluation of the potential of electronic message transfer, we cannot help but agree that the level of innovation associated with the concept is high. Also, the energy saving potential is notable, particularly with regard to fuel and vehicles. While we would agree also with a contention of Lee and Meyburg that the USPS represents a unique assembly of resources and management practices, we have no evidence to believe that the results to date at the USPS have produced an unusual number of efficiencies, economic or otherwise. The simple fact is that without its exclusive franchise for the delivery of first-class mail, the USPS would have preceded the fate of REA Express by many years. Thus, innovation to date by the USPS has occurred largely in the environment of monopoly business enterprise, and has relegated economic efficiency to the role of sacrificial lamb. The net energy and resource savings that would result from a greater trend toward free market enterprise would without question far surpass the relatively meager savings resulting from electronic message transfer. Our recommendation is that any government interest in stimulating the development and use of electronic message transfer should place a high priority on coordinating its actions and policies with the skills and abilities of the private sector. Firms such as UPS, IBM, and ITT have proven themselves capable of operating in economically competitive environments, and they should be given an equal opportunity to contribute. What we are really saying here is that the problem is not with the technology but with the institutional realities.

Another perspective on the problem is the concern expressed recently by Sorkin (14) that the development of electronic message transfer capabilities on a fully competitive basis would spell financial disaster for the USPS. This conclusion is supported by three contentions, namely that

1. The postal service is far behind private industry in the area of technological development,
2. The postal service has performed little market research or evaluation of alternative technical systems for electronic message transfer, and

3. The postal service would be required to provide a standard set of services in competition with a set of diverse and unstandardized offerings by other firms.

Considering factors such as these, it seems that a cooperative, rather than competitive, environment between government and the private sector would be the most appropriate solution.

As a general statement, however, the success of the system will depend ultimately on how readily society accepts it. While the system itself could bring about tremendous changes in the habits of people, businesses can be expected to be early adopters due to the greater value they place on the prompt communication of information. When a considerable number of private persons and businesses do not consider an electronic letter to be a proper substitute for a regular letter, the simultaneous existence of two parallel systems of communication might result. The likely impacts would be an increase in the cost and a reduction in the efficiency of regular letter-mail service.

Lee and Meyburg have mentioned a number of other important implications of the transportation-communications trade-off--specifically, the issues of privacy, liability, and capital-labor substitution. Among these, the issue of privacy might have the greatest impact on the implementation of the technology. Business and private persons might not readily accept human handling of their uncovered private letters. This problem could be alleviated by a high degree of automation in the handling of letters and by technological development that would ensure that only authorized persons would have access to the information contained in the letter. We will look forward to learning of future developments in this area.

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Publication of this paper sponsored by Committee on Social, Economic, and Environmental Factors of Transportation.

Abridgment

Estimation of Gasoline Price Elasticities for New Jersey

JOHN G. J. DeJONG

Gasoline price elasticities are useful in projecting vehicle miles of travel, gasoline use, and gasoline tax revenues. The two objectives of the study were (a) to develop a method for the estimation of two types of price elasticities of demand for travel by automobiles and (b) to arrive at empirical elasticities for a state. One-year and medium-term elasticities were estimated for New Jersey. Travel counts and real gasoline prices from 1972 to 1979 were correlated to determine the one-year and medium-term elasticity for New Jersey. The elasticities that resulted out of this correlation were compared with other elasticities in the literature. The estimated four-year elasticity conforms very well with the medium-term elasticities in the literature. Four scenario adjustments were used to represent the growth rate in travel as caused by factors other than the real gasoline price. The first scenario resulted in elasticity estimates that conformed to the best of those in the literature: a four-year elasticity of -0.28 and a one-year elasticity of -0.14.

The purpose of the study was to develop a one-year and a four-year elasticity of demand for travel by automobiles. A price elasticity of demand for travel is defined as the change in the quantity of automobile miles demanded in response to a change in the gasoline price. Vehicle travel counts and real gasoline prices in New Jersey for each month from 1972 to 1979 were correlated to determine a one-year and a four-year elasticity for New Jersey. By comparing two of the same months with four years in between, or two of the same months in two consecutive years, a large number of elasticity estimates were arrived at and can be used in calculating an average elasticity estimate.