

Sociotechnical Factors in Air Travel: Some New Insights into Telecommunications Interactions

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Recent developments in sociotechnical factors that influence the interaction of air travel demand and telecommunication systems, including technical innovations, have renewed interest in this subject. Airlines have expressed concern that they will lose a significant portion of their future business travel growth to the electronic media. To improve the scientific basis for developing estimates of replaced travel and associated impacts such as infrastructure utilization, a research project was carried out on this topic. In this paper are presented highlights of findings on the determinants of travel substitution and stimulation phenomena. A systematic investigation of factors and their interrelationships is reported. The factors treated include socioeconomic variables, communication needs, technical capability and cost of telecommunications and transportation, institutional and policy variables, human factors, and transportation-telecommunications trade-offs in representative spatial and service contexts. Analyses and compiled behavioral information lead to a better understanding of travel impacts. Complexities and uncertainties are highlighted. An attempt is made to provide insights into the determinants and their interrelationships that could form an improved basis for projecting the effects of rapidly evolving telecommunications on air travel demand and related factors.

The cost and technology of telecommunication systems are improving rapidly while the air transportation sector is experiencing congestion-related difficulties, at a number of locations, in maintaining a level of service that is attractive to business travelers. It is hardly surprising that there is considerable interest in transportation and telecommunications. Air transportation interests have expressed their concern that teleconferencing, more than any other single factor, will adversely affect the growth of business travel, which is the most lucrative segment of their market. Other interests are also desirous of knowing more about this complex subject. Telecommunications firms, agencies, and institutions would like to gain an insight into the extent of substitution for market estimation purposes. Government agencies would like to know the impacts on transportation carriers, services and facilities, and energy consumption. In the following sections are presented highlights of the findings of a research study on transportation and telecommunications in which substitution and stimulation were examined (1).

METHODOLOGY

A four-step methodological framework was used to study the nature and extent of the effects of telecommunications on air travel. The research was conducted in the Department of Civil Engineering, Carleton University, Ottawa, Ontario K1S 5B6, Canada.

The initial step required the identification of major sociotechnical factors that affect the interaction of transportation and telecommunications. These are economic and spatial factors; urban and regional development patterns; travel context (e.g., short haul, long haul); communication needs; human factors (i.e., life-style, values, and attitudes); market pull; incentives for the use of teleconference services; perceived user benefits; quality and cost of telecommunication modes; institutional factors; regulatory policies; and support structure. In the second step, the influence and interrelationships of these variables are investigated. In the third step, knowledge gained through actual experience, surveys, and demonstrations is assessed as trends leading to increased use of teleconferencing. Finally, in the fourth step, trade-offs and travel impacts are investigated.

Because of lack of sufficient data on the use of teleconferencing, formal models could not be calibrated in this research (2, 3). Instead, reliance is placed on interrelationships among the factors studied, attitudinal survey data, and trade-off analyses for drawing inferences about travel and related impacts. Also, in this paper, the scope of travel impacts is limited to air travel. Telecommunications are not likely to influence travel by intercity bus and automobile because these modes are chosen by the business traveler for reasons other than saving time and are therefore not considered competitors to teleconferencing. Passenger rail in short-haul corridors, on the other hand, may potentially be affected. However, such impacts are not covered here.

ECONOMIC AND SPATIAL FACTORS

Travel and telecommunications expenditures of organizations are affected by general economic conditions. The availability of investment capital for the development of in-house studios is also influenced by economic conditions. Travel and telecommunications expenditures could be viewed as competitors for corporate budget funds. Recent interest in all forms of teleconferencing has been due in part to the recent recession that caused businesses to look for ways to reduce costs and improve productivity. Also, if there were energy supply problems, travel would be curtailed and the prospects of teleconferencing would increase.

Spatial factors in association with the availability and quality of telecommunications systems have an impact on the interaction of travel and teleconferencing. Experience in many regions

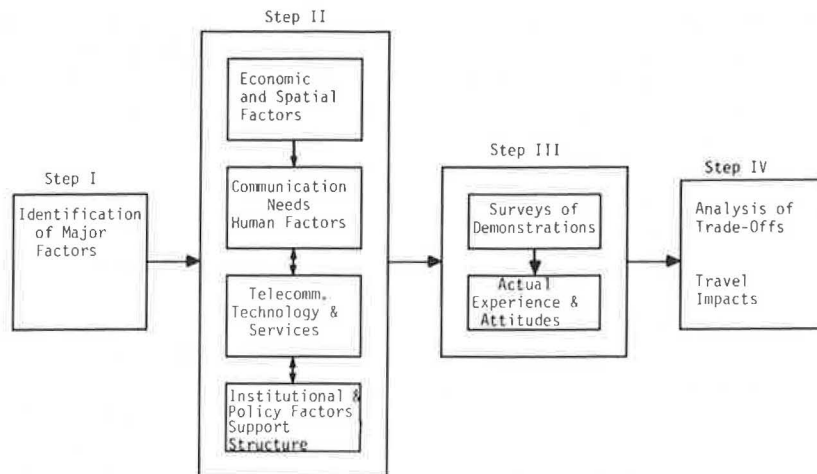


FIGURE 1 Study methodology.

in North America, the United Kingdom, and Europe suggests that telecommunications and regional development structure are mutually reinforcing. Improved telecommunications have changed business locational decisions and could potentially serve as a complement to business travel—with possible substitution and stimulation effects. Clustering of businesses and their proximity to common teleconference studios in central or satellite urban developments has the potential of inducing travel substitution.

Travel context has an effect on the interaction of travel and telecommunications. Consequently, substitution or stimulation of travel may be nonuniform for short-haul corridors, long-haul (domestic, transborder, international) routes, and Canadian North-South (low-density) travel contexts. Reasons for this include cost differentials, inconvenience of same-day return, relatively low incentive to make frequent trips to the same destination (except for frequent flyer incentives offered by the airlines), and attractions of international travel—especially for the infrequent traveler. Therefore it is appropriate to study the influence of travel context on the extent of substitution and stimulation.

COMMUNICATION NEEDS AND HUMAN FACTORS

A cornerstone of research on the interaction of transportation and telecommunications is the identification of communication needs that could be met effectively by telecommunications. Substitutable communication needs are identified on the basis of the nature of the tasks to be performed and the communicators' behavioral attitudes and preferences of medium, which are partly influenced by the attributes (e.g., quality) of the medium. Since 1970 laboratory experiments and actual demonstrations have been carried out in Canada, the United States, the United Kingdom, Europe, Australia, and Japan to study the effectiveness of a number of kinds of telecommunications relative to in-person meetings. Coupled with survey data on estimated frequencies of different types of meetings, these findings led to the identification of substitutable communication needs.

Communication needs substitutable by teleconferencing include

- Information exchange (routine): sales meetings, staff training, new product or service introductions, project control and status reporting, and committee meetings.
- Information exchange (recent events): problem solving, remote consulting, scientific and technical information, and seminars.
- Exploratory communications: identification and review of considerations basic to establishing a policy or plan of action.
- Planning: formulating a plan, establishing priorities, and selecting alternative courses of action.
- Implementation oriented: administrative activities—development, assignment of responsibilities for action (delegation of work), and scheduling.
- Crisis decision making (crisis management): speed necessary—almost instant decision required.
- Social services including those for handicapped persons.
- Medical information exchange.

Communication needs substitutable by other telecommunication systems include

- Messages and mail: electronic messaging and mail.
- Ordering items: teleshopping.
- Banking: electronic funds transfer.
- Forms processing, transmission of text and word processing, joint authorship: teletex.
- Transmission of data: data communications.
- Education: telecourse.
- Voting: interactive community television.

Most studies suggest that teleconferencing could be used effectively for about 40 to 60 percent of all business meetings. Meetings with substitution potential can be broadly classified as information transmission and exchange, planning- and implementation-oriented tasks, and exploratory (problem-solving) communications. For a number of communications, face-to-face, in-person meeting has been considered necessary for reasons that include the nature of the task (i.e., negotiations, crisis decision making, or decision making with risk) and the necessity of the proper atmosphere for in-person meetings (e.g., friendly relations, courtesy, personal contact). Recent research implies that transactional tasks (negotiations) could be

carried out as well through teleconferencing (4). This increases the percentage of substitutable business meetings to 70 percent or more. Telecommunication services would be a clear choice in cases involving urgency in decision making (e.g., crisis decision making, crisis management).

A number of nonbusiness communication needs are regarded as substitutable [e.g., social services, education, medical information exchange and training, voting, and shopping (for specific items)]. Social and recreational travel is generally regarded as nonsubstitutable. However, interesting observations have been reported in the literature that suggest both substitution and stimulation of travel. Telecommunications could induce travel for nonbusiness reasons as well as for such business reasons as implementation of decisions and negotiations that evolve from teleconferencing.

Human factors play a key role in the acceptance of teleconferencing as a substitute for face-to-face meetings involving travel. Likewise, telecommunication-induced travel is influenced by human factors. Research indicates that increased attention to human factors is essential when implementing teleconference systems. Specifically, promotion and software should be approached with special attention devoted to human factors.

ADVANCES IN TELECOMMUNICATIONS

A large number of advanced telecommunication services have been made possible by the confluence of the technologies of computers and communications. Teleconference services in Canada and the United States range from simple audio facilities through narrowband slow-scan (freeze-frame) video systems to full-motion two-way color video augmented with stereo audio and conference facilities.

Narrowband systems include

- **Audio teleconferencing:** Voice-only communication using appropriate equipment for voice amplification and transmission to enable multipoint communication among individuals and groups. A conference telephone call is the simplest form of audio teleconferencing.
- **Teletyping:** Electronic transmission of writing to remote television monitors, often through normal telephone lines (e.g., the "electronic blackboard").
- **Telecopying:** These devices transmit page-sized photocopies over normal telephone lines or special transmission circuits. Depending on equipment and system capability, transmission time could be from less than 1 to 3 min.
- **Electronic mail and computer-based conferencing:** These are keyboard text-based group communications media in which all exchanges take place through a computer terminal. The participants are typically not present simultaneously.
- **Teletext or videotex:** These are hybrid communications systems that use television technology in a variety of ways to make possible access on demand to stored information. These systems offer flexibility in selecting and viewing the information.
- **Slow scan (freeze frame):** This system allows still pictures to be transmitted over narrowband channels such as the regular telephone network and displayed on monitors in remote loca-

tions. In case of transmission (of participants, visual aids, or objects) over the regular telephone network, transmission times range from 6 sec for low-resolution black-and-white pictures to 5 min for high-quality color.

Broadband systems include

- **Slow-scan video:** It is the same system described under narrowband systems; it is often categorized as a broadband system because it uses broadband transmission.
- **Interactive cable television:** It is a mass communication medium with various capabilities and flexibility for audience involvement.
- **Video teleconferencing:** Capabilities include full-motion (compressed and noncompressed) and completely interactive television linking participants on a point-to-point basis and full-motion point-to-multipoint transmission coupled with interactive audio capability. Transmission is via microwave, coaxial cable, cable television system, and satellites. Widespread availability of fiber optics would increase the options for signal transmission.

Recently, videoconference systems have improved significantly as a result of technology that reduces transmission capacity (requirements) and cost. Satellite-based videoconference systems for domestic, transborder, and international communications were introduced in commercial services in the early 1980s. International teleconferencing has also become technically advanced because of specially designed picture-processing and signal compression equipment (i.e., codec) that overcomes the difficulty of different videoconference equipment standards in North America and Europe.

Future developments in teleconference technology include full audio stereo transmission with close approximation of physical presence, high-speed document transfer, and integrated graphics projection; compression techniques applied to freeze-frame video and associated autographic systems; higher-power high-capacity satellites; improved small-sized earth stations close to end users; time division multiple access (TDMA) for satellite capacity use; multipoint (many-to-many) videoconferencing; more efficient video compression devices; high-quality video (resolution) and stereo sound; life-sized screen projection; regular satellite access by most organizations; high-capacity local lines; availability of conference rooms with minimum access time; mobile facilities at short lead times; computer and videotex applications in video conferencing; and fiber optics (e.g., digital fiber optics systems for long-haul transmission) (1).

Also, developments in automated offices (including audiographic work stations with desk-to-desk or desk-to-conference room teleconferencing, voice recognition, and numerous other innovations), mobile telephones, local area networks (LANs), digital communications, and the Integrated Services Digital Network (ISDN) in association with satellite techniques (for voice, data, and video services) will result in further advances in telecommunications (1).

Improved quality, reduced cost, increased availability, and increased convenience of telecommunications services are likely to enhance travel substitution potential. Stimulation of travel, although to a lesser extent than substitution, is also

probable. Until now, and even at present, a number of constraints (e.g., the high cost of videoconferencing) have inhibited the growth of teleconferencing. Further developments in technology coupled with favorable developments in other factors are likely to make widespread use of teleconferencing practical. Furthermore, the current "technology push" as well as "market pull" are expected to accelerate acceptance of teleconferencing.

INSTITUTIONAL AND REGULATORY FACTORS

A number of favorable developments in institutional factors are contributing to increased availability of teleconference systems. These include (a) ease of transborder transmission; (b) sharing of satellite capacities between Canada and the United States; operating agreements (transborder, international); and (c) cooperation of the post, telephone, and telegraph agencies in Europe with Teleglobe Canada and U.S. carriers. A number of institutional constraints, however, still remain.

Regulatory policies in Canada and the United States have already influenced the development of teleconferencing services (e.g., terminal attachment and interconnect decisions). A more competitive environment, as the result of deregulation or regulatory reform, could result in diversified, improved service at reduced cost. Future policy developments in Canada with respect to long-haul versus short-haul rates, satellite rates and capacity allocations, further interconnect activities, relaxed market entry, and other pro-competitive regulatory reforms are likely to contribute to growth of teleconference systems.

Support structures in the form of integrated sets of activities can help to promote successful applications and the integration of teleconferencing into an organization. Examples include software development, training, and promotional activities. Such activities are already under way. Favorable institutional and policy developments would enhance the environment for successful support structures.

ACTUAL EXPERIENCE, SURVEYS, AND DEMONSTRATIONS

There is a trend toward increased use of teleconferencing. A majority of user companies surveyed plan to increase their use of teleconference systems in the near future. In Ontario, about 72 percent of companies surveyed use some form of teleconferencing (5). Sixteen percent of Ontario users of teleconference systems use computer conference or electronic mail. Estimates for slow-scan and videoconference systems are not available. However, these are believed to account for a relatively small percentage of use (6). Audio teleconferencing installations and usage exceed those of all other electronic modes of conferencing. Freeze-frame and videoconference facilities have been installed in a small number of public and private locations. The use of private facilities of this type is rather limited whereas trends in the use of public services are relatively more pronounced (6).

Revenue derived by telecommunications carriers from teleconferencing, as a percentage of total income, is about 1 percent. For a number of interrelated reasons, including lack of aggressive marketing and high cost, full-motion, compressed

videoconference services of telecommunication carriers have not been used extensively in the past. Their usage is expected to grow in the future as a result of technical and cost improvements. Users of teleconferencing, ranked on the basis of their use, are business, governments (federal and provincial), universities, service industry (banks etc.), and the residential sector (1). The typical user firm in Ontario is large, with six to ten branches and 500 to 1,000 employees.

Teleconferencing, according to the Ontario survey of companies, is used by almost all administrative and finance departments (92 percent) and is also used extensively by marketing and sales groups (77 percent). About 50 percent of all user firms suggest that their personnel, data processing, production, and engineering research departments use teleconferencing. Teleconferencing is also heavily used for information exchange (92 percent of users). Specifically, a majority of users use teleconferencing for problem solving (66 percent) and planning (58 percent). Other uses are committee and staff meetings (42 percent) and inspection or supervision and training (21 percent) (5, 6).

A survey of North American organizations carried out by the University of Michigan revealed that travel costs of respondents had decreased as a result of teleconferencing (7). Survey results obtained from the Ontario study suggest that about 25 percent of teleconference users are experiencing a drop in travel, which is attributable to teleconferencing. On the other hand, 2 percent of users see an increase in business travel as a result of teleconferencing. For those who indicated a reduction in trip making, the average decrease in business travel amounted to about 20 percent (5).

TRADE-OFFS

Modal Attributes

Attributes considered by consumers in assessing the perceived desirability of travel versus teleconferencing are given in Table 1. The same attributes are likely to be considered in travel stimulation decisions. Cost of air travel by Canadian trunk carriers has been increasing, since 1971, at a rate that is slightly lower than the consumer price index. Regional air carriers have experienced cost increases that are greater than general inflation since 1979 (Figure 2). During the 1980s, air fares are expected to reflect the effects of a large number of factors including a competitive environment resulting from deregulation policies and stable fuel prices. Here it is assumed that air fares, in constant dollars, will decline by about 10 percent by the end of the decade. During the 1990–2000 period, fares are likely to rise again in real terms as a result of increases in fuel and aircraft (capital) costs. Other costs incurred during travel, namely accommodation, meals, and local transportation charges, are assumed to grow at the level of general inflation.

The influence of technology in reducing the cost of telecommunications has already been noted. The likely trend is exemplified by the international telephone charges shown in Figure 2. In the case of domestic intercity business telephone charges, the drop in price has not been as impressive as for international service because of the distance factor and possibly

TABLE 1 SELECTED ATTRIBUTES OF TRANSPORTATION AND TELECOMMUNICATIONS (level-of-service variables)

| | Transportation | Telecommunications (teleconferencing) |
|-------------------------|---|--|
| Cost to user | Door-to-door travel, accommodation, and meals | Service including access to and egress from studios |
| Time | Total door-to-door travel time, layover time during normal working hours, and meeting time ^a | Travel time to and from public studio, waiting time (if applicable), and conference time ^a |
| Service availability | Availability of service on demand (probability of getting service at desired time, frequency, convenient departure and arrival times) | Availability of service on demand (probability of getting at desired time), availability of required features of service (e.g., graphics capability) |
| Comfort and convenience | Comfort—seating comfort and availability, access and egress comfort, service reliability (on-time arrival), changing vehicle (transfer) | Studio design for user physical and psychological comfort, service reliability (reliability of equipment), quality and capability of service |

^aTime spent in a teleconference meeting is generally less than that spent in a face-to-face meeting.

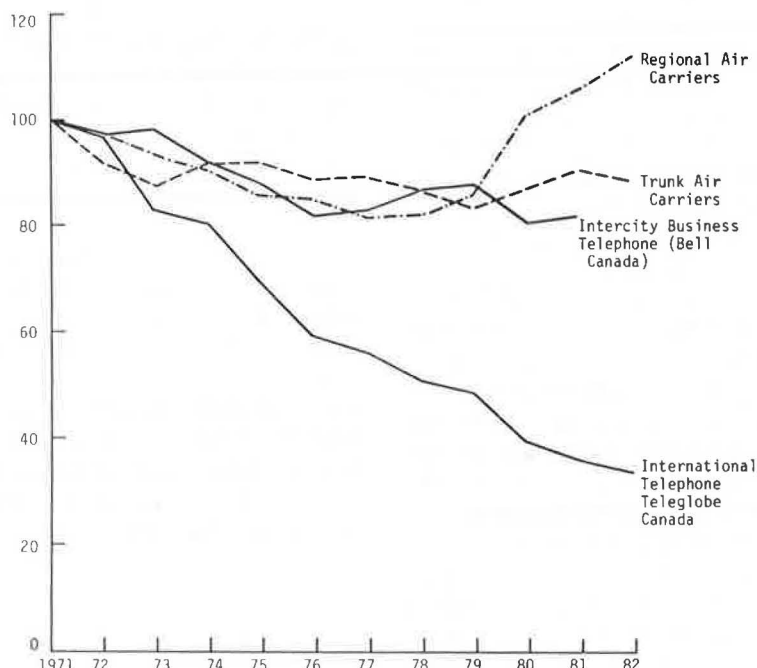


FIGURE 2 Changes in unit revenue of air carriers and price of telecommunication services (in constant dollars, 1971 = 100).

the practice of cross-subsidizing urban services from the overall revenues of the carriers. In the United States increased competition and the use of modern technology have resulted in reduced intercity business rates.

The cost of teleconferencing is likely to drop in the future. Transmission costs, which account for about 50 percent of total end-to-end costs, are expected to be about one-third of their 1985 level (in constant dollars) by the end of the decade. Consequently, teleconference charges in 1990 would be two-thirds of their 1984–1985 level. During the 1990–1995 period, other cost reductions are expected as a result of increased use of facilities (resulting from increased traffic) and shared use of local and space segment components. Therefore teleconference charges in 1995 are projected to be 50 percent of the 1985 tariff (in real dollars). For the 1995–2000 period, no further cost reductions are projected.

Table 1 gives three components of time related to in-person meetings. Among these, travel time and layover (business hours) time are generally the most pronounced. For instance, depending on travel distance, a 4-hr business meeting could easily necessitate a 2-day absence from the office. Studies show that most managers spend as much as 8 percent of their

time in travel to meetings. Also, as much as 50 percent of a manager's time is spent in scheduled meetings. Because teleconferences are better organized and take less time per meeting, a manager need not spend as much time teleconferencing as would be required for in-person meetings.

As for access to public studios, there have been conflicting reports about the inconvenience encountered by customers. A recent survey by Teleglobe Canada contradicts findings of other studies by suggesting that a centrally located accessible studio would not be a constraint to the use of teleconferencing. It was found that 70 percent of respondents would use a conveniently located studio (8). Because of the up-front investment required for private facilities, the option of developing in-house studios is not attractive. Also, local video wideband networks, which would be required to serve customer premises, are scarce.

Service availability is a significant attribute of teleconferencing. Although, in theory, arranging a teleconference takes less time, the availability of desired facilities could be a problem. According to Teleglobe Canada studies, about 40 percent of all business meetings involve the exchange of documents, and 65 percent of such meetings require that information be

presented visually. Teleconference facilities therefore must be well equipped with conference support equipment for maximum effectiveness.

Comfort, convenience, and reliability attributes of teleconference systems have been improving because substantial research, development, design, and planning efforts have been focused on technical and human factors. Also, human factors are becoming favorable to teleconferencing because technical and managerial personnel are becoming increasingly familiar with computers and communications. The same cannot be said of air travel. It is becoming difficult to maintain a level of service attractive to the business traveler because of increasing congestion at busy airports and on access and egress facilities.

Benefits of Teleconferencing

The benefits of teleconferencing have become better known through research studies and demonstrations. Productivity improvements result from time savings and, possibly, efficient communications. Meetings conducted as teleconferences are shorter, better organized, and arranged at shorter notice than are face-to-face in-person meetings. Teleconferencing allows communication when in-person meeting is infeasible (e.g., urgent decision required). For a number of tasks, teleconferencing is a reasonable simulator of in-person meetings. Faster decision making and easy access to additional resource persons are among the highly valued benefits of teleconferencing.

It can be used for improved planning for in-person meetings, and rapid follow-up meetings can be arranged for the implementation of decisions.

For multibranch organizations, the quality and quantity of communications among branch offices and between branch offices and headquarters can be enhanced. Teleconferencing makes possible improved control by management in central (headquarters) locations over branch operations. Participation of employees in dispersed offices is made possible by teleconferencing at reasonable cost—which is likely to strengthen their commitment to the organization.

Travel costs and associated inconveniences can be reduced under appropriate circumstances and conditions. According to the Telelobe Canada survey of organizations in Ontario and Quebec, the travel cost savings benefit of teleconferencing was considered the most important criterion for selection of this mode by 97 percent of respondents. In relative terms, 82 percent of respondents credited teleconferencing with saving travel time and thereby enhancing productivity (9). It offers opportunities for professional education and training, integration with other automated office technologies, planned decentralization of organizations and land use developments, energy conservation, enhanced communication with sales personnel, and marketing. User companies could enhance their image as innovators, and governments could extend their services on a cost-effective basis through the applications of teleconferencing (10).

A number of disadvantages have been perceived: lack of personal interaction that may be regarded as essential for

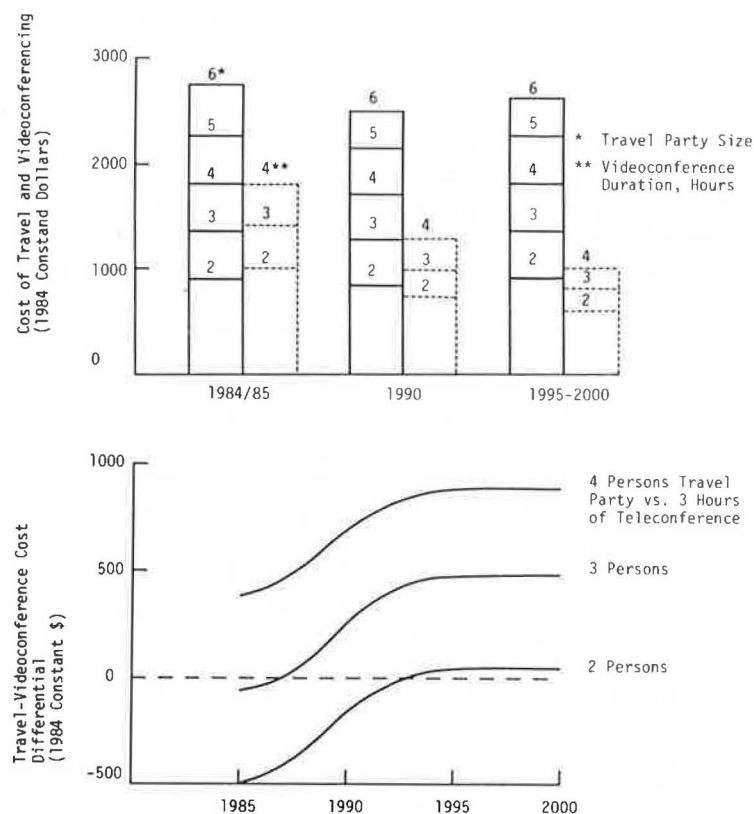


FIGURE 3 Travel versus teleconference cost differential, Toronto-Montreal.

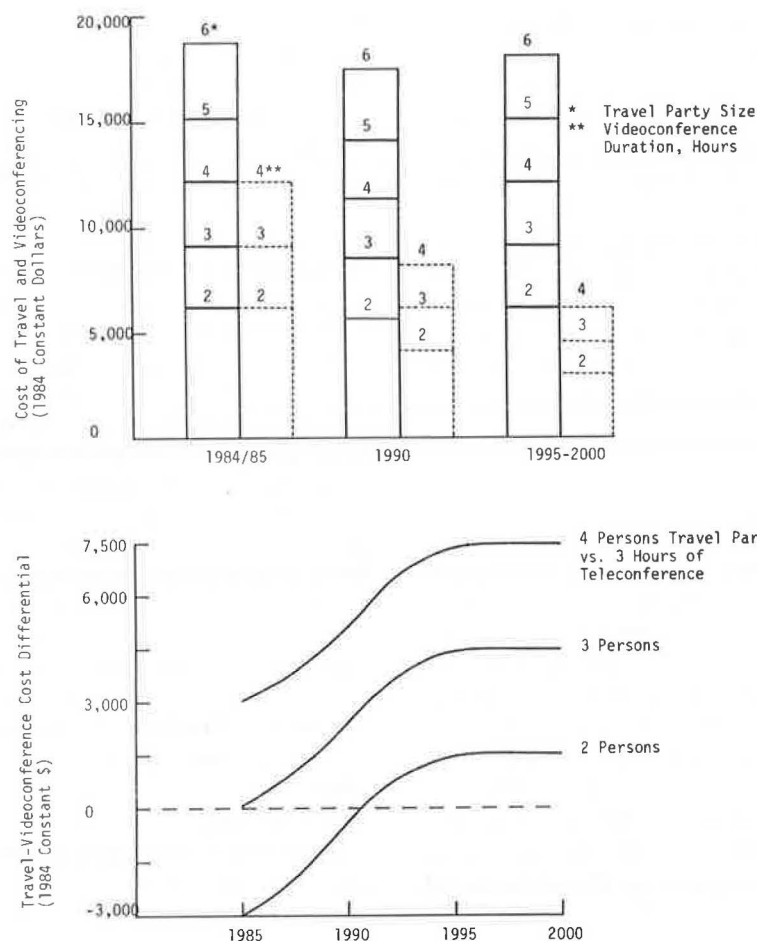


FIGURE 4 Travel versus videoconference cost differential, Toronto-London, England.

improvement and morale, working relationships, and the like; lack of social or recreational opportunities at destination, which are a by-product of travel; a feeling of frustration with teleconferencing; and perceived limitation of level of exchange for some tasks—given the quality of available systems.

Service and Cost Differentials

Cost and service (including time) are perceived by potential users of teleconferencing as its most important attributes. This implies that cost and service differentials are the most important determinants of travel substitution decisions. Cost and service differentials between air travel and teleconferencing are analyzed for selected travel routes. Generalized costs of air travel and teleconferencing are computed and compared for 1985, 1990, 1995, and 2000 (Figures 3 and 4). Cost projections were made according to the analyses presented earlier. Generalized cost differences were developed by including time costs and costs of accommodation and meals.

As expected, the cost difference between travel and teleconferencing increases over time because of a relative decrease in teleconference costs. Sample results shown in Figures 3 and 4 indicate that, at the 1985 level, teleconferencing does not yield economic benefits. However, the economic desirabil-

ity of teleconferencing increases over time. For a given year, generalized cost savings increase because of an increase in the size of the travel party. At the 1984–1985 tariff levels, teleconferencing costs more than travel in the case of a 3-hr teleconference vis-à-vis travel by two persons. As the size of the travel party increases, economic benefits become much more pronounced for long-haul routes than for short-haul corridors.

North-South travel in Canada by scheduled air service on low-density routes is quite costly. In those cases in which charter air services are the only means of travel, costs are even higher. Because a high proportion of travel to and from northern Canadian regions is for business purposes, including government and institutional travel, the substitution of teleconferencing for a part of such travel would likely result in substantial monetary savings. Other factors, such as enhanced communications resulting from more frequent teleconferences and the avoidance of inconveniences associated with travel, would provide further incentives to substitute telecommunications for part of travel.

CONCLUDING REMARKS

Prediction of the extent of substitution and stimulation is fraught with risk because of the complex nature of these

TABLE 2 EFFECTIVENESS OF COMMUNICATION MEDIA AS INDICATED BY LABORATORY AND FIELD TESTS

| Type of Communication | Two-Way Audio | Two-Way Audio Plus Graphics | Two-Way Audio, One-Way Video | Two-Way Audio Plus Video | Face-to-Face |
|--|---------------|-----------------------------|------------------------------|--------------------------|--------------|
| Intraorganization (mostly acquaintances) | | | | | |
| Operating discussions | High | High | High | Very high | Best |
| Executive discussions | Low | Average | Average | High | Best |
| Interorganization (mostly strangers) | | | | | |
| Operating discussions | Low | Average | High | High | Best |
| Executive discussions | Very low | Low | Low | Average | Best |

behavioral phenomena. Although the technology of telecommunications is far from mature, there is significant evidence of user satisfaction (Table 2) even in its present form. The economic and general availability attributes are, however, not favorable at this time. Also, efforts of telecommunications carriers to promote and market their teleconference services are relatively low keyed in comparison with those of air carriers. Consequently, it is hardly surprising that there is

limited actual experience with the effects of teleconferencing on air travel demand.

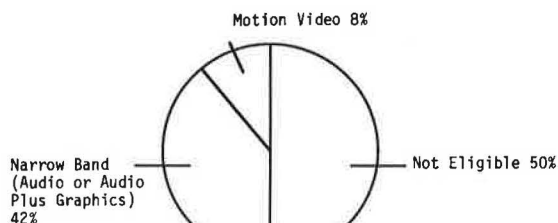
Analyses and survey data reported in this paper provide a sufficient basis for stating that, under favorable conditions in the future, teleconferencing is likely to replace some air travel and that stimulation of travel is also likely to occur—although to a lesser extent. This research also provides a reasonable basis for discussion of the extent of travel impacts, although formal analytical models cannot be developed because there has been insufficient experience with communication mode choice decisions. Analysis of the generalized cost differential of travel versus videoconferencing suggests that, on the basis of projected economic benefits (i.e., savings), travel substitution is probable (Figures 3 and 4).

Numerous laboratory and field observations are consistent about the substitutability of teleconference systems for in-person face-to-face meetings (Figure 5). About 10 percent of all business meetings could be carried out effectively by videoconferencing. Because videoconferencing is an effective simulator of face-to-face meetings, it is probable that 10 percent of business meetings may not require travel.

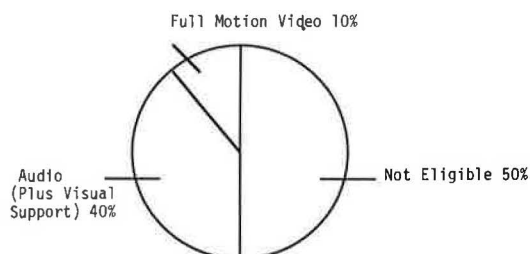
Surveys of attitudes suggest that the upper limit of the level of substitution is 20 to 25 percent of business travel. The upper limit for the stimulation of business travel is 2 percent of base travel. It is believed that the reliability of attitudinal survey results in the "real world" is about 50 percent. These estimates obtained from attitudinal surveys should be reduced by a factor of 2. There is another reason for reducing the extent of replaced travel suggested by surveys: research indicates that 50 to 60 percent of participants in teleconferencing would not have been present if an in-person meeting (involving travel) had taken place.

Ad hoc teleconferencing (point to multipoint) is expected to have differential effects on air travel. Although travel substitution is likely on trunk routes, feeder air links would experience stimulation of travel due to travel by participants to teleconference sites.

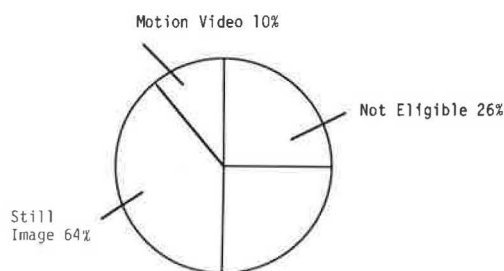
On the basis of the foregoing, it is projected that teleconferencing may substitute for as much as 11 percent of business travel by air. A 1 percent level of stimulation of business travel is projected for the air mode. The balance of substituted and stimulated trips leads to an upper limit of 10 percent of business travel replaced by teleconferencing. The profiles of cost differentials and market penetration of teleconference systems suggest that the curve of growth of replaced travel will



British Research By CSP, London (4)



Ontario TEMP (The Problem Solver) (10)



Satellite Business Systems Studies (USA)
Source: Harkness & Burke (11)

FIGURE 5 Behavioral eligibility of meetings.

be S-shaped. Travel replacement is likely to be phased—taking as much as two decades to reach its potential and, of course, subject to technological developments described in this paper and marketing and promotional efforts of the carriers.

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